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Munster Technological University

Research to Impact

2023 Posters booklet

Athena SWAN
Bronze Award
Legacy Award

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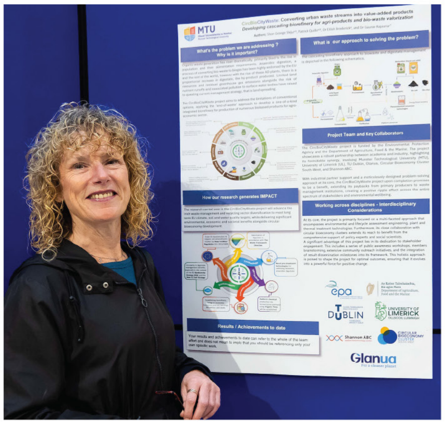
Exploring the benefits of Willow bark extracts for skincare
What is our approach to solving the problem?
Project Team and Key Collaborators
Working across disciplines - Interdisciplinary Considerations


MTU
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What is our approach to solving the problem?
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INTRODUCTION

This e-booklet is derived from a showcase of 65 posters presented at the “MTU Research to Impact” event in October 2023. It provides an insight into the wide breadth of expertise in MTU that spans Creative and Performing Arts & Media, Health & Social Sciences, Engineering, Business and Science & Informatics.

This is also an e-booklet with a difference because each poster uses the same format and answers the same six questions:

What’s the problem we’re addressing and why is it important?
What is our approach to solving the problem?
Who are the project team and collaborators?
How is the project interdisciplinary?
How does our research generate impact?
What results or achievements have we made to date?

This approach where every poster addresses the same questions makes this “Research to Impact” e-booklet unique in the Irish higher education landscape. Importantly, the questions are aligned with how national and European research funding agencies are now assessing research propositions.

The geographical distribution of MTU’s campuses means we are embedded in urban, rural and coastal communities. This puts us in a prime position to build multidisciplinary teams of researchers who thrive on solving complex interrelated problems that will make our region a “globally connected exemplar of healthy, sustainable and responsible living”. The posters themselves represent the efforts of over 200 researchers from over 80 countries, reflecting a diversity of the research community that is a real strength for MTU.

We live in a world which faces many challenges. We are familiar with many of these – climate change, food and water security, health, privacy. MTU researchers’ ambitions to better understand how our world operates, from the forces that determine our climate, to the physiology that influences our health and our changing social interactions, means we will contribute to a better present and a brighter future for all. That aspiration, which can be realised, is why “Research to Impact” is so important to everyone.

We hope this e-booklet will provide you with information and inspiration.

-The Research Office Team

MEET THE TEAM

Dr. Niall Smith - Head of Research Cork Campus and Head of BlackRock Castle Observatory

Dr. Siobhan MacSweeney - Head of Research Kerry Campus

Elizabeth Carroll-Twomey - Senior Research Officer/ cRIS Project Coordinator

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ICT

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OPEnS – Optimise Predict Energy Saver System

Authors: Dr C. Lynch, C. O'Leary, G. Smith, M. Caballero, Dr P. Q. An

What's the problem we are addressing ? Why is it important?

Energy Managers in high energy-using organisations are facing dual challenges in seeking to reduce their energy bills while simultaneously meeting Green House Gas (GHG) protocol carbon reduction targets.

OPEnS or the Optimise Predict Energy Saver platform was designed with the premise being that if you know what your energy demand is, what the wind or solar power generation output is likely to be, and what the energy prices are, then one should be in an optimal position to capitalise on all potential savings, and OPENS automates this process. It has the capacity to optimise based on energy cost, carbon emissions or both simultaneously.

How our research generates IMPACT

OPEnS, a grid-connected smart network system encompassing energy market-tracking tariff prediction technologies used in conjunction with an auxiliary battery supply and any customer-own electricity generation assets, is designed to bridge the gap between when renewable energy is generated and when we want to use energy. For example, at a domestic level, users predominantly have high energy requirements early in the morning before they go to work, and late in the evening when they are making dinner. However, the majority of solar energy is generated during the day when most of us are at work, and wind power generally prevails at night when most of us are asleep.

So, to bridge this gap, OPEnS uses predictions of renewable energy generation, electrical load demand and energy prices, with an auxiliary battery supply to facilitate load shifting to deliver an optimal schedule as to when to charge or discharge your battery in order to bridge this gap. OPEnS can maximise the contribution of renewable energy supply to the overall energy mix based on cost or CO_2 emissions or both.

OPEnS can be used in Industrial, Commercial and Domestic settings and is particularly attractive to high energy-using organisations. In using OPEnS, customers can significantly reduce their energy costs by 20% (Industrial/Commercial customers) and by 50% (Domestic customers), by empowering customers to switch to the Integrated Single Electricity Market (I-SEM) tracker tariffs and to operate cost-effectively via automated control of their respective energy system assets.

Results / Achievements to date

OPEnS

To date, the system is currently being trialled by Shannon Vale foods, Clonakilty, Cork (300 kWp PV system), a large international German-based supermarket chain (150kWp PV array) and a domestic dwelling, at Kildorrery, Cork comprising an 18 no. 380Wp panel dual aspect PV array.

The energy savings market is a huge global market. Once the team has validated the business model in the retail sector the team plan to target the high energy using MNC segment. This segment is particularly focused. The team plan on raising seed investment in 2024 in order to launch operations, begin sales and to recruit key personnel.

What is our approach to solving the problem?

Evaluated on the Nimbus microgrid testbed, c.f. Figure 1, OPEnS takes an integrated machine learning approach - takes account of renewable energy assets, storage devices and merges them with price, emission and power demand forecasts to generate optimum operating schedules relative to the highly accurate means of predicting the future hourly market cost of electricity. OPEnS is a Decision Support Platform which automates customer decisions on when to use / buy lower-cost underutilised renewable energy from the grid or from the clients' generating source and when to schedule auxiliary battery supply for equipment at a high grid cost or high-usage periods. This enables energy managers to meet energy cost and carbon emissions targets.

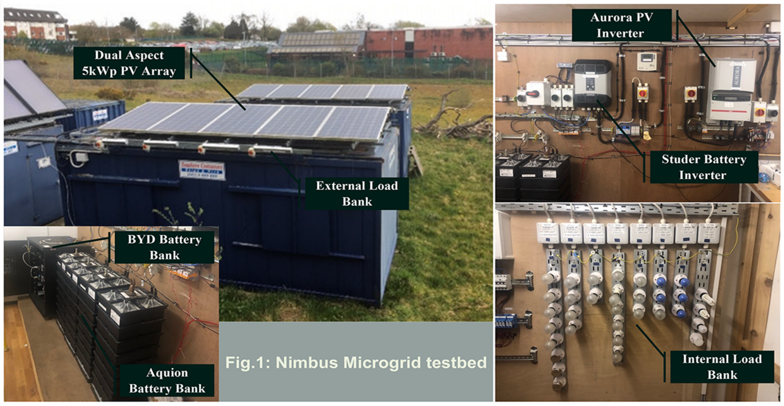

Fig.1: Nimbus Microgrid testbed

Project Team and Key Collaborators

Funded under the Enterprise Ireland Commercialisation Fund, and in collaboration with our project trial partners, Lidl Ireland and Shannon Vale foods, the Nimbus Research Centre, located in MTU, is performing state-of-the-art research and development to address the current energy grid challenges.

Shannon Vale Foods LIDL Nimbus Research Centre

This primarily involves the Data Science team in Nimbus, led by Dr Lynch, and Dr An of the Ho Chi Minh City University of Technology (HCMUT) Vietnam National University, Ho Chi Minh City, Vietnam, who are actively involved in research topics in machine learning, deep learning, optimisation, scheduling and resource allocation.

Working across disciplines - Interdisciplinary Considerations

In is envisaged that the algorithm developed in this research will be integrated into a customer-facing platform that will be used by utility managers and prosumers to determine optimal actions to be taken regarding their energy asset portfolio. To this end, this project will become increasingly multi-faceted over time with elements of software development, artificial intelligence, data science, user experience (UX) and business development.

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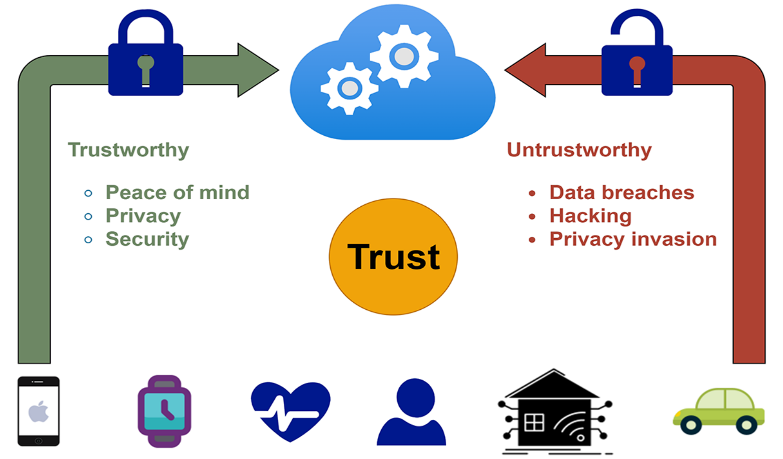
Can you Trust your smart device?

How to ensure secure and trustworthiness of smart devices and prevent unauthorised access?

Authors: Indika Dhanapala, Tharindu Ranathunga, Sourabh Bharti, Bernd-Ludwig Wenning, Alan McGibney, and Susan Rea

What's the problem we are addressing ? Why is it important?

Smart devices are transforming our lives, but Trust concerns persist.



Trustworthy

- Peace of mind
- Privacy
- Security

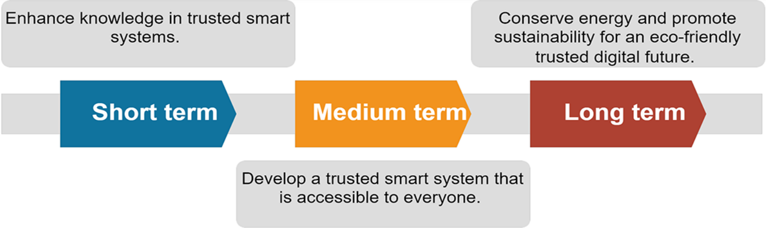
Trust

Untrustworthy

- Data breaches
- Hacking
- Privacy invasion

Ensuring Trust in smart devices and applications is essential for your security and privacy.

How our research generates IMPACT



Enhance knowledge in trusted smart systems.

Conserve energy and promote sustainability for an eco-friendly trusted digital future.

Short term

Medium term

Long term

Develop a trusted smart system that is accessible to everyone.

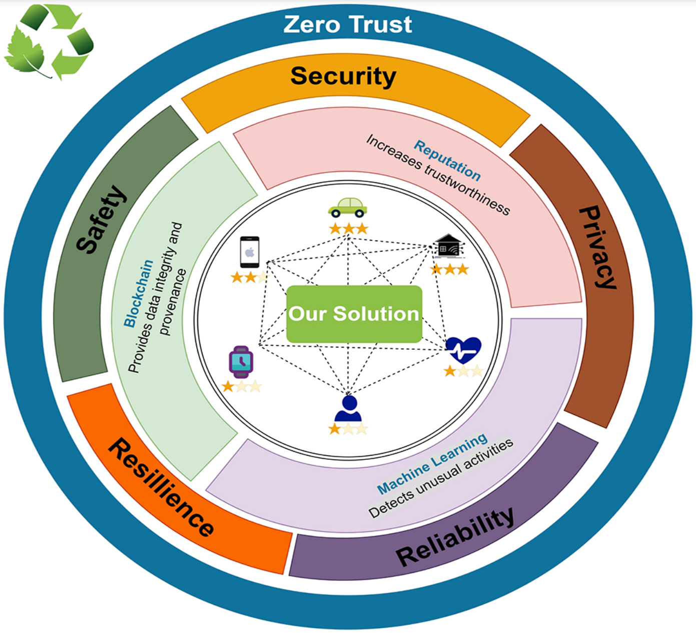
Project Team and Key Collaborators

- Research Team at the Nimbus Research Centre: Dr. Indika Dhanapala, Dr. Tharindu Ranathunga, Dr. Sourabh Bharti, Dr. Bernd-Ludwig Wenning, Dr. Alan McGibney, and Dr. Susan Rea.
- Our research:
  - ensures that your data remains private and secure when using our trustworthiness techniques for smart devices and applications.
  - aligns with "Safeguarding public interest and trust in the digital world" section in the "Creating Our Future" report by the Government of Ireland.

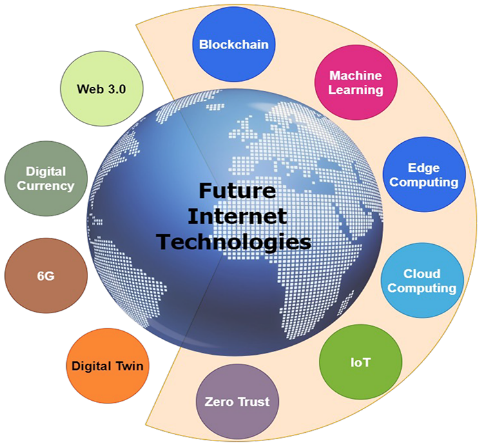
Working across disciplines - Interdisciplinary Considerations

Through engaged research we create technology solutions with the end users of this technology, which ensures that our solutions meet their needs. We are creating a flexible security solution that can help end users in many different fields.

What is our approach to solving the problem?


Zero Trust
Security
Privacy
Reliability
Resillience
Safety
Reputation
Increases trustworthiness
Blockchain
Provides data integrity and provenance
Machine Learning
Detects unusual activities
Our Solution

Smart devices are not automatically trusted. Interaction depends on past activities and ongoing activities are continuously monitored to identify malicious behaviours to ensure safe and secure operation.


Future Internet Technologies
Blockchain
Machine Learning
Edge Computing
Cloud Computing
IoT
Zero Trust
Digital Twin
6G
Digital Currency
Web 3.0

Nimbus Research Centre

Enabling Technologies that Nimbus leverage & extend.

Results / Achievements to date

Implementation

- A Blockchain-based Trust Architecture.
- Energy Asset Management Application (Digiblocks).
- A Reputation Model for Zero Trust and Edge Computing.

Scalability & Energy Saving

- Handle 1000 simultaneous trust updates transactions in less than 10 seconds.
- 8% energy saving for mobile devices within just 4 hours.

Trustworthiness

- Improved resilient to attacks.
- Ability to test and verify smart devices and systems.
- Capability to share threat intelligence.

Science Foundation Ireland For what's next
CONNECT SFI Research Centre for Future Networks
Horizon Europe THE NEXT EU RESEARCH & INNOVATION PROGRAMME (2021 – 2027) European Commission
European Commission

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IoT Platform for Water Management and Actuation in Smart Buildings

Authors: M. Caballero, K. Maxwell, C. O'Leary, G. Smith, A. Sordo, Dr C. Lynch

What's the problem we are addressing ? Why is it important?

Within the realm of business infrastructure management, particularly in facilities lacking automated flushing systems, a substantial portion of the workforce currently finds it necessary to conduct physical site visits. These visits are primarily dedicated to the activation of water valves and the execution of system flushing procedures. At present, the validation of water system temperatures relies on manual protocols, ensuring that hot water consistently maintains a temperature surpassing 50°C, while cold water remains below 20°C.

This meticulous temperature regulation is implemented with the primary objective of preventing the proliferation of bacteria within the system. In instances where temperature readings deviate from the prescribed parameters, the labor-intensive task of outlet flushing becomes imperative to eradicate the potential for water stagnation.

How our research generates IMPACT

Automated flushing systems are currently operational in certain single or grouped water outlets. However, it's important to note that these systems are time-based and not interconnected, consequently lacking real-time monitoring and actuation capabilities. In contrast, some other facilities have adopted temperature and flow control measures, typically at a single or multiple reservoir level. However, these controls are not extended to cover the distributed network of outlets spread throughout a building or facility.

The implementation of the required technological solution, stemming from the research findings of this project, holds significant benefits for both the company and end-users. This initiative presents a unique technological opportunity to introduce a water management service supported by IoT (Internet-of-Things) and machine learning. Such a service aims to ensure the sustainable circulation of water within smart buildings - a concept that aligns with modern environmental considerations.

Results / Achievements to date

As of now, all functionalities of the system have been successfully developed and rigorously validated in laboratory conditions. This encompasses data reading, external actuator management, initial data preprocessing, followed by data transmission to the cloud.

The device is capable of working with different wireless technologies, such as BLE, Wi-Fi, or LoRaWAN - with LoRaWAN being the preferred wireless protocol. This choice is primarily due to its extensive range and minimal power consumption.

Upon arrival in the cloud, the data is presented within an interface equipped to handle error messages relayed by the device, in addition to offering configuration options for various parameters.

With the completion of these phases, the system is now fully prepared for field testing and validation in its intended real-world environment.

What is our approach to solving the problem?

The Nimbus Centre has innovatively crafted a comprehensive IoT platform, tailored for water management within Smart Buildings, encompassing both sensing and actuation functionalities. Following the modular design principle, the designed electronic device, shown in Figure 1, possesses the capability to capture measurements, primarily focusing on water temperature and water flow. Additionally, the device allows for the incorporation of various other sensor types as needed. In addition, it possesses the capability to control an external solenoid valve for the purpose of water flushing.

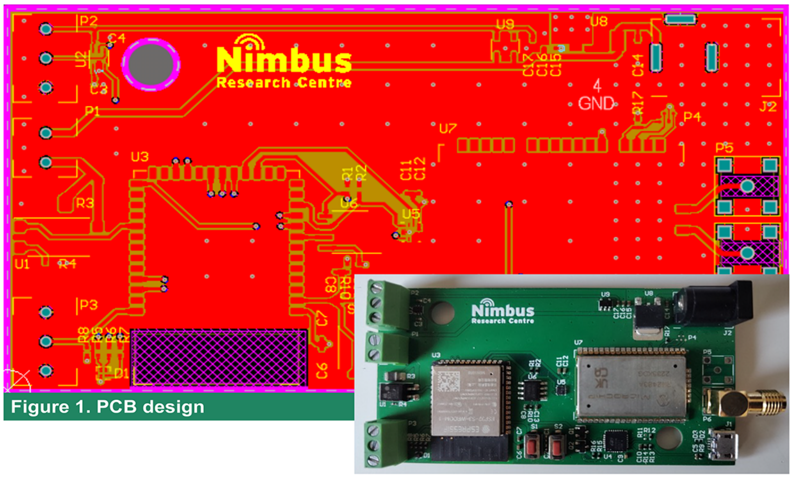
Nimbus
Research Centre
P1
P2
P3
P4
P5
J2
U1
U3
U5
U6
U7
U8
U9
C3
C4
C6
C7
C11
C12
R1
R2
R3
R4
R8
R17
GND
Nimbus
Research Centre

Figure 1. PCB design

The data gathered is transmitted to the cloud, serving a dual purpose of visualisation and analysis, as illustrated in Figure 2 below.

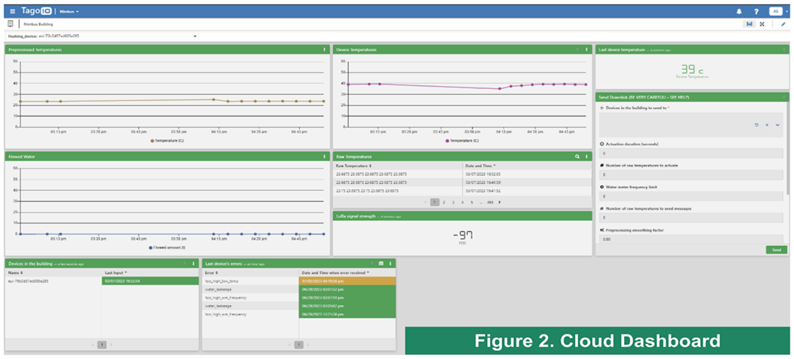
TagoIO
Nimbus
Nimbus Building
Preprocessed temperatures
Temperature (C)
Device temperatures
Temperature (C)
Last device temperature
39 c
Device Temperature
Send Downlink (BE VERY CAREFULL - SEE HELP)
Devices in the building to send to
Actuation duration (seconds)
Number of raw temperatures to actuate
Water meter frequency limit
Number of raw temperatures to send messages
Preprocessing smoothing factor
Send
Flowed Water
Flowed amount (l)
Raw temperatures
Raw Temperature
Date and Time
LoRa signal strength
-97
RSSI
Devices in the building
Name
Last Input
Last device's errors
Error
Date and Time when error received
too_high_low_temp
water_leakeage
too_high_wm_frequency

Figure 2. Cloud Dashboard

Project Team and Key Collaborators

LANDMARK
ENVIRONMENTAL SERVICES

Funding for this project is provided by Enterprise Ireland under the Innovation Partnership Program Express. This collaborative effort involves our client, Landmark Environmental, a dedicated team of experts specialising in Water and Air Hygiene and Nimbus Centre, responsible for spearheading all research efforts.

Working across disciplines - Interdisciplinary Considerations

Beyond its primary objectives, the implementation of the intellectual property generated by this project opens doors to additional value-added services. These may encompass predictive capabilities, such as anticipating pump failures, monitoring water toxicity levels, and offering strategic advice for enhanced water management practices.

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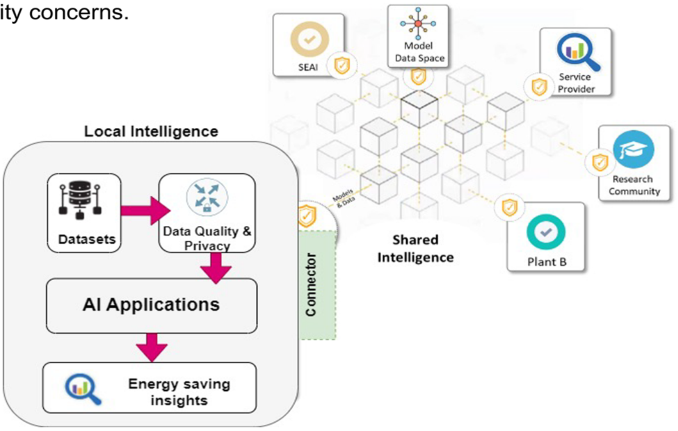
The Green Transition: 'Sharing is Caring' Empowering Collaboration through Trusted Data Sharing

Authors: Sourabh Bharti, Tharindu Ranathunga, Susan Rea, Alan McGibney

What's the problem we are addressing? Why is it important?

Climate action goals require improved energy efficiency in the manufacturing processes as the **industry sector was responsible for 37% of the total global energy use in 2017**. To achieve this, the processes must become smart and all the participants in the process must share data to avoid redundancies. We aim to ensure that the data is shared in a reliable and trustworthy manner to address any data privacy and security concerns.

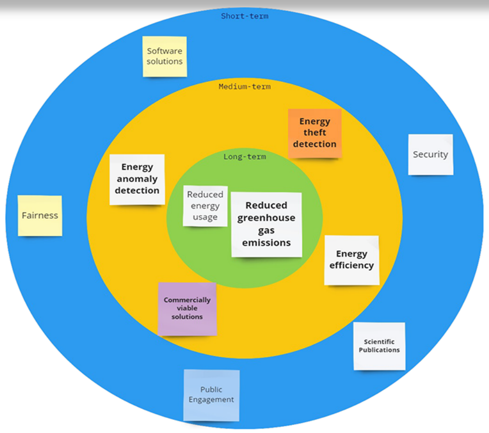

SEAI
Model Data Space
Service Provider
Research Community
Plant B
Models & Data
Shared Intelligence
Local Intelligence
Datasets
Data Quality & Privacy
AI Applications
Energy saving insights
Connector

What is our approach to solving the problem?

DENiM	SmartQC	CORDS
Accelerating **digitalization** to monitor energy flows across complex processes	Data driven **decision support** and data integrity for quality control	**Collaborative** data and knowledge sharing to address energy efficiency in manufacturing

How our research generates IMPACT

This research is well aligned with the **European Union's** data strategy under '*a single data market*' initiative.


Short-term
Software solutions
Security
Fairness
Scientific Publications
Public Engagement
Medium-term
Energy theft detection
Energy anomaly detection
Energy efficiency
Commercially viable solutions
Long-term
Reduced energy usage
Reduced greenhouse gas emissions

Results / Achievements to date

Deployment	Energy savings	Cost savings
Real-world demonstration in sectors: 1. Medical 2. Steel 3. Automotive 4. Composite	Reduction of energy across the diverse industrial sectors accumulating to 30-40%	15-20% cost saving from optimized operation and reduction of waste between 5-10%

Project Team and Key Collaborators

Project team includes Dr. Susan Rea, Dr. Alan McGibney, Dr. Bernd-Ludwig Wenning, Dr. Sourabh Bharti, Dr. Indika Dhanapala, Dr. Tharindu Ranathunga

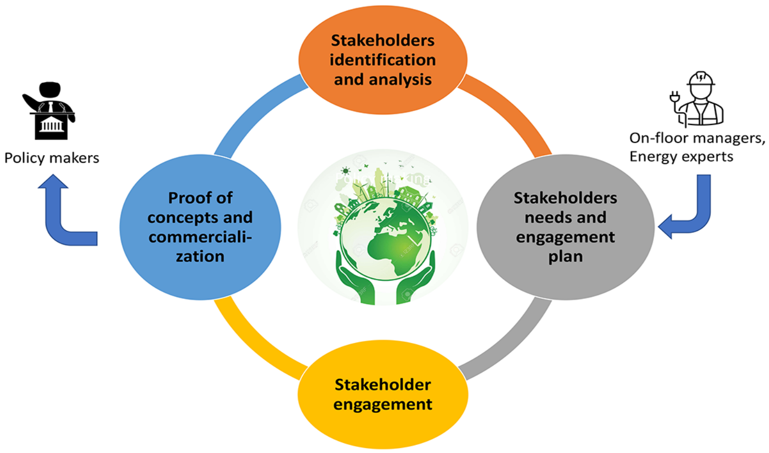
Collaborators: Community of Practice

Large Industry + Academia & Research + Stakeholder Community

Creating our Future: research addresses the need to reduce operational and embodied energy use and greenhouse gas emissions from manufacturing processes.

Working across disciplines - Interdisciplinary Considerations

Taking a co-design approach to engage and make all stakeholders active participants in addressing the green and digital transition.


Stakeholders identification and analysis
On-floor managers, Energy experts
Stakeholders needs and engagement plan
Stakeholder engagement
Proof of concepts and commerciali-zation
Policy makers

Science Foundation Ireland For what's next
Confirm Smart Manufacturing
seai SUSTAINABLE ENERGY AUTHORITY OF IRELAND
European Commission | Horizon 2020 European Union funding for Research & Innovation

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Automatic Object Detection and Pitch Segmentation in Irish Soccer Footage using Deep Learning Techniques

Authors: Peter Sunny Markappa, Christian O'Leary, Dr Conor Lynch

What's the problem we are addressing ? Why is it important?

Soccer, or Association Football, is the most popular sport worldwide and is commonly recorded for remote viewing. Soccer footage can be used by coaches and trainers to analyse their team's performance and generate useful insights. An analysis of soccer player and team performance can be invaluable in supplying statistics and tracking data for post-game evaluation. This process is typically executed manually, which results in experts annotating individual frames of video to identify player positions etc. However, manually analysing soccer footage is highly time consuming and thus, an automated approach is beneficial.

PlayerStatData

The Nimbus Research Centre has collaborated with PlayerStat Data (https://playerstatdata.com/), an Irish-based soccer analysis company, to research and develop a system for automatically performing object detection and pitch segmentation. This is envisioned to be used as part of a larger system for automatic performance analysis of players in soccer matches using computer vision techniques. The proposed system is unique in its ability to automatically generate insights into player actions, positions, etc. via machine learning algorithms.

What is our approach to solving the problem?

The application of AI implemented in this proof-of-concept uses state-of-the-art machine learning and computer vision techniques to automate the process of detecting players and balls in soccer videos. Object detection in soccer footage is uniquely challenging in that much of the available footage is collected from moving cameras which renders simpler approaches such as Kalman Filtering ineffective. Players are not always in frame, objects occlude each other (particularly pitch lines), the ball is not always visible, jersey designs vary, lighting conditions are changeable and moving cameras result in blur frames at times.

Our implementation leveraged existing object detection models such as YOLOv2 via transfer learning to infer bounding box coordinates for objects of interest within the image. These coordinates are exported to JavaScript Object Notation (JSON) format where they can be post-processed for action inference. The algorithm is made more effective through the application of pitch detection algorithms that attempt to filter out background or irrelevant sections of the image that contain non-game related objects. The algorithms were programmed using Python-based libraries including TensorFlow and OpenCV.

Results / Achievements to date

The project to date has been able to successfully perform post-game ball detection (c.f. Fig.1) and player identification (c.f. Fig. 2) in soccer footage. In running the deep learning models for 20% of frames (1 in 5), player movements can be tracked which is a component of ongoing research currently being conducted between Nimbus and PlayerStat Data. The Pitch Segmentation (c.f. Fig. 3) algorithm is relatively quick, and boosts model accuracy by disregarding objects outside of the area of interest. This disposes of irrelevant detections of spectators, pitch side advertising etc.

The generated outputs of the algorithms are passed into JSON files and can be more easily processed. Our new follow-on research is currently focussed on player number identification and tracking.

How our research generates IMPACT

To the authors' knowledge, no such automated soccer analysis system similar to that proposed in this research is publicly available. The proposed system would be unique in its ability to automatically generate insights into player actions, positions, etc. via machine learning algorithms. An automated version of this workflow would provide companies such as PlayerStat Data with a competitive advantage in analysing soccer footage, while providing local teams with an unprecedented level of feedback and insights.

Project Team and Key Collaborators

PlayerStat Data are specialists in performance development for soccer athletes across Ireland. They collect and analyse data to optimise player retention and generate player profiles to be used by coaches and managers alike.

The Nimbus Research Centre is located in MTU and performs state-of-the-art research and development for client companies in Ireland and abroad. The Data Science team in Nimbus is led by Dr Conor Lynch and is actively involved in research topics in machine learning, deep learning, optimisation, scheduling and sentiment analysis.

Working across disciplines - Interdisciplinary Considerations

The algorithms developed in this research are envisioned to be integrated into a customer-facing platform that will be used by coaches and trainers to examine insights and determine actions to be taken regarding their teams.

To this end, this project will become increasingly multi-faceted over time with elements of software development, artificial intelligence, data science, user experience (UX) and business development. To date, the work has involved collaborating with PlayerStat Data, a local business operating in the field of soccer performance solutions.

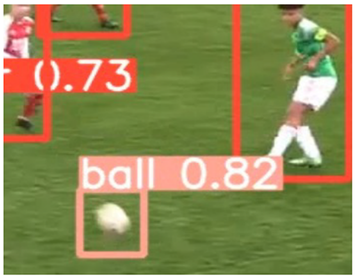

Figure 1: Ball detected in a frame

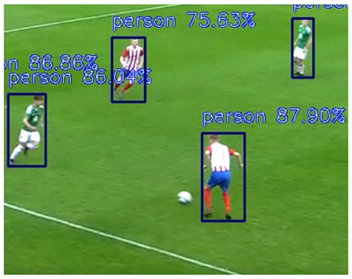

Figure 2: Player detected in a frame

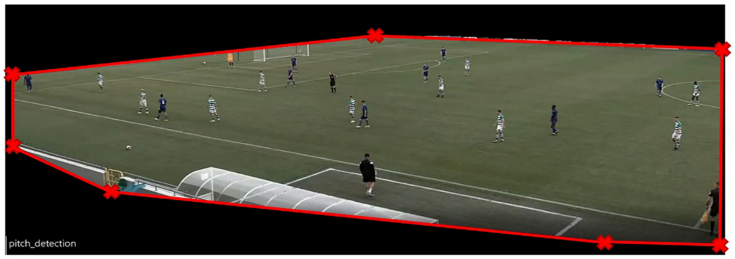

Figure 3: Pitch detection in a frame

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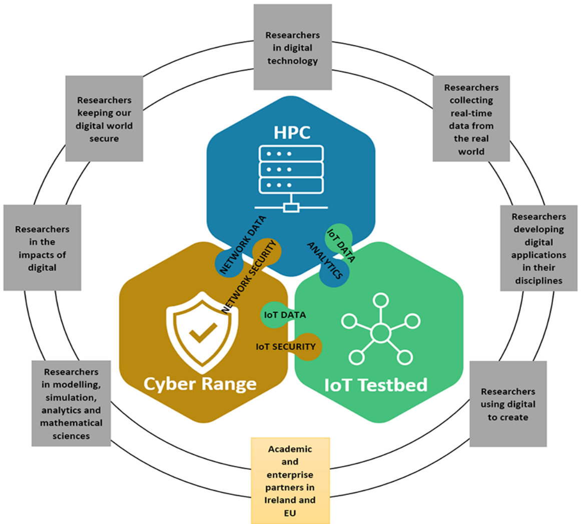
IDIR: Integrated Digital Infrastructure for MTU Research

TUTF Research Project

Authors: Juan Martinez, John Barrett

What's the problem we are addressing ? Why is it important?

While MTU has an excellent "day-to-day" ICT infrastructure, in a world where Digital increasingly underpins almost every aspect of enterprise and societal activity, and where Digital is a driver for economic growth and sustainability , including being a key tool for reaching the SDGs , MTU must have a powerful integrated digital infrastructure dedicated to research. IDIR's objectives are to put this infrastructure in place and support user groups across MTU to use it. The infrastructure has three components addressing high-performance computing, cybersecurity and Internet of Things which can be used individually or as an integrated network.


Researchers in digital technology
Researchers collecting real-time data from the real world
Researchers developing digital applications in their disciplines
Researchers using digital to create
Academic and enterprise partners in Ireland and EU
Researchers in modelling, simulation, analytics and mathematical sciences
Researchers in the impacts of digital
Researchers keeping our digital world secure
HPC
Cyber Range
IoT Testbed
NETWORK DATA
NETWORK SECURITY
IoT DATA
ANALYTICS
IoT DATA
IoT SECURITY

How our research generates IMPACT

IDIR generates impact through:

- Giving MTU a state-of-the-art digital infrastructure that is competitive at international level
- Add research and innovation capacity across MTU by supporting the growth of existing research and stimulating new intra- and inter-disciplinary research
- Enabling MTU to support regional smart specialisation, digitalisation and green transition targets
- Strengthening MTU's position in bidding for national, EU and industry funding

Results / Achievements to date

The HPC and Cyber-Range have been procured and installed with 50+ researchers who have undergone training and are using them. 11 user groups are developing and using new IoT testbeds with IDIR equipment and we are providing support throughout the different stages of implementation of the testbeds. We are entering the integration phase of networking the IoT testbeds to build a heterogenous, geographically-dispersed IoT network delivering and analysing data securely using the HPC and Cyber-Range.

IDIR is open to new ideas from any researcher in any discipline.

What is our approach to solving the problem?

IDIR is putting an MTU-wide digital research infrastructure in place and developing collaborations with research entities across all disciplines in MTU to support them in exploiting that infrastructure to increase research capacity and activity. We are building an integrated digital infrastructure with three Pillars:

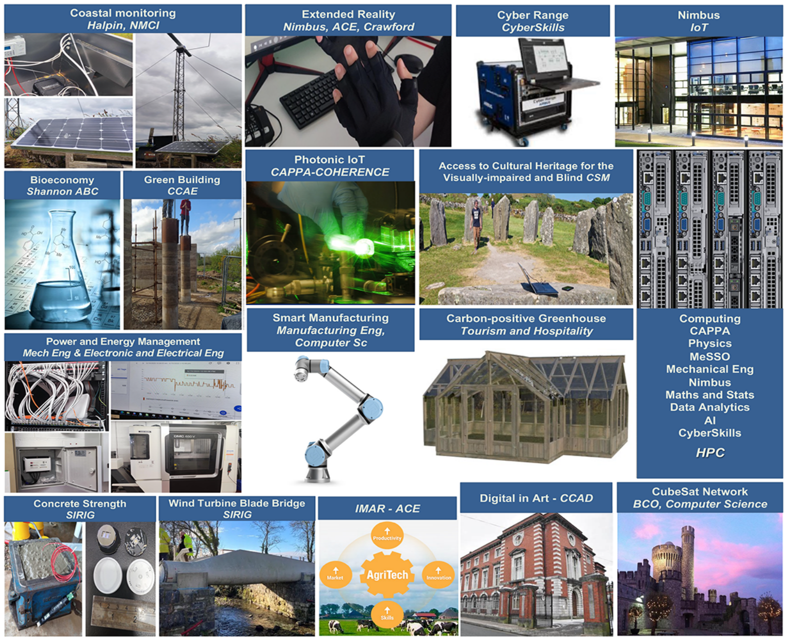
- A high-performance computing (HPC) network providing "large-scale challenge" research capacity to model, simulate, analyse, and process data in all disciplines.
- Cyber-Ranges for cybersecurity R&I and for integration of cybersecurity in digital applications, adding research capacity in keeping our digital world safe, private and secure.
- An MTU-wide IoT (Internet of Things) Testbed for IoT R&I and multidisciplinary applications, adding capacity for all disciplines to collect real-time data from the physical world.

Project Team and Key Collaborators

- Professor John Barrett Nimbus Research Centre
- Dr Ted Scully, Computer Science (Cork)
- Dr Susan Rea Nimbus Research Centre
- Professor Donna O Shea, MTU SALI Chair of Cybersecurity
- Professor Joseph Walsh, IMAR-ACE, Kerry
- Dr Liam Lewis, CAPPA
- Collaborating teams from STEM and AHSS across all of MTU

Interdisciplinary Collaborations

IDIR's focus is to enable and support interdisciplinary research collaborations with those who do research *in* digital, *using* digital or *on the impacts of* digital. This interdisciplinary collaboration is essential to ensure that digital is used safely for positive human and societal benefit and to address major global challenges.


Coastal monitoring
Halpin, NMCI
Extended Reality
Nimbus, ACE, Crawford
Cyber Range
CyberSkills
Nimbus
IoT
Photonic IoT
CAPPA-COHERENCE
Access to Cultural Heritage for the Visually-impaired and Blind *CSM*
Bioeconomy
Shannon ABC
Green Building
CCAE
Smart Manufacturing
Manufacturing Eng, Computer Sc
Carbon-positive Greenhouse
Tourism and Hospitality
Computing
CAPPA
Physics
MeSSO
Mechanical Eng
Nimbus
Maths and Stats
Data Analytics
AI
CyberSkills
HPC
Power and Energy Management
Mech Eng & Electronic and Electrical Eng
Concrete Strength
SIRIG
Wind Turbine Blade Bridge
SIRIG
IMAR - ACE
Productivity
Market
AgriTech
Innovation
Skills
Digital in Art - *CCAD*
CubeSat Network
BCO, Computer Science

HEA HIGHER EDUCATION AUTHORITY
AN tÚDARÁS um ARD-OIDEACHAS

MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

Cyber Safety for Vulnerable Populations

Research Hypothesis: How can cybersecurity advice be tailored to the needs of vulnerable populations

Authors: Michelle O'Keeffe, Moya Cronin, Miriam Curtin, Dr Aoife Long and Dr. Hazel Murray

What's the problem we are addressing? Why is it important?

Our challenge is to ensure that minority groups are not more **vulnerable to cyber-attacks** because of a difference of ability. Appropriate cyber hygiene measures are a requisite for any engagement with technology. This problem is of **global and regional importance** because it can influence how minority groups interact with technology.

In the Creating our Futures report, mitigating the digital divide in society, in particular for older people, was a core concern to citizens. Older adults are highlighted as in need of technological help and are also the cohort most at risk and apprehensive of cyber-attack.
It's important to provide older adults with digital literacy education, support, and specific awareness of online threats. Cybersecurity is a key digital skill and our aim is to make the internet safer for who are at risk by creating **easy-to-follow security advice** that's just right for them.

Project Team and Key Collaborators

This international research team combines the skills of social scientists, user design experts, cryptographers, engineers and usable security researchers all working with the Public Sector, NGOs and the national Cyber Security Centre to achieve its goal.

How our research generates IMPACT

We're making it safe and easy for older adults to use technology. Access to the internet improves well-being and reduces loneliness. We'll provide simple, personalized advice instead of complex security rules. For instance, we'll challenge common myths, like password changes being necessary. This will **boost mental well-being and trust online.**

As more services make the move online, we want to make sure everyone can access them safely. For instance, older adults could benefit from digital healthcare services, but they need to feel confident using them.

Our research will also help **shape government policies**, ensuring that all citizens have access to user-friendly security guidelines. These guidelines will be based on research and designed to maximize security without overwhelming users. This will make Ireland a leader in practical and compassionate security advice and help the country deal with cyber threats effectively.

What is our approach to solving the problem?

We will address this challenge by understanding the **needs** of identified cohorts of users and creating tailored security guidelines that are security beneficial and usable for different user contexts.

This is different because it's not the same advice for everyone; it's customized based on how people use the internet. The guidance and education we provide will be piloted within the community and continuously adapted based on the feedback received directly from the community. Both the tailored guidelines and the methodology for how to tailor advice and disseminate it through existing ecosystems will be the output of the project.

Working across disciplines - Interdisciplinary Considerations

Our research will **combine technical cybersecurity and social science disciplines** to support vulnerable adults to stay safe using technology.

While digital skills have emerged as a key part of the problem, we are operating in a context where many adults are experiencing abuse from someone they have a close relationship with.

We arranged safeguarding training from Safe Ireland to understand this social issue more, from how it can potentially impact the project and also research participants' lives. The 'threat actor' and their harmful behaviour will influence technology use and this awareness will improve the tailored advice that we provide.

Results / Achievements to date

We have engaged with **over 100 older adults**, and we have also spoken to over 30 key stakeholders who work with this cohort of participants including active retirement groups, daycare centres and clubs.
Older adults reported a positive attitude to the role of technology in their lives but fear of doing something wrong and making an irrecoverable financial loss. An ecosystem of charities and public sector bodies exists to support older people but their capacity for technology advice is low.

Age Friendly Meath
cmetb
AgeAction Age Equality
TREND MICRO
vmware
vodafone
Friendly Call Cork
Lancaster University
Comhairle Contae Chorcaí Cork County Council
Monaghan Age Friendly County
City of Dublin
Embassy of Israel in Ireland
NIST National Institute of Standards and Technology U.S. Department of Commerce
Age Friendly Ireland Healthy Age Friendly Homes Programme
glencree transforming violent conflict building peace
etb Tipperary Education and Training Board
Banking & Payments Federation Ireland
Embassy of Estonia Dublin
Age Friendly Library
STOP | THINK CONNECT
Patient Advocacy Service
Active Retirement Ireland
cetb
NCSC National Cyber Security Centre
Houses of the Oireachtas
Maynooth University National University of Ireland Maynooth
Revenue Cáin agus Custaim na hÉireann Irish Tax and Customs

Science Foundation Ireland sfi For what's next
CYBERSKILLS Building Ireland's cyber security skills

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Munster Technological University

DESIGNING DIGITAL PUBLIC SERVICES TOGETHER

IDEATE
Inclusive Design for
Digital Public Services

WHAT'S THE PROBLEM WE ARE ADDRESSING & WHY IS IT IMPORTANT?

The Irish government is in the process of transforming public services (e.g. driving license applications, tax management) into digital services. However, there is a significant portion of the Irish general public who struggle to access digital services, due to a lack of resources or poor digital literacy. There is a risk that already marginalised communities will be left behind or disadvantaged in a society increasingly reliant on digital technologies. This project seeks to break this model and provide a pathway towards the design of inclusive digital public services.

WHAT IS OUR APPROACH TO SOLVING THE PROBLEM?

We are working with public sector departments and the representatives from the general public to develop a resources and design strategies for creating more inclusive digital services, which emphasise citizen engagement and prioritise digital inclusion. This will include tools and methods for embedding design skills in the public sector and supporting participatory design, as well as proof-of-concept prototypes of Irish digital public services to validate the impact of this approach.

WORKING ACROSS DISCIPLINES - INTERDISCIPLINARY CONSIDERATIONS

In order to create inclusive digital services, we need the active participation of people from across the **public sector**, the fields of **design** and **software development**, and the **general public**. It is not sufficient that expert groups dictate to the public how their services should work - in order for digital services to be truly inclusive, the voices of Irish citizens, including those from marginalised groups, must be heard. With this in mind, we will adopt a **participatory design approach**, in which citizen engagement and digital inclusion will be prioritised.

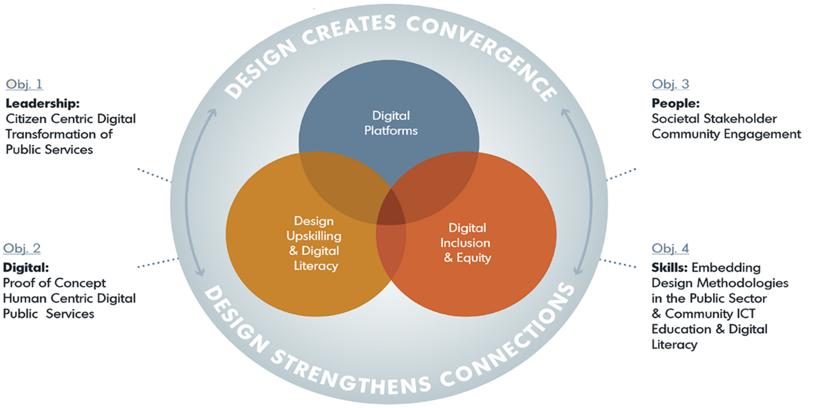
PROJECT TEAM AND KEY COLLABORATORS

The project team consists of MTU researchers within the Nimbus Research Centre, Applied Social Studies, Media Communications and Dept of TEL, working with our Societal Champions within the Department of Public Expenditure, NDP Delivery and Reform (DPENDER).

HOW OUR RESEARCH WILL GENERATE IMPACT

This project will bring a human-centric focus to the digital transformation of public services so that they better serve the general public, including marginalised communities.

Our work is aimed at reducing the digital divide, and making people's everyday interactions with digital public services easier and more accessible. Beyond this, our work will identify ways that the public sector in Ireland can design future digital public services to put the needs of Irish citizens first, no matter what their background or digital skills are.


DESIGN CREATES CONVERGENCE
Digital Platforms
Design Upskilling & Digital Literacy
Digital Inclusion & Equity
DESIGN STRENGTHENS CONNECTIONS

Obj. 1
Leadership:
Citizen Centric Digital Transformation of Public Services

Obj. 2
Digital:
Proof of Concept
Human Centric Digital Public Services

Obj. 3
People:
Societal Stakeholder Community Engagement

Obj. 4
Skills: Embedding Design Methodologies in the Public Sector & Community ICT Education & Digital Literacy

RESULTS / ACHIEVEMENTS TO DATE

Early results have highlighted that within government stakeholders there is a **misunderstanding of what human-centred design is** and is not. Creating digital platforms that are truly focused on people's needs is not just about making them aesthetically-pleasing - it is about understanding people's requirements, skill levels, and day-to-day lives, and designing a service that meets them where they are.

Our engagement with the public sector so far has revealed a **willingness to participate** in this process - but a **lack of knowledge or skills** on how to get there. There are no clear pathways or methods of engaging with citizens to capture their needs, outside of large costly public consultation. This is a gap that IDEate seeks to fill, through the development of **resources and communities**.

This process has already begun - the findings from our initial user studies have directly impacted the **Design Action Plan** that is being prepared by DPENDER. This document describes the **strategy** that the Irish government will take towards embedding design in the creation of new digital services. By collaborating closely with our government partners, our research has already started to influence the future direction of the digitial transformation of Irish public services.

Authors: Dr. Susan Rea, Nimbus Research Centre, Dr. Mary Galvin, Dept. Applied Social Studies, Dr. Sarah Hayes, Dept. Media Communications, Denise Heffernan, Nimbus Research Centre

National Challenge Fund
OurTech Challenge
Rialtas na hÉireann
Government of Ireland
Fondúireacht Eolaíochta Éireann
Dá bhfuil romhainn
Science Foundation Ireland
For what's next
Maoinithe ag an Aontas Eorpach
Funded by the European Union
NextGenerationEU
MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

MTU
Ollscoil Teicneolaíochta na
Munster Technological Unive

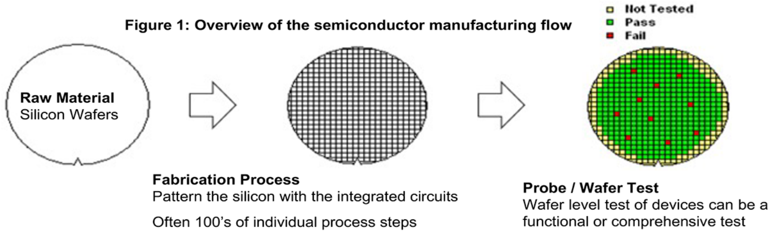
AI Based Wafer Map Analysis System

Authors: R. Bain, C. O'Leary, G. Smith, Dr. C. Lynch

What's the problem we are addressing ? Why is it important?

Semiconductor process manufacturing flows (c.f. Fig. 1), used to create Integrated Circuits, take months to complete and comprise hundreds of processing steps, using a variety of complex equipment. Electrical results at end-of-line and their spatial distribution across silicon wafers are critically important for the timely diagnosis and resolution of in-line issues.

Figure 1: Overview of the semiconductor manufacturing flow



Raw Material
Silicon Wafers

Fabrication Process
Pattern the silicon with the integrated circuits
Often 100's of individual process steps

Probe / Wafer Test
Wafer level test of devices can be a functional or comprehensive test

How our research generates IMPACT

Automatic Wafermap Recognition System is designed to automatically categorise wafer maps by spatial distribution. Thus, enabling a timely correlation to in-line equipment and processing parameters. The classification of these patterns and their tracing to root cause is currently an engineering intensive activity that is optimised and made more consistent by the implementation of this system. Using this research, the company defines existing failure patterns, c.f. Fig. 2, and uses these to generate a model .

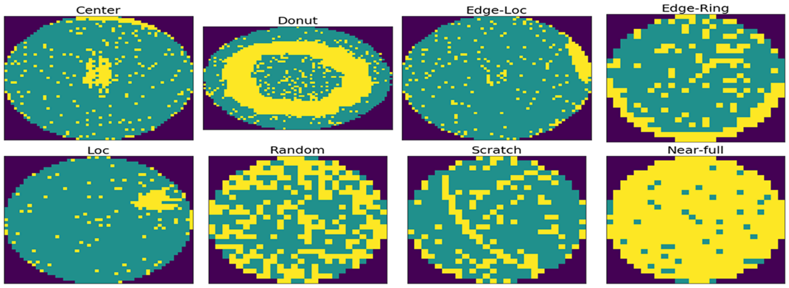


Figure 2: Overview of Wafer Map Failure Categories

This model can then automatically categorise new wafer maps by these failure types and give early warnings of out-of-control events that are impacting the end-of-line performance.

Both the cost incurred by an out-of-control product and time delays in resolving issues can be minimised by using this system. Products manufactured can have different die sizes and this can lead to different patterns at end-of-line for the same root cause issue. This system standardises the maps automatically and, by employing specific algorithms, allows one model to be used across a broad range of die sizes - ensuring patterns are consistently detected.

Results / Achievements to date

Firstly, the algorithms were proven on an open state-of-the-art dataset, 811k, to prove their validity. Then, models were developed based on proprietary Analog Devices data. Presented in Table I and Fig. 3, results were excellent across the range of failure modes that were examined. Furthermore, models were also proven across a large range of die sizes, i.e., 5.72 x 6.945 (Analog2) and 2.58 x 1.13 (Analog3). To date, the system is currently being trialed by Analog Devices International at their manufacturing plant in Limerick.

Category	Precision	Recall	f1-score
Cluster	0.99	1	0.99
Control	1	0.91	0.95
Edge	0.98	1	0.99
Handling	0.97	1	0.98
High dd	1	1	1
Reticle	1	1	1

Table I: Results Per Wafer Map Category

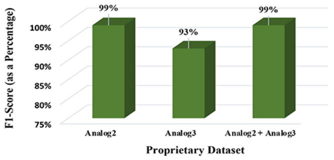
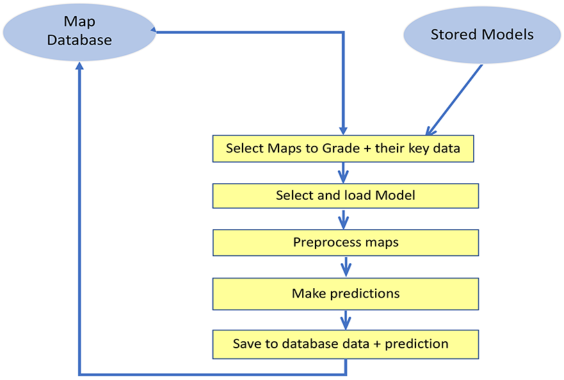


Fig. 3: Multi-class F1-score results across die sizes datasets

What is our approach to solving the problem?

Initial work focussed on gathering consistent data from real like wafer maps from the Analog Devices Wafer Manufacturing plant. Then Wafer Map Multiclass Classification is carried out using a specific type of neural network, i.e., Convolution Neural Network (CNN) models that are commonly used in image recognition tasks. These models gave excellent results on the Analog Devices provided data.

Work was done to design the structure of the neural network model and in addition, augmentation routines were optimised, and finally specific algorithms were developed and then used in the pre-processing of wafer map data, which enable the model to be used across different die sizes.



Map Database
Stored Models
Select Maps to Grade + their key data
Select and load Model
Preprocess maps
Make predictions
Save to database data + prediction

Figure 4: Model Implementation Flowchart

Project Team and Key Collaborators

Funded under Science Foundation Ireland's Connect program, and in collaboration with our project trial partners, Analog Devices International(ADI), the Nimbus Research Centre, located in MTU worked to address the automation of wafer map pattern recognition needs.

The Nimbus Research Centre is located in MTU and performs state-of-the-art research and development for client companies in Ireland and abroad. The Data Science team in Nimbus is led by Dr Conor Lynch and is actively involved in research topics in machine learning, deep learning, optimisation, scheduling and sentiment analysis.

Working across disciplines - Interdisciplinary Considerations

In is envisaged that the algorithm developed in this research will be integrated into a process and product engineering platform that would enable engineers to improve yields more efficiently and managers to understand more clearly the causes of yield loss in their areas of responsibility. To this end, this project will become increasingly multi-faceted over time with elements of software development, artificial intelligence, data science, user experience (UX) and business development.

ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

Rialtas na hÉireann
Government of Ireland

Cómhaoinithe ag an
Aontas Eorpach
Co-funded by the
European Union

Tionól Réigiúnach an Deiscirt
Southern Regional Assembly

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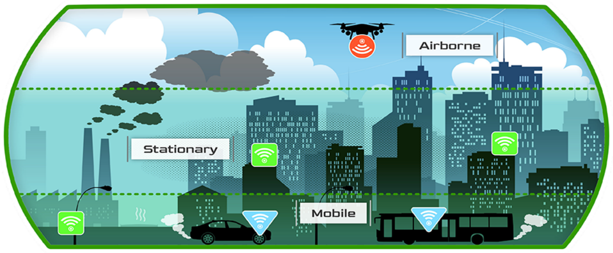
Munster Technological University

PASSEPARTOUT
Photonics Sensors for Pollution Monitoring
An EU Horizon 2020 Innovation Action

PASSEPARTOUT
Photonic Sensors for Pollution Monitoring

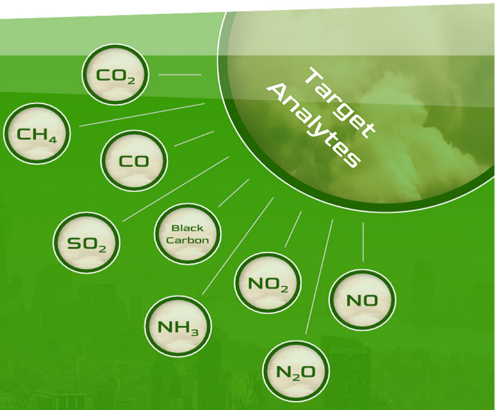
CAPPA – Centre for Advanced Photonics & Process Analysis
Coordinator: Dr. William Whelan-Curtin
Project Manager: Dr. David Williams



What's the problem we are addressing? Why is it important?

PASSEPARTOUT aims to deliver real-time pollution monitoring with high spatial resolution and public alerts

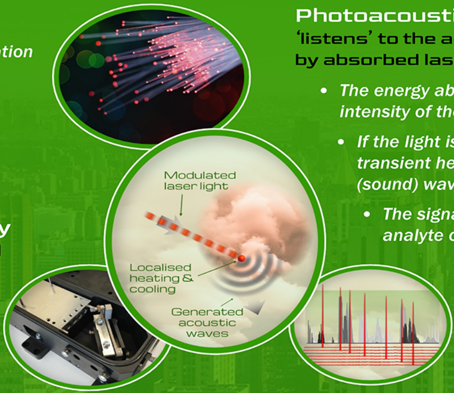
***PASSEPARTOUT** is a research project aiming to develop compact, photonic-based gas analysers for a smart sensing solution to environmental pollution monitoring in urban areas. It combines expertise on lasers, spectroscopy, data analysis, systems integration, environmental testing and drone operations in a Europe-wide consortium involving both academia and industry.*



What is our approach to solving the problem?

Photonic Sensors
(sensors using light)

- *Ideally suited to in situ evaluation*
- *Non-destructive*
- *Non-invasive*
- *No consumables component*



Photoacoustic Spectroscopy
'listens' to the acoustic waves generated by absorbed laser light

- *The energy absorbed is proportional to the intensity of the incident light*
  - *If the light is modulated, it causes localised transient heating, generating acoustic (sound) waves*
    - *The signal is directly proportional to the analyte concentration, and baseline free*

Photothermal Interferometry
probes the air heated by absorbed laser light

- *The localised transient heating is directly measured by refractive index change*
- *The interferometer phase change is directly proportional to the trace gas/black carbon concentration*

Hyperspectral Sensing

- *Allows for detection of multiple analytes*
- *A different laser is used for each compound*

Working across disciplines – Interdisciplinary Considerations

*The **PASSEPARTOUT** consortium consists of a strong, inter-disciplinary mix of physicists, chemists, electronic engineers, computer scientists, industry and civil administration, all of whom are crucial to achieving the project goals.*

18 Partners
10 Countries
10 Industry
7 Academic
1 City Authority

How our research generates IMPACT

"If you can't measure it, you can't manage it, and you can't fix it"

PASSEPARTOUT will be the first 3D mobile optical gas analyser network capable of operating in an urban area

3-Level Sensor System
- *Ground Level*
- *Building Level*
- *Over-Building Level*

Multi-Format Gas Analysers
- *Stationary - on buildings*
- *Mobile - on vehicles*
- *Airborne - on drones*

Deployed in:
- *Urban Areas*
- *Landfills*
- *Ports*

Community Alerts
- *Via smartphone app*
- *Advice on route choice (recommender system)*

- Low-cost, robust analysers
- Real-time pollution monitoring
- 3-level sensor network
- Certifiable analyser data

Results / Achievements to date

- *A fully-operational benchtop analyser based on QEPAS has been realised*
- *New lens-on-cap Interband Cascade Laser module on the market*
- *Fibre-coupled ICLs demonstrated*
- *Multi-mode – Single-mode combiners in the mid-infrared with 60% efficiency demonstrated – a world first*
- *CH_4, CO_2, N_2O, CO, NO, NO_2, SO_2 NH_3 successfully detected*
- *Drone-mounted analyser trials have begun*

Project Team and Key Collaborators

Munster Technological University
Cork, Ireland
(Coordinators)

Università degli studi di Bari Aldo Moro
Bari, Italy

nanoplus Nanosystems and Technologies GmbH
Gerbrunn, Germany

Green Lab Hungary Engineering Ltd
Budapest, Hungary

Politecnico di Bari
Bari, Italy

Argotech A. S.
Trutnov, Czech Republic

Technische Universität Wien
Vienna, Austria

Technische Universität München
Munich, Germany

ETG Risorse e Tecnologia S.r.l.
Chivasso, Italy

Centre National de la Recherche Scientifique - Université Côte d'Azur
Sophia Antipolis, France

Ecospray Technologies S.r.l.
Alzano Scrivia, Italy

vario-optics ag
Heiden, Switzerland

Techno Sky S.r.l.
Rome, Italy

University of Applied Sciences and Arts Northwestern Switzerland
Brugg-Windisch, Switzerland

Haze Instruments d.o.o.
Ljubljana, Slovenia

Le Verre Fluoré
Bruz, France

A. U. G. Signals Hellas
Athens, Greece

City of Bari
Bari, Italy

Tyndall National Institute, University College Cork
Cork, Ireland (Linked Third Party)

www.passepartout-h2020.eu

info@passepartout-h2020.eu

PHOTONICS21
PHOTONICS PUBLIC PRIVATE PARTNERSHIP
www.photonics21.org

PASSEPARTOUT has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101016956, in the context of the Photonics Public Private Partnership.

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Munster Technological University

Advanced materials, processes and characterizations for quantum devices

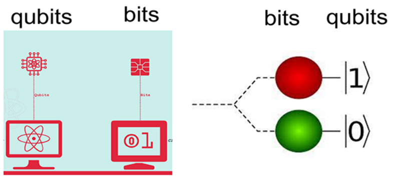
Nikolay Petkov

What's the problem we are addressing ? Why is it important?

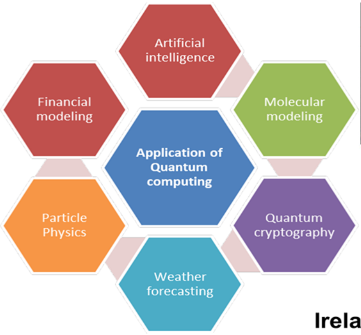
Develop new material platform and processes for next generation quantum computing devices

What is Quantum Computing?

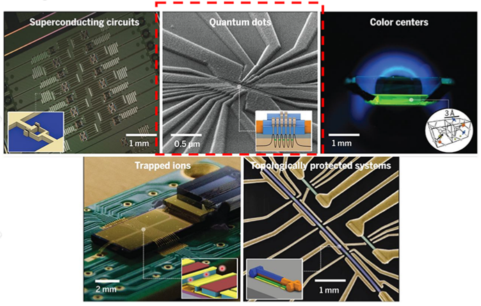
- no bits but qubits with multiple states simultaneously
- new performance levels in everything from scientific research to financial analysis


qubits
bits
Qubits
Bits
bits
qubits
|1⟩
|0⟩

The promise of Quantum supremacy


Artificial intelligence
Financial modeling
Molecular modeling
Application of Quantum computing
Particle Physics
Quantum cryptography
Weather forecasting

Main platforms

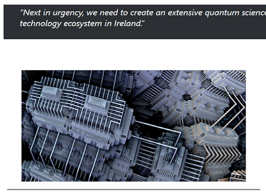

Superconducting circuits
1 mm
Quantum dots
0.5 µm
Color centers
1 mm
3 Å
Trapped ions
2 mm
Topologically protected systems
1 mm

Irelands' Quantum pathway

IBM in €10m training programme as part of 'reimagined workforce'

Updated / Thursday, 18 May 2023 09:00

Simon Coveney (L) Michael Lohan (R) and Deborah Threadgold (C) pictured as IBM announced its new training programme



"Next in urgency, we need to create an extensive quantum science and technology ecosystem in Ireland."

Minister Simon Harris launches Ireland's first Quantum Computer Engineering Centre at Tyndall

What is our approach to solving the problem?

Use well-established Si-based microelectronics technology with quantum empowered materials

Main research objectives

- replace conventional Si with another group IV but "**better**" **quantum material**
- advance the fabrication of architectures with **optimal quantum size, fidelity and functionality**

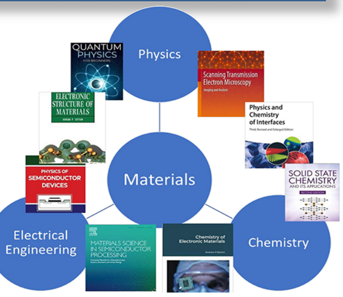
Quantum advantages gained

- enhanced quantization and higher temperature of operation
- fault tolerant, reconfigurable and scalable platform

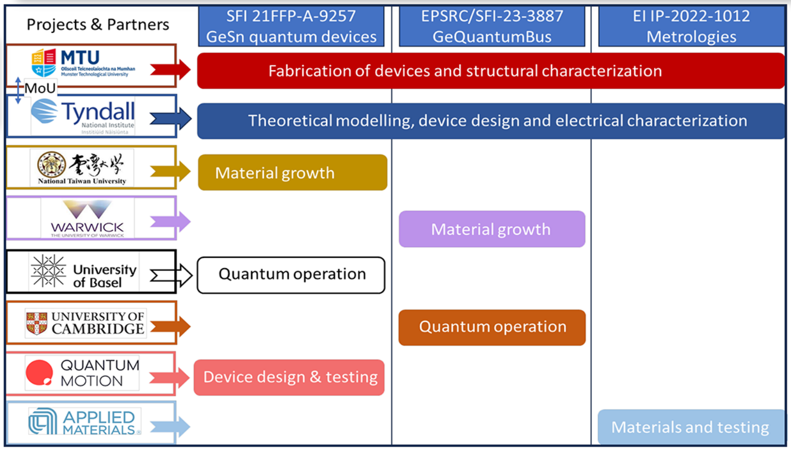
How our research generates IMPACT

- Train next generation researchers in quantum engineering of devices
- Demonstrate national capability in quantum computing devices
- Gain EU leadership in quantum flagship programmes
- Publish widely to multiple audiences from general public to patenting

Interdisciplinary Considerations


Physics
Materials
Electrical Engineering
Chemistry
QUANTUM PHYSICS FOR BEGINNERS
Scanning Transmission Electron Microscopy
Imaging and Analysis
ELECTRONIC STRUCTURE OF MATERIALS
Physics and Chemistry of Interfaces
PHYSICS OF SEMICONDUCTOR DEVICES
SOLID STATE CHEMISTRY AND ITS APPLICATIONS
MATERIALS SCIENCE IN SEMICONDUCTOR PROCESSING
Chemistry of Electronic Materials

Project Team and Key Collaborators



Projects & Partners	SFI 21FFP-A-9257 GeSn quantum devices	EPSRC/SFI-23-3887 GeQuantumBus	EI IP-2022-1012 Metrologies
MTU Ollscoil Teicneolaíochta na Mumhan Munster Technological University MoU	Fabrication of devices and structural characterization	Fabrication of devices and structural characterization	Fabrication of devices and structural characterization
Tyndall National Institute Institiúid Náisiúnta	Theoretical modelling, device design and electrical characterization	Theoretical modelling, device design and electrical characterization	Theoretical modelling, device design and electrical characterization
National Taiwan University	Material growth		
WARWICK THE UNIVERSITY OF WARWICK		Material growth	
University of Basel	Quantum operation		
UNIVERSITY OF CAMBRIDGE		Quantum operation	
QUANTUM MOTION	Device design & testing		
APPLIED MATERIALS			Materials and testing

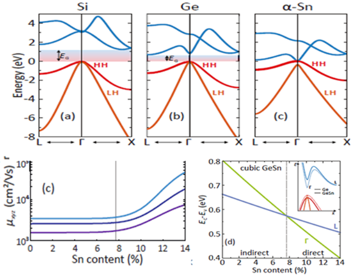
Results / Achievements to date

New material for realizing qubits

Why replace conventional Si with Ge or GeSn alloy

- direct band gap
- lower effective electron and hole mass
- much higher hole and electron mobility

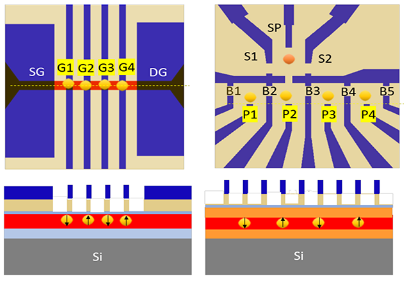
Better quantization
Possible optical and electrical control
Possible >4K temperature of operation



Major challenge: Ge device fabrication and processing are less mature than Si

Quantum device architectures

Field effect transistor (FET) qubit devices *Quantum well qubit devices*


SG
G1
G2
G3
G4
DG
Si
SP
S1
S2
B1
B2
B3
B4
B5
P1
P2
P3
P4
Si

FET qubit devices

G1-4 channel gates
SG source gate
DG drain gate

Quantum well qubit devices

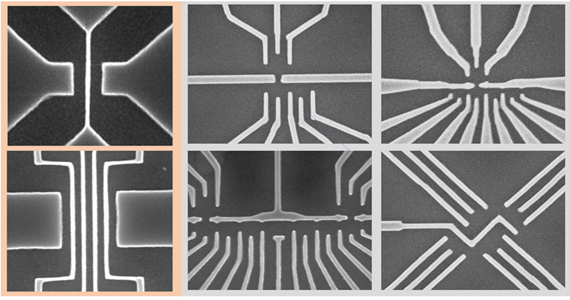
B1-5 barrier gates
P1-4 plunger gates
S1-2 sensor barrier gates
SP sensor barrier gates

Materials

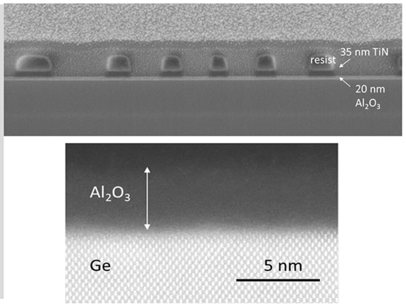
- 🟦 EBL resist
- 🟨 TiN gate metal
- ▢ Al_2O_3 gate oxide
- 🟥 Ge device layer
- ● Quantum dots with single carriers

Processing steps for Ge and GeSn quantum devices

Electron beam lithography (EBL)



Reactive ion etching (RIE)


resist
35 nm TiN
20 nm Al_2O_3
Al_2O_3
Ge
5 nm

Science Foundation Ireland For what's next
UKRI Engineering and Physical Sciences Research Council
Enterprise Ireland

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Cooperative High-speed Wireless Communication in Industrial Environments

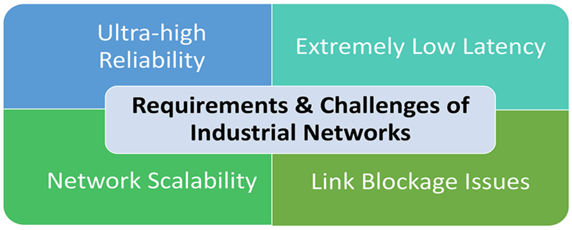
Authors: Tabinda Ashraf, Sean McSweeney, Alvaro de Medeiros, Victor Cionca

What's the problem we are addressing ? Why is it important?

Industrial wireless networks require ultra-high reliability (data integrity) and low latency (delay). The industrial application scenarios are different from the traditional wireless communication scenarios due to the nature of propagation conditions, and channel behavior. Specifically, the main challenge in industrial communication is the abundance of static, and/or mobile metallic obstacles that results in frequent obstructions, link blockages, and deep fades.

These propagation conditions lead to temporary communication failure problem, that needs to be solved because it results in higher number of re-transmissions, thus increasing the end-to-end delay, and reducing the data integrity. In addition, the industrial networks also require a scalable wireless technology that not only supports a large number of users but is also capable of self-organization as the network grows.

In this research, we are addressing the problem of communication failures encountered in industrial environments by using advanced communication technologies empowered through cooperation to provide reliable connectivity in industrial networks.


Ultra-high Reliability
Extremely Low Latency
Requirements & Challenges of Industrial Networks
Network Scalability
Link Blockage Issues

How our research generates IMPACT

This research will help in the realization of reliable communication in industrial networks that will allow for real-time data exchange between machines, sensors, and systems. This enables industries to optimize their processes, reduce downtime, and **improve overall productivity**. This, in turn, can lead to **economic growth and job creation**.

It will help monitor and control potentially hazardous processes efficiently, ensuring the safety of workers. In this way, industries can become more efficient and eco-friendlier, which is essential for **mitigating climate change** and **positive environmental impact**.

It will enable industrial networks to facilitate international trade and collaboration on a global trade. This connectivity helps businesses expand their reach, access new markets, and **promote global cooperation**.

Industrial networks are also vital in healthcare, particularly in the context of telemedicine and remote patient monitoring. Reliable communication will enable doctors to remotely diagnose and treat patients, **improving access to healthcare services**, especially in underserved areas.

Also, this research maps to the **UN SDG-9 (Industry, Innovation and Infrastructure)** by developing a flexible, and reliable solution to build a resilient & sustainable infrastructure to impact the society by supporting domestic and international industries.

Project Team and Key Collaborators

The project comprises of Tabinda Ashraf, Sean McSweeney, Alvaro de Medeiros, and Victor Cionca, all from Munster Technological University, Cork Campus. It is anticipated the SFI CONFIRM Center, one of the sponsors of this research, will benefit from the research findings.

What is our approach to solving the problem?

Our approach to solving the problem comprises of integrating various advanced multiple access approaches to support large number sensors (users) in the industrial network. To meet the diverse quality of service requirements, we aim to optimally develop a grouping and scheduling framework by using genetic algorithm that will guarantee the desired data rate requirements of all the users in the network. Further to this, a new cooperative communication mechanism with less re-transmission overhead will be developed to ensure the ultra-high reliability.

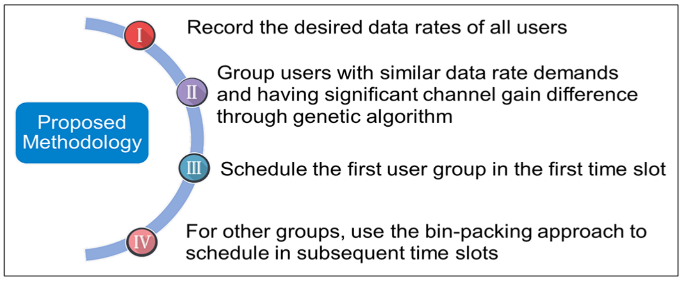
Results / Achievements to date

To achieve the desired research objectives, firstly, we have carried out a quantitative performance analysis of uplink (sensors to access point) communication by using non-orthogonal multiple access (NOMA) with respect to the channel gain difference. Considering the impact of the channel gain difference on the performance, the users having similar demanded throughput, and significantly different channel gains are grouped together. We have also proposed a scheduling framework for the allocation of time slots to each user group for their transmission. Currently, we are using genetic algorithm as the optimization scheme to formulate appropriate user groups.

The next stage will be to incorporate cooperative communication and develop suitable protocols to realize the complete system.

Working across disciplines - Interdisciplinary Considerations

The research certainly has interdisciplinary considerations as it integrates the knowledge from various domains including wireless communication, computer science, smart manufacturing and mathematics. During research, we keep engaging with experts from optimization theory, industrial automation and smart manufacturing domains to get useful insights and future directions. We have presented our research multiple times at various SFI events and conferences having both the expert and non-expert audience. Recently, we had a meeting with an optimization theory expert regarding the simulation design of our optimization problem.

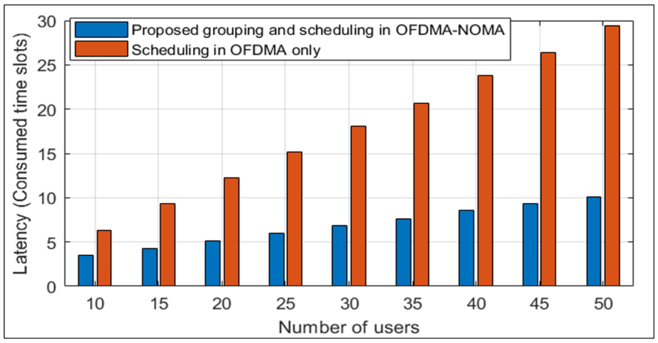

Proposed Methodology

I Record the desired data rates of all users

II Group users with similar data rate demands and having significant channel gain difference through genetic algorithm

III Schedule the first user group in the first time slot

IV For other groups, use the bin-packing approach to schedule in subsequent time slots



Confirm
Smart Manufacturing

ADVANCECRT

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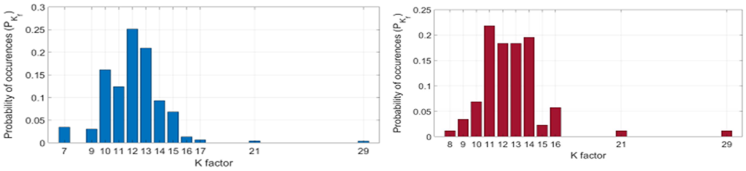
How to tackle highly varying industrial channel conditions and keep up the wireless network performance high?

What's the problem we are addressing ? Why is it important?

Harsh radio channels in industrial environments challenge achieving Ultra Reliable Low Latency (URLLC) performance, when communication system parameters are optimized at a considered channel state, and performance deteriorates at temporal variation in channel states

Majority of existing analysis are limited to a specific channel state based on provided physical layer characteristics, and do not consider impact of time varying channel conditions on performance

An analytical approach to tune the communication system parameters taking on board real-time channel variations and maintain URLLC performance is a prudent requirement which enables online optimization of communication system parameters and guarantee URLLC performance



The probability distribution of K factor for industrial channels (Machine shop and Boiler channels)

What is our approach to solving the problem?

The approach will consider a polar coded physical layer, and resulting reliability and latency of the same is calculated using analytical approaches for varying realistic industrial channel conditions.

A novel mean URLLC cost metric is introduced and the polar coding configuration which minimizes this metric for each channel state is determined. The approach uses Simulated Annealing for discrete optimization.

Project Team and Key Collaborators

The external collaborations are made with Dell EMC, and the proposed approaches are tested in the MTU-Dell collaborative cloud robotic project. This approach guarantee URLLC performance online for efficient robotics control. Further, this project was funded by SFI CONFIRM center.

How our research generates IMPACT

This research will advance the knowledge in the field of URLLC for industrial communications. The use of analytical expressions for polar code reliability and latency combined with theoretical optimization offers new knowledge.

The proposed approach leads to new solutions which tune the communication system parameters online to adapt time varying channel conditions. This strongly impacts factory automation, robotics control areas which required guaranteed wireless performance over time.

Over long term, these solutions contribute towards the goal of creating sustainable products and services, with collaborative collaboration required for Industry 5.0.

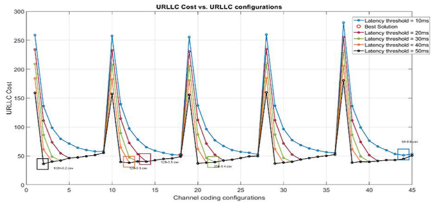
Working across disciplines - Interdisciplinary Considerations

At present, the project involves wireless engineers, electronic engineers and project managers. However, as the project progress further, there will be more interdisciplinary considerations. There will be a 5G-network enables robotics control demonstration for students/public.

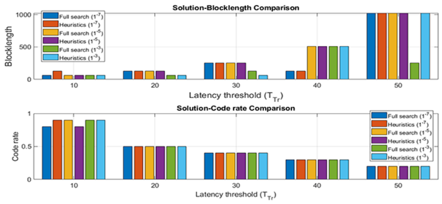
Further, new expertise/ideas/knowledge will be drawn from mechatronic engineers, artists and architects through key collaborations mentioned above. Overall, objectives will be to transfer knowledge accessible to public and work across disciplines of smart manufacturing, wireless communications, product, services and academia.

Results / Achievements to date

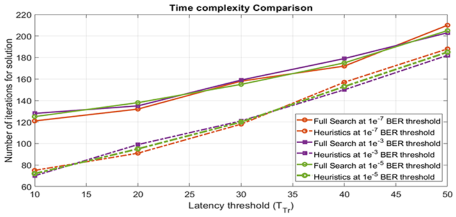
1) Mean URLLC cost variation across channel coding configurations (AWGN)



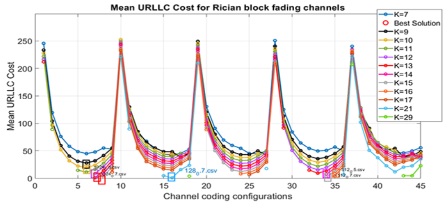
2) Solution variation across channel coding configurations (AWGN)



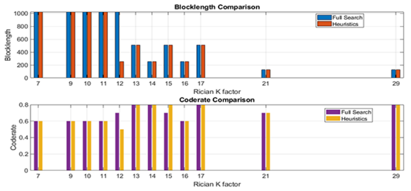
3) Time complexity comparison (AWGN)



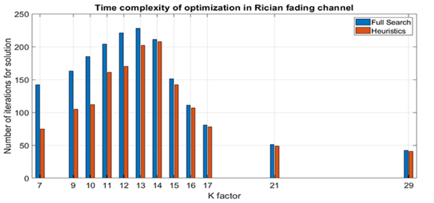
4) Mean URLLC cost across channel coding configurations (Rician block fading)



5) Solution variation channel across different channel states (K factors)



6) Time complexity across different channel states (K factors)



Overall, the proposed approach has successfully determined the best channel coding configurations to tackle time varying channel conditions. A Heuristics based approach has reduced time complexity without depleting accuracy considerably, to improve practicality of potential solutions.

Authors: Yasantha Samarawickrama, Alvaro Medeiros, Victor Cionca

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Too Many Tasks Not Enough Resources

Can low-cost hardware satisfy the demand for AI applications at the Edge?

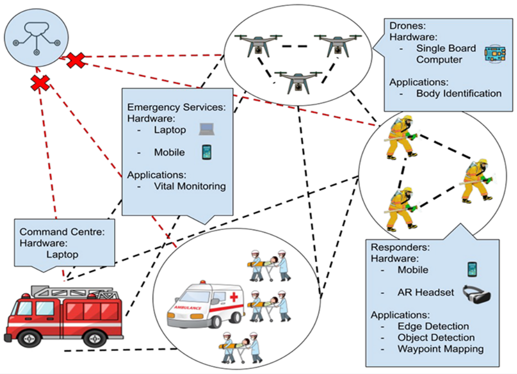
Authors: Jamie Cotter, Ignacio Castiñeiras, Donna O' Shea, Victor, Cionca

What's the problem we are addressing ? Why is it important?

In recent years the mobile devices that operate at the edge of our networks have grown considerably in power.

However, we are now seeing more computationally expensive applications such as AI image recognition tasks used on our mobile devices. Despite the increase in computational power, these tasks cannot always be completed on the device in a timely manner. In such scenarios, this task is sent elsewhere, either to servers in the edge or the cloud.

However, in some scenarios, such as disaster response, it is often impossible to access remote data centres. Regardless of the state of the underlying infrastructure, devices must meet their tasks reliability and deadline requirements. These requirements can be met by offloading to nearby devices.



How our research generates IMPACT

The goal of this work is to develop a framework for offloading AI tasks into resource-constrained networks, by providing the following:

- An understanding of the minimum hardware threshold that can support this approach.
- Scheduling mechanisms to ensure that high priority applications receive resources they need in times of resource scarcity.

This approach facilitates complex applications in scenarios when remote servers are unavailable/too far away; such as disaster response, remote wildlife monitoring and deadline constrained smart city applications.

Results / Achievements to date

Over the course of this project we have produced three papers. Two of which have been published, with the third currently under review.

Our first work examined several different offloading techniques from generic offloading scenarios against DNN partitioning in a three-tier network and found that the best approach for maximising throughput was a proactive allocation scheme with flexible placement of DNN layers.

We then examined the communication overheads of several DNN partitioning techniques when used in homogeneous networks and found that a single split approach resulted in the smallest communication overheads.

In our most recent work, we have developed a DNN offloading framework modeled on automated waste sorting that uses a deadline preemption mechanism to prioritise resources to high priority tasks in times of resource scarcity.

What is our approach to solving the problem?

In this context, there is little reduction in processing time by executing on another device, additionally the network can only support a limited number of tasks simultaneously.
Therefore, we examine, formulate and implement scheduling approaches that minimise task communication and mechanisms that prioritise more important tasks when resources are limited.

Project Team and Key Collaborators

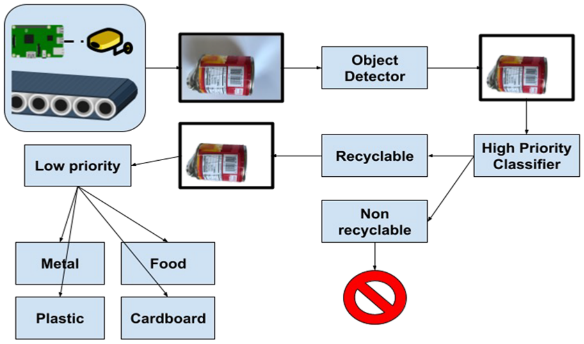
The research team for this project is comprised of researchers from the department of Computer Science in MTU.

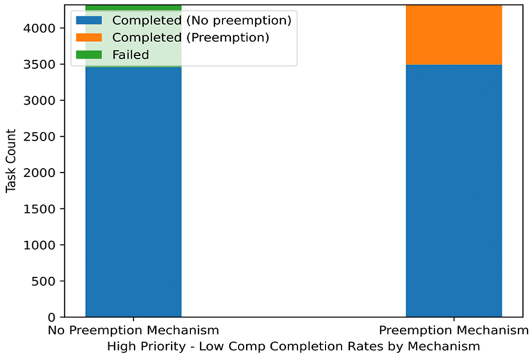
As part of this work we are exploring collaboration with a researcher from the UVA Link Lab in utilizing batch processing to reduce redundant communication in distributed waste sorting.

Working across disciplines - Interdisciplinary Considerations

The main benefits of such an approach is that it allows for more complex applications (photogrammetry, body identification, etc.) to be used in scenarios where they were not previously viable due to considerable hardware requirements.

This can be of benefit to response teams in disaster contexts due to its approach to processing. However, it can also be used as a low cost-offloading solution as it utilises commodity hardware to process tasks. These can be dedicated edge devices or repurposed *older hardware* too weak to process modern complex applications on their own.





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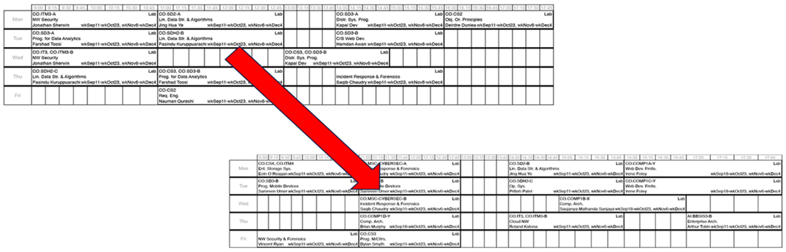
University Course Timetabling: Solver and Simulation Tool

What's the problem we are addressing ? Why is it important?

Munster Technological University is a multi-campus technological university, with six campuses across the South-West region in Cork and Kerry, and a student body of 18,000.
In the Bishopstown campus alone there are

- >20 departments
- >100 lecturing staff
- ~9,000 students
- ~1,000 modules, resulting in approximately 3,000 activities to schedule, per semester
- ~250 rooms

Each year, an updated timetable must be produced accounting for changes, while maintaining the previous years timetable as much as possible.



How our research generates IMPACT

Improve student and staff experience, engagement with courses.
Sustainability:
Improve logistics, infrastructure and resource usage

- Simulation tool for assessing impact of different infrastructure expansion / renovation options on timetabling.
- Simulation tool for investigating staggering cohort arrivals/departures to/from campus.

What is our approach to solving the problem?

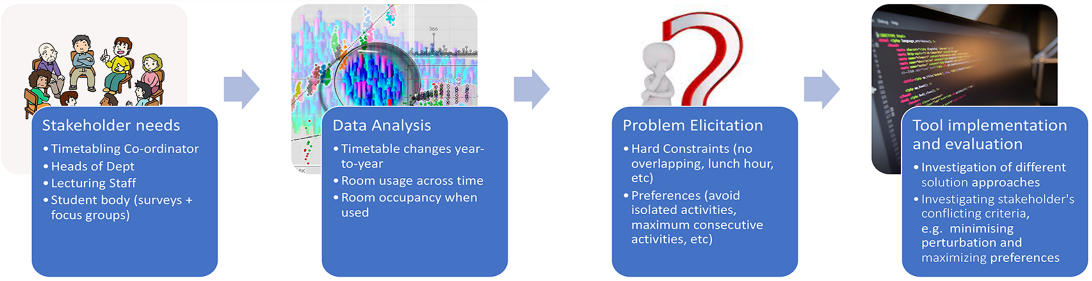
We are developing a decision-support tool to solve
Short-term: Generating a robust timetable each semester that minimizes the changes from the previous academic year's to minimize disruptions
Long-term: Simulation tool to assess the impact of various infrastructure investments

Project Team and Key Collaborators

The primary team consists of Dr. Ignacio Castineiras and Dr. Diarmuid Grimes of Dept of Computer Science, and Dr. Cemalettin Ozturk, Dept of Process, Energy and Transport Engineering.
Key collaborators include the MTU timetabling Co-Ordinator, the heads of departments, and the student body.

Working across disciplines - Interdisciplinary Considerations

Collaboration between the Department of Computer Science and the Department of Process, Energy and Transport Engineering.
Future directions for further interdisciplinary collaboration include, but are not limited to:
Transport – Logistic analysis of timetabling such that staggered arrival/depearture of student cohorts, traveling distances of students between different classes
Energy – Consumption reduction through combination of tailored timetablIng and zonal heating, and minimizing energy usage.
Construction – informed decisions for new classroom construction or refurbishment by understanding bottlenecks.



Stakeholder needs
- Timetabling Co-ordinator
- Heads of Dept
- Lecturing Staff
- Student body (surveys + focus groups)

Data Analysis
- Timetable changes year-to-year
- Room usage across time
- Room occupancy when used

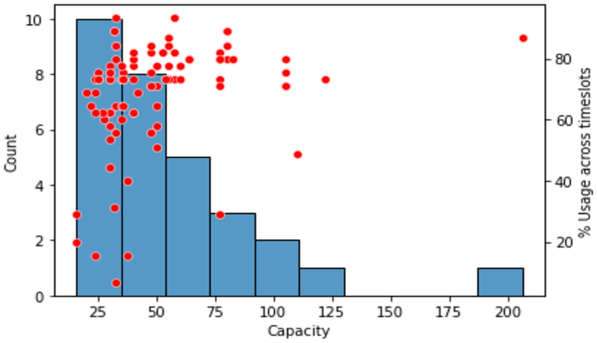
Problem Elicitation
- Hard Constraints (no overlapping, lunch hour, etc)
- Preferences (avoid isolated activities, maximum consecutive activities, etc)

Tool implementation and evaluation
- Investigation of different solution approaches
- Investigating stakeholder's conflicting criteria, e.g. minimising perturbation and maximizing preferences

Results / Achievements to date

Data analysis of the utilisation of rooms, both in terms of usage per timeslot and occupancy when used.

-Under utilization of rooms yet dense timetable for students and dispersed schedule for lecturers due to not having a holistic decision support system that considers all stakeholders and their priorities simultaneously.



Dr. Ignaico Castineiras, Dr. Diarmuid Grimes, Dr. Cemalettin Ozturk

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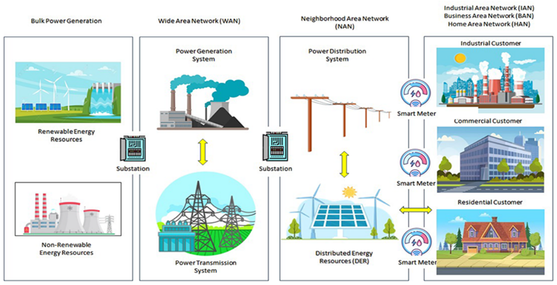
Enhancing the Reliability and Security of Electrical Grid Substations

What's the problem we are addressing ? Why is it important?

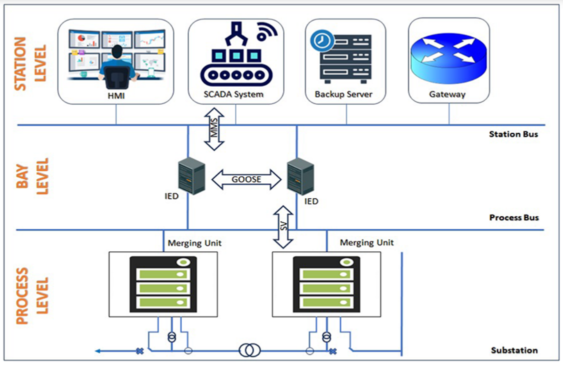
- Electrical grids comprise of a wide range of components from power sources, generation systems, transmission systems to consumers such as homes, businesses and industries.
- The electrical grids have transformed into smart grids, which integrate renewable energy sources like wind, solar, etc., and “prosumers” who can both produce and consume electricity.
- Information is critical to the effective real-time operation of smart grids.
- **Substation** is a key component within the smart grid where communication system is integrated to ensure safe and reliable transmission of electricity from power plants to consumers.
- Currently, substations use **Ethernet Technology** where flexibility and programmability are limited.
- We aim to achieve enhancements to the performance of the existing **Substation Automation Systems (SAS)** using **Software-Defined Networking (SDN)**.


Bulk Power Generation
Wide Area Network (WAN)
Neighborhood Area Network (NAN)
Industrial Area Network (IAN)
Business Area Network (BAN)
Home Area Network (HAN)
Renewable Energy Resources
Non-Renewable Energy Resources
Substation
Power Generation System
Power Transmission System
Substation
Power Distribution System
Distributed Energy Resources (DER)
Smart Meter
Smart Meter
Smart Meter
Industrial Customer
Commercial Customer
Residential Customer

High Level Architecture of Smart Grids

How our research generates IMPACT

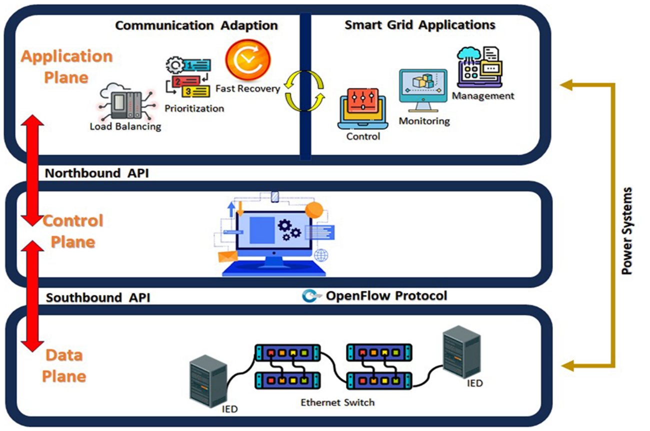
- Smart grids comprise of sophisticated networks and exchange high volumes of energy and data.
- Substations ensure stability through control and automation.
- Several time-critical and non-time-critical messages are exchanged within the substation to perform monitoring, protection and control functions.
- These messages have latency requirements mandated by IEC 61850 standard, non-compliance to which could lead to degradation performance, damage to substation equipment, large-scale blackout, etc.
- Therefore, it is imperative to ensure the timely transmission of the messages within the substation for a stable and reliable operation.


STATION LEVEL
HMI
SCADA System
Backup Server
Gateway
MMS
Station Bus
BAY LEVEL
IED
GOOSE
IED
SV
Process Bus
PROCESS LEVEL
Merging Unit
Merging Unit
Substation

Levels of Substation Automation System

What is our approach to solving the problem?

- SDN is a promising state-of-the-art technology.
- SDN can offer enhancements to existing Ethernet-based approach.
- SDN enables prioritization of time-critical messages and manage and adapt networks at run-time, allowing to counteract against accidental and malicious failures.
- SDN can be exploited to implement security mechanisms.


Communication Adaption
Smart Grid Applications
Application Plane
Fast Recovery
Prioritization
Load Balancing
Management
Monitoring
Control
Northbound API
Control Plane
Southbound API
OpenFlow Protocol
Data Plane
IED
Ethernet Switch
IED
Power Systems

Software-Defined Networking Layers

Project Team and Key Collaborators

- The research would involve the participation of substation network engineers and electricity service providers for acquiring substation data.
- The main benefactor of this research would be the consumers of electricity.
- The issue is a part of **Future-proofing energy and water systems** in the “Creating our Future” report https://creatingourfuture.ie/reports/ which outlines high level energy harnessing and distribution problems identified by the Irish public.

Working across disciplines - Interdisciplinary Considerations

- **Engineers:** Understanding and developing the characteristics and components of the substation.
- **Computer Science:** Data Analytics and Cybersecurity are key considerations for managing and securing the substation communication systems.
- **Energy Policy and Economics:** Regulatory compliance, cost-benefit analysis and energy efficiency measures.
- **Policy and Regulations:** Understanding the legal and regulatory frameworks.
- **Sociology:** Impact of the substation operation on local communities such as zero disruptions to transport systems, supply systems, etc.

Results / Achievements to date

- Previous research on performance analysis use Network Calculus, where worst-case scenarios are assumed.
- The actual results in real-time substation operation differ vastly from the assumed results.
- We are undertaking an experimental approach and simulating real-time operation of substation to obtain a more realistic analysis of the performance and a better view of the issues in the model.

Author: Saujanya Mathanda Sanjaya, **Supervisors:** Donna O’Shea, Thomas Newe, Mubashir Husain Rehmani

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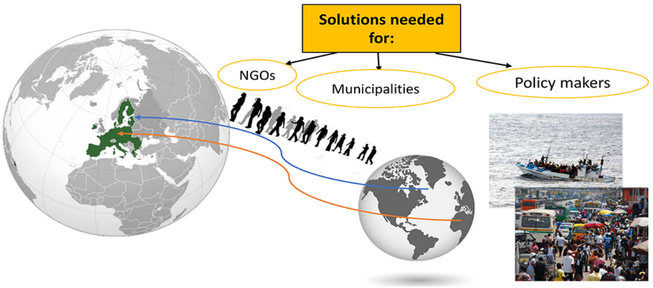
Munster Technological University

ITFLOWS:
IT tools and methods for managing migration FLOWS

IT TOOLS AND METHODS FOR MANAGING MIGRATION FLOWS

What's the problem we are addressing ? Why is it important?

Prediction of migration flows is a major challenge for the European Union and for stakeholder groups within the humanitarian sector that provide resources and assistance to migrants, including refugees, as part of humanitarian efforts. Yet, in order to develop more humanitarian strategies and instruments among policy makers and practitioners in the field of migration, we need a better understanding of the migration flows into the EU in terms of gender, race, sexuality, class, ethnicity, religion, age etc.



Solutions needed for:

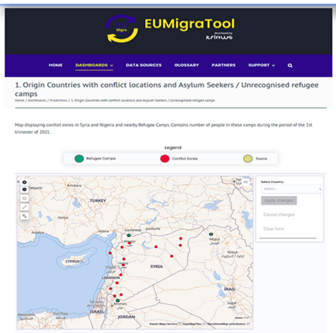
NGOs

Municipalities

Policy makers

How our research generates IMPACT

The research conducted by ITFLOWS has a significant impact by simultaneously supporting NGOs and policy makers while upholding ethical considerations and human rights. The project's technical solution, the EUMigraTool, plays a pivotal role in this regard. By harnessing cutting-edge technology and data-driven insights, ITFLOWS empowers NGOs working in the field of migration with valuable information, enabling them to better plan and implement their initiatives. At the same time, policy makers benefit from these precise predictions and evidence-based analyses, facilitating more informed decision-making regarding migration policies and practices. Importantly, ITFLOWS operates within a framework that places a strong emphasis on ethical considerations and human rights, ensuring that its technical solutions and data usage adhere to the highest ethical standards. In doing so, ITFLOWS not only contributes to the effective management of migration flows but also sets a model for responsible and ethical research in the field, ultimately fostering a more humane and just approach to addressing migration challenges.

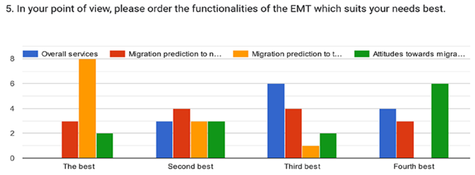


EUMigraTool
developed by itflows
HOME
DASHBOARDS
DATA SOURCES
GLOSSARY
PARTNERS
SUPPORT
Legend
Refugee Camps
Conflict Zones
Towns
TURKEY
CYPRUS
SYRIA
LEBANON
ISRAEL
JORDAN
IRAQ
Select Country:
Select...
Apply changes
Cancel changes
Clear form

1. Origin Countries with conflict locations and Asylum Seekers / Unrecognised refugee camps

Home / Dashboards / Predictions / 1. Origin Countries with conflict locations and Asylum Seekers / Unrecognised refugee camps

Map displaying conflict zones in Syria and Nigeria and nearby Refugee Camps. Contains number of people in these camps during the period of the 1st trimester of 2021.



5. In your point of view, please order the functionalities of the EMT which suits your needs best.

Results / Achievements to date

ITFLOWS has achieved significant milestones in migration prediction and human rights preservation through the development of the EUMigraTool. This ICT-enabled solution offers crucial insights into EU migration flows across phases. The tool's usability and services were validated through real-life scenarios, such as analyzing armed conflicts and forced displacement. The Users Board members rated the EMT highly, with a score of 7.1 for its current state, 7.3 for meeting organizational needs, and 7.5 for accuracy. They found it to be a valuable, innovative, and powerful tool for addressing complex emergency management requirements. ITFLOWS showcases success in interdisciplinary collaboration, upholding ethical standards while delivering practical solutions.

What is our approach to solving the problem?

ITFLOWS presently offers tailor-made recommendations for practitioners and policymakers in the fields of migration, asylum, and human rights. The EUMigraTool serves as an advanced decision-support system, catering to first-line practitioners, second-level reception organizations, and municipalities. This tool currently delivers modular solutions by leveraging predictive insights into migration flows and identifying potential tension risks among individuals residing in the EU, including EU citizens, their non-EU family members, and migrants, including refugees.

Project Team and Key Collaborators

In total there are 14 consortium partners from the EU Member States. The consortium as a whole has been designed to ensure complementarity and balance concerning nationality, type of partner, expertise and role in the project. We have brought together a team that unites the leading expertise in the relevant scientific and technical fields while at the same time providing the project with diverse hands-on experience and relevant networks for dissemination.

CEPS
UAB Universitat Autònoma de Barcelona
Migration Policy Centre
Brunel University London
OXFAM Italia
European University Institute
open cultural center
CERTH Centre for Research & Technology Hellas
CSD Center for the Study of Democracy
ifw Kiel Institute for the World Economy
MTU Ollscoil Teicneolaíochta na Mumhan Munster Technological University
terracom
iti Information Technologies Institute
FIZ Karlsruhe

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 882986. (as indicated by the GA)

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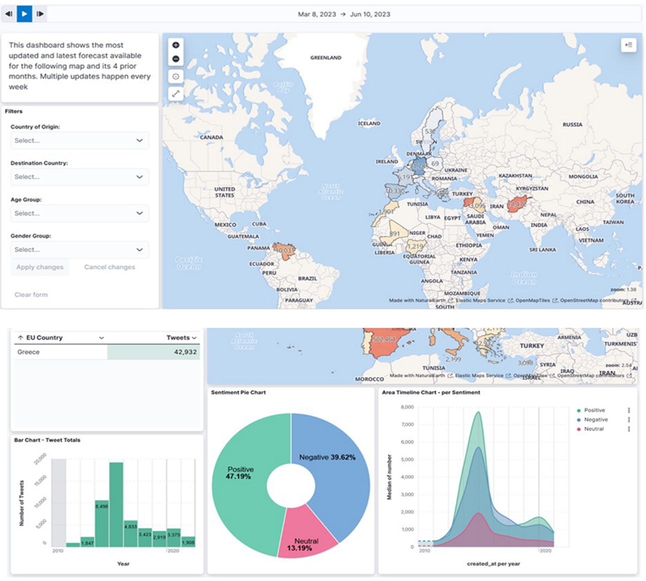
Berlaymont building architects:
Lucien De Vestel,
Jean Gilson,
A&J Polak;
Renovation:
Berlaymont 2000

www.itflows.eu

Working across disciplines - Interdisciplinary Considerations

ITFLOWS stands as a stellar example of a transdisciplinary project, where researchers from diverse fields of expertise come together to collectively address a pressing societal challenge. This collaboration unites professionals from law, human rights, Artificial Intelligence, and economics, alongside NGOs specializing in migration issues. By weaving together these multifaceted perspectives and areas of knowledge, ITFLOWS demonstrates the power of interdisciplinary considerations in tackling complex issues. This transdisciplinary approach not only enhances the project's capacity to generate innovative insights on migration prediction and human rights but also illustrates how synergy among various fields can yield comprehensive solutions to pressing challenges in our society.



Mar 8, 2023 → Jun 10, 2023

This dashboard shows the most updated and latest forecast available for the following map and its 4 prior months. Multiple updates happen every week

Filters

Country of Origin: Select...

Destination Country: Select...

Age Group: Select...

Gender Group: Select...

EU Country	Tweets
Greece	42,932

Apply changes
Cancel changes
Clear form
GREENLAND
ICELAND
CANADA
UNITED STATES
MEXICO
CUBA
GUATEMALA
PANAMA
ECUADOR
PERU
BRAZIL
BOLIVIA
PARAGUAY
IRELAND
DENMARK
SWEDEN
UKRAINE
ROMANIA
TURKEY
TUNISIA
LIBYA
EGYPT
SAUDI ARABIA
IRAN
OMAN
YEMEN
NIGER
CHAD
ETHIOPIA
KENYA
TANZANIA
ANGOLA
MOZAMBIQUE
LIBERIA
EQUATORIAL GUINEA
RUSSIA
KAZAKHSTAN
KYRGYZSTAN
MONGOLIA
CHINA
SOUTH KOREA
NEPAL
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VIETNAM
TAIWAN
SRI LANKA
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1,219
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3,095
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zoom: 1.38
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3,098
TURKEY
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SYRIA
IRAQ
IRAN
MOROCCO
TUNISIA
zoom: 2.54
Bar Chart - Tweet Totals
Number of Tweets
20,000
15,000
10,000
5,000
0
1,847
8,498
4,833
3,423
2,919
3,375
1,908
2010
2020
Year
Sentiment Pie Chart
Positive 47.19%
Negative 39.62%
Neutral 13.19%
Area Timeline Chart - per Sentiment
Median of number
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7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
2010
2020
created_at per year
Positive
Negative
Neutral

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 882986

Authors: Dr Haithem Afli on behalf of the ITFLOWS team

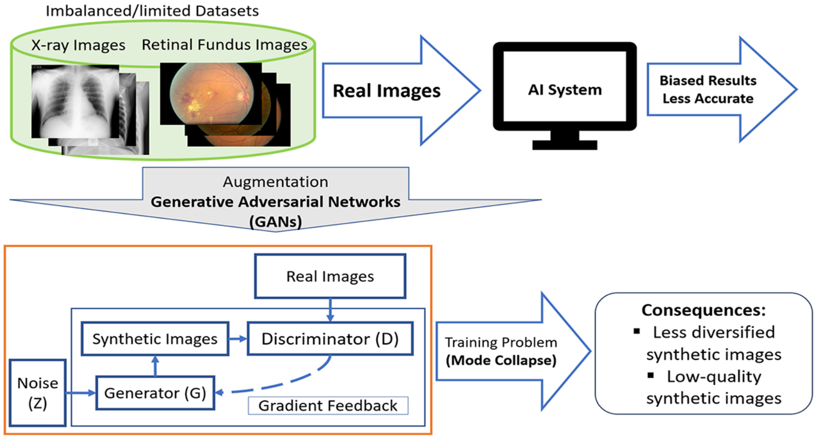
MTU Ollscoil Teicneolaíochta na Mumhan Munster Technological University

Improving Medical Diagnostics using Advanced Artificial Intelligence Techniques

What's the problem we are addressing ? Why is it important?

- Generative Adversarial Networks (GANs) generate synthetic images to augment the imbalanced datasets
  - Face mode collapse problem i.e., generate similar images repetitively and avoid diversified features
  - Mode collapse problem limits the utility of GANs for diverse biomedical images

- Addressing mode collapse problem in GANs for biomedical images is important
  - Biomedical images are disease oriented, have sensitive information, and require highly accurate diagnostic artificial intelligence (AI) models.



Consequences:
- Less diversified synthetic images
- Low-quality synthetic images

How our research generates IMPACT

Enhanced Diagnostic Accuracy

More realistic and diverse synthetic images can be generated leading to improve the diagnostic accuracy of AI systems.

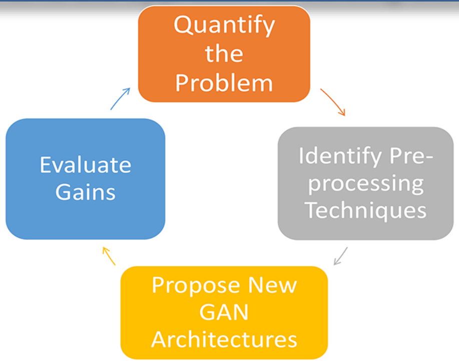
Healthcare professionals can benefit from AI systems trained on high-quality, diverse synthetic data that better represents the complexity of medical cases.

Research & Development

Synthetically generated diverse biomedical images open-up new possibilities for research in areas with data limitation such as disease understanding, drug discovery, and treatment optimization.

Synthetic images can facilitate the development and deployment of AI systems in healthcare, even in regions with limited access to comprehensive biomedical datasets.

What is the approach to solving the problem?


Quantify the Problem
Identify Pre-processing Techniques
Propose New GAN Architectures
Evaluate Gains

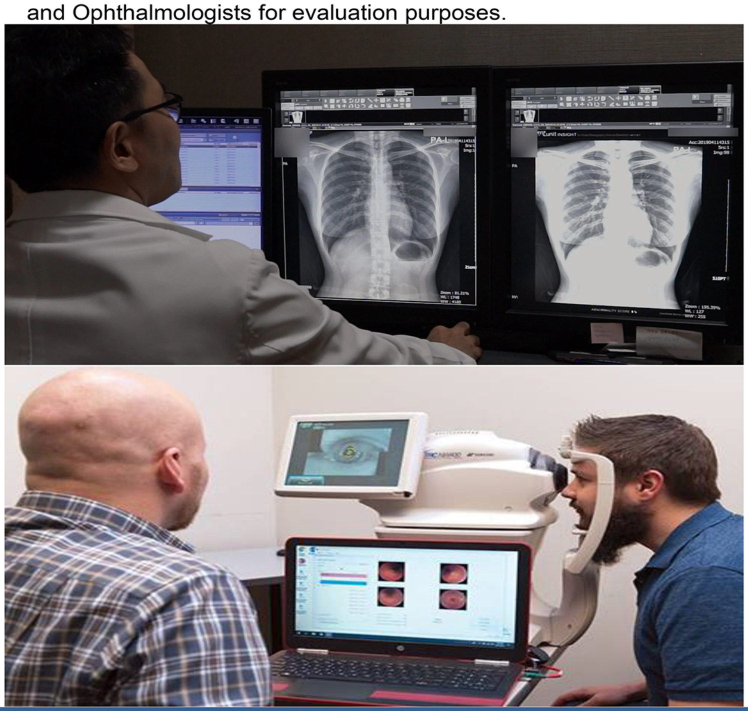
Project Team and Key Collaborators

This work is a part of PhD project, funded by MTU's Risam scholarship award, that is done by Muhammad Muneeb Saad under the supervision of Dr. Ruairi O'Reilly and Dr. Mubashir Husain Rehmani.

Working across disciplines - Interdisciplinary Considerations

- This work relies only on quantitative research-based analysis using publicly available biomedical image datasets.

- Future work includes qualitative analysis that requires Radiologists and Ophthalmologists for evaluation purposes.



Results / Achievements to date

Pre-processing Technique	Highlighting the diversified features of X-ray images using **Adaptive input-image normalization** It helps a DCGAN to generate synthetic images with those highlighted diversified features [1]
Modified Architecture	**Self-attention with multi-scale gradient learning** It helps MSG-SAGAN to focus on high-quality diversified X-ray image features during the training to generate synthetic images [2]
Evaluation of Diversity and Quality	The diversity and quality of synthetic images within biomedical and non-biomedical settings are assessed. It helps to quantify the gains in biomedical and non-biomedical settings [3]

Key References

1. Saad, M.M., Rehmani, M.H. and O'Reilly, R., 2022, July. Addressing the intra-class mode collapse problem using adaptive input image normalization in GAN-based X-ray images. In *2022 44th Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC)* (pp. 2049-2052). IEEE.

2. Saad, M.M., Rehmani, M.H. and O'Reilly, R., 2022, December. A Self-attention Guided Multi-scale Gradient GAN for Diversified X-ray Image Synthesis. In *Irish Conference on Artificial Intelligence and Cognitive Science* (pp. 18-31). Cham: Springer Nature Switzerland.

3. Saad, M.M., Rehmani, M.H. and O'Reilly, R., 2023. Assessing Intra-class Diversity and Quality of Synthetically Generated Images in a Biomedical and Non-biomedical Setting. *arXiv preprint arXiv:2308.02505*.

Author: Muhammad Muneeb Saad. **Supervisors:** Ruairi O'Reilly, and Mubashir Husain Rehmani

Image sources: GE-Healthcare_report_via_Fierce_Biotech, FDA_report_via_DARKDaily

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Enhancing Psychophysiological Analysis for Mental Health Insights

How can automated classification and complex adaptive systems aid the analysis psychophysiological data?

Authors: Zachary Dair, Samantha Dockray, Ruairi O'Reilly

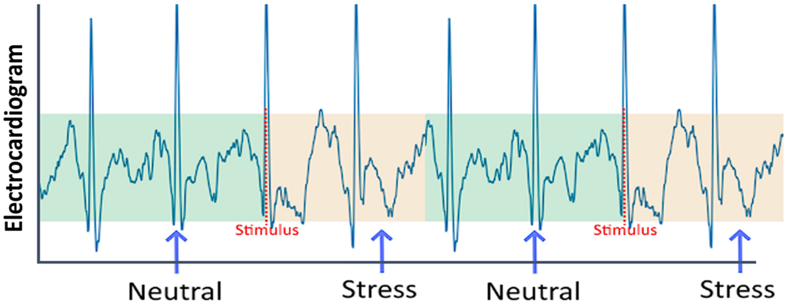
What's the problem we are addressing ? Why is it important?

Investigating the relationship between psychology and physiology can enable deeper insights into mental health, experiences and behaviour.

Psychophysiological analysis examines how thoughts and feelings impact physiology and vice versa. By analysing heart activity under various mental states, an observable change occurs. This is due to the links between the heart and the autonomic nervous system. Heart activity is one example of the various physiological signals that can be analysed.

Currently, identifying these changes is quite labour-intensive, requiring manual analysis from domain experts with an understanding of psychology and physiology. Different methods and models further complicate the analysis, making it hard to compare results across studies.

This work focuses on developing a framework to handle psychophysiological data, prepare it, and extract useful information automatically. This project tackles several challenges: (i) making automated analysis more adaptable, (ii) ensuring the quality of physiological data, (iii) capturing complex relationships, and (iv) interpreting diverse psychological findings.



How our research generates IMPACT

This research has broad applications, both in research and commercial. For researchers, it alleviates a significant burden and enables much larger-scale analysis. In commercial applications, it could enhance personalised healthcare by incorporating these analyses into wearable technology.
Furthermore there is huge potential for adopting this in virtual reality for personalised, adaptive entertainment. The focus on well-being and mental health is a core motivator in providing real-world value to many individuals.

Results / Achievements to date

An initial version of the framework has been developed. This has been backed by publications in both national and international conferences, (AICS, EMBC, BHI-BSN).

Current work is focused on a novel signal quality assessment that is adaptable to electrocardiogram data from varied datasets.

Experimental research is being conducted on modelling the physiological responses to emotions.

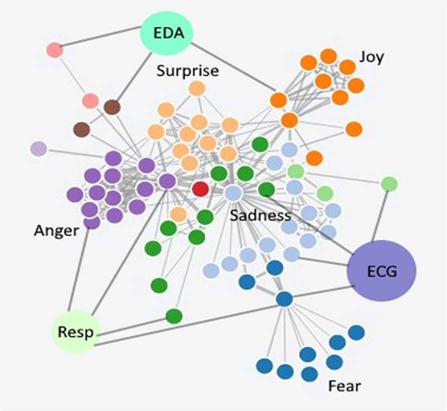
What is our approach to solving the problem?

The proposed framework leverages machine learning to accurately detect changes in mental and emotional states by analysing physiological data from wearable devices such as heart rate monitors or even smartwatches. This automation will significantly reduce the research burden.

Further work will establish a standardised data handling process and quality assessments to enable easier cross-study comparisons. This expands the analysis, enabling more generalised insights to be derived, ultimately leading to a more robust and universally applicable analysis.

Additionally, the framework will model the complex relationships between physiological responses and psychology, aiming to uncover the intricate dynamics of how our minds and bodies interact.

Modelling Emotions From Physiological Data:



Working across disciplines - Interdisciplinary Considerations

This work is conducted from a technical computer science perspective, and in parallel, a theoretical applied psychology perspective. The technical perspective is dedicated to creating robust tools and techniques for efficiently handling, processing, and extracting valuable insights from extensive datasets.
These tools are constructed upon a solid foundation of well-established principles from applied psychology. Seamlessly integrating domain expertise into the technical development, enriches the approach and provides profound interdisciplinary insights.

Project Team and Key Collaborators

With connections in both the Beats Lab and PAT research group at University College Cork, there is an exciting opportunity to collaborate with domain experts. This collaboration enables the research to applied in the real-world, and ensures that the findings are directly applicable to the expected stakeholders.

These research efforts focus on mental health and well-being, which resonates with the "Creating Our Future" report's emphasis on understanding and addressing mental health issues and promoting healthier, happier, and more inclusive communities.

ADVANCECRT

Title: Authentication and Authorization in Zero Trust IoT(Internet-of-Things)

Authors: Meha James, Thomas Newe, George O’Mahony & Donna O’Shea

What's the problem we are addressing ? Why is it important?

- Cyberattacks are on the rise in IoT networks because just securing the outer wall of a network isn't enough. When a user/device is allowed into an IoT system, it's trusted for a long time. This means that even if a bad device or a device with access gets in, it can keep causing problems inside the network. That's why the "zero trust" approach is gaining popularity. It means never fully trusting anything in the network and always double-checking their identity and intentions.
- In a zero-trust setup, devices must be recognized as unique, and we also need to know what each device can do and why it's there. But, in places like a factory, not all devices have special IDs, and you can't always figure out what they are just by looking at their IP address and operating system(OS). Usually, we use something called a MAC address to tell devices apart, but even that can be tricked.
- In simple terms, when it comes to controlling who can do what in a zero-trust IoT system, there are two main problems. First, it's hard to quickly figure out if a device is behaving badly and stop it when it's attacking. Second, we can't really learn from a device or user's past actions to make better policies to protect against cyberattacks.

How our research generates IMPACT

- Enhance security in smart environments (e.g., smart factories) & preserve network integrity in long term and be a global solution in ZT IoT networks.
- Safeguard Zero Trust IoT networks from malicious devices & protect against cyberattacks will be benefit to both companies and people in smart environment.
- This research is applied to all demographics and enhances the knowledge of the cybersecurity in the domain of ZT IoT.

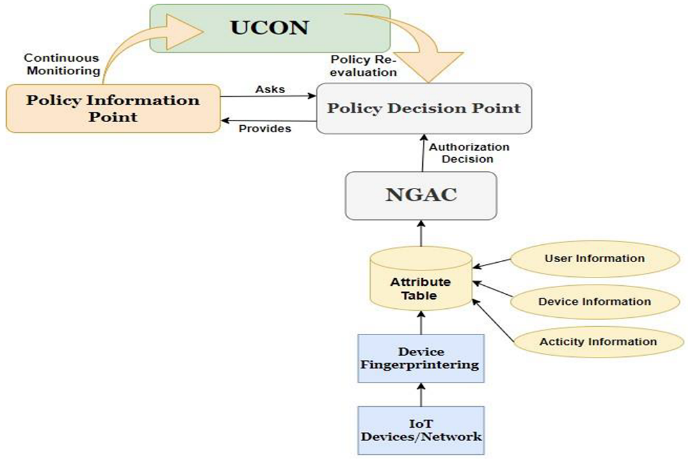
Results / Achievements to date

It stands poised at the break of dawn in its developmental phase, with the literature review completed, we now embark on the journey of implementation of its development.

Working across disciplines - Interdisciplinary Considerations

My research is an interdisciplinary effort that brings together cybersecurity engineers and AI scientists. Together, we aim to address the challenges of granting temporary privileges and understanding behavioral aspects in access policies within Zero Trust IoT. From a societal perspective, our research will be valuable for both companies and individuals, helping them protect against cyberattacks and enhance their cybersecurity measures.

What is our approach to solving the problem?



- Dimitrakos et al.’s research [1] brings together two security methods[2]: Attribute-based access control (ABAC), which lets you access something only when certain conditions related to the characteristics of users, things, and the environment are met, and the Usage Control Model (UCON), which gives permissions based on changing attributes of users, things, and the environment. They've combined these with IoT protocol MQTT, making it work smoothly even with different types of devices and allowing for continuous authorization. However, it lacks temporary privileges, leading to trust management and fine-grained access control issues.
- In contrast, ABAC doesn't include a way to analyze how IoT devices behave, which affects trust and security. If an IoT device starts behaving badly, it's tough to spot because there are no behavioral cues for IoT devices or users. This opens the door to cyberattacks and hackers becoming a problem.
- So, to solve the problem of missing temporary privileges in ZT IoT, we employ Next Generation Access Control (NGAC) which is a standard that's based on relationships and architecture, and it's designed to define, oversee, and apply access control rules by setting up these relationships. Additionally, we bring in DL (Deep Learning) techniques for device fingerprinting, which helps us study how IoT devices behave. We then integrate this information into NGAC and ABAC for managing rules and attributes. Finally, we use UCON for keeping a constant watch and evaluating our security policies.

Project Team and Key Collaborators

I am collaborating with my supervisors Donna O'Shea, Thomas Newe, and George O'Mahony at the Nimbus Centre, Cork. I am part of a research community called ADVANCE CRT, which is supported by Science Foundation Ireland and focuses on training for Future Networks and the Internet of Things, with applications in sustainable and independent living. The beneficiaries of my research will be companies operating in the smart environment domain, such as smart factories.

References

[1]T. Dimitrakos, T. Dilshener, A. Kravtsov, A. La Marra, F. Martinelli, A. Rizos, A. Rosetti, and A. Saracino, “Trust aware continuous authorization for zero trust in consumer internet of things,” in 2020 IEEE 19th International Conference on Trust, Security and Privacy in Computing and Communications (TrustCom). IEEE, 2020, pp. 1801–1812.
[2] P. Colombo, E. Ferrari, and E. D. Tumer, “Access Control Enforcement in IoT: state of the art and open challenges in the Zero Trust era,” in 2021 Third IEEE International Conference on Trust, Privacy and Security in Intelligent Systems and Applications (TPS-ISA), Atlanta, GA, USA: IEEE, Dec. 2021, pp. 159–166. doi: 10.1109/TPSISA52974.2021.00018.

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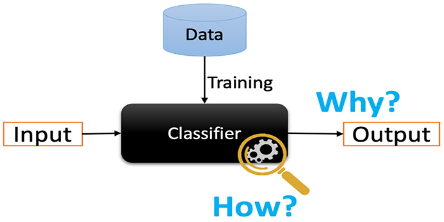
Evaluating Explainability of Machine Learning Models Via Formalised Domain-Specific Questions

Authors: Urja Pawar, Christian Beder, Ruairi O'Reilly, Donna O'Shea

What's the problem we are addressing ? Why is it important?



Concerns over trust and transparency are slowing down the rate at which AI and ML technologies are being adopted, despite rapid advancements in research.

We're tackling the issue of "**black box**" decision-making in medical AI systems. Imagine a computer program recommends a specific medication or treatment plan for you, but your doctor can't explain why. This lack of transparency can be unsettling and even risky. Our research aims to make these AI-driven medical decisions understandable to healthcare professionals and patients alike.

Clear explanations from medical AI-based systems can enhance trust, lead to better-informed healthcare choices, and ultimately improve patient outcomes. When both doctors and patients understand what's going on, they can work together more effectively to make the best possible health decisions.

How our research generates IMPACT

In the short term, our research targets improved medical decision-making. We're developing explainable AI systems that can offer clear interpretations of their reasoning with respect to specific medical questions. This aims to enhance the healthcare experience for both patients and professionals.

In the long term, we expect our transparent AI methods to set new industry standards, as healthcare tech companies integrate them into their products. We aim for our research to have global reach, benefiting everyone from tech enthusiasts to those skeptical of technology, thereby improving crucial decision-making.

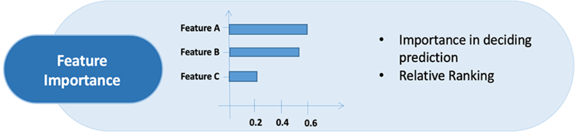
Results / Achievements to date

Our team has developed a new way to evaluate Explainable AI, focusing on medical domain-specific questions. We evaluated popular explainable AI frameworks like SHAP, LIME, and DiCE to to see how well they could answer these questions in the cervical cancer dataset. Further, we compared AI's performance with and without explainability to appreciate the effectiveness of explainable AI frameworks.

As shown in the Figure on the right-hand side, all the explainable AI frameworks are much more effective in answering domain-specific questions than random guessing (brown bars). Tweaking the settings made specific frameworks even more effective. For instance, "custom" settings improved LIME's performance for a specific question. This highlights that the right neighborhood context can elevate the success of Explainable AI. While our focus was on healthcare, our approach can be adapted to improve AI explainability in other fields as well.

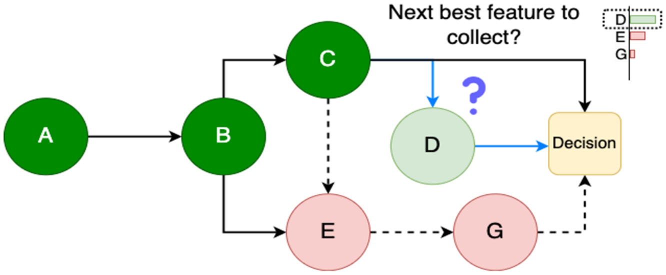
What is our approach to solving the problem?

We're focused on making medical AI transparent and useful. Current methods, like feature importance, often don't fully meet the needs of real-world healthcare. Our unique approach focuses on formalising specific questions that clinicians often face, enhancing the explainability and relevance of AI decisions.



- Importance in deciding prediction
- Relative Ranking

For example, to identify the next crucial information for efficient patient care, we innovate on techniques like Feature Importance. We analyze how well they perform in specific sets of medical records, called "neighborhood contexts." This fine-tunes the AI explanations, making them more relevant and helpful for healthcare-specific questions.

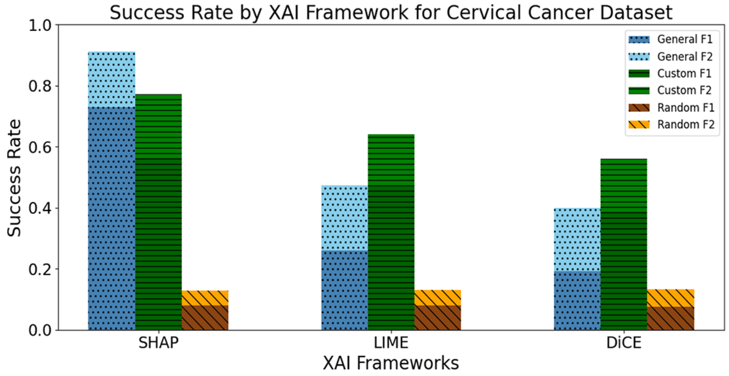


Project Team and Key Collaborators

Our research involves a partnership between academics, guided by our supervisors, and McKesson, a healthcare tech leader. This collaboration blends scholarly depth with practical use. The main beneficiaries are healthcare firms closely tied to hospitals.

Working across disciplines - Interdisciplinary Considerations

While our core team focuses on AI and healthcare, we recognize the value of interdisciplinary collaboration for a holistic impact. We have worked with the McKesson team to get industrial perspectives of this research as well as incorporated medical literature reviews. This diversity of perspectives helps us fine-tune our approach, making our research not only technologically robust but also applicable and relevant.



Fondúireacht Eolaíochta Éireann
Dá bhfuil romhainn
Science Foundation Ireland
For what's next
McKESSON
ADVANCECRT

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Munster Technological University

An output comparison study of a powder dispensing machine in a research environment with solid-core versus coreless auger wheels.

September 2023

Authors: Luke O'Donnell, Sainath Shivdas, Ciaran Doyle, Anshul Awasthi, Daniel Riordan, Tom Fitzmaurice, Joseph Walsh

What's the problem we are addressing ? Why is it important?

Powder dispensing is a common process in most Pharma and Biotech R&D laboratory applications. Manually dispensing small amounts of compounds is error-prone and extremely time-consuming, due to the difficulty of weighing powder. Powders can vary greatly in density and particle size, leading to vastly different characteristics. For instance, they may have low density and a light structure ("light and fluffy") with a tendency to be electrostatically charged; heavy and free-flowing; crystalline with varying particle shapes; or sticky with a tendency to absorb moisture (hygroscopic). Some of these traits not only make these substances physically difficult to handle but can also lead to weighing errors and incorrect measurements. Handling of these materials requires skill, extreme concentration and a very steady hand. The task becomes all the more challenging if performed on hazardous substances or frequently. Accurate dispensing of small amounts of a diverse range of powders for high-throughput experimentation (HTE) is currently a major challenge. It may quickly result in a workflow bottleneck when weighing out many individual powders, or a high testing frequency is required.

Automated powder dispensing can save time and deliver highly reproducible results, giving lab technicians freedom to focus on other critical tasks and decision-making. Low-cost automated powder dispensing facilitates the advancement of research in lab automation in the food industry.

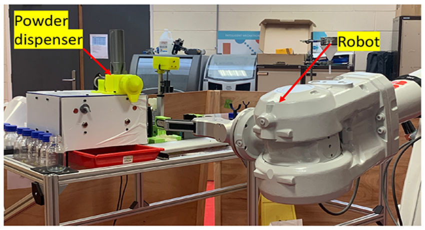

Powder dispenser
Robot

Figure 1: Lab automation model

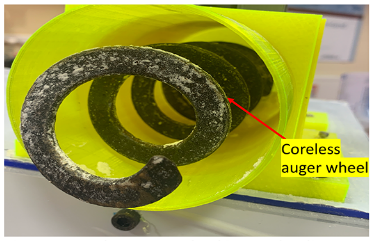

Coreless auger wheel

Figure 4: Coreless auger wheel in powder dispenser machine

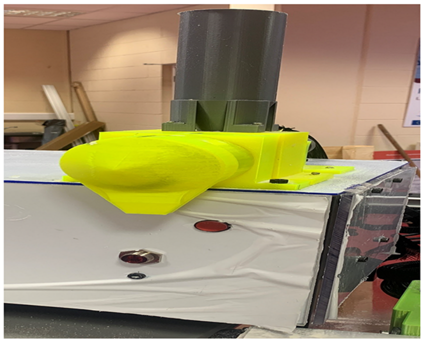
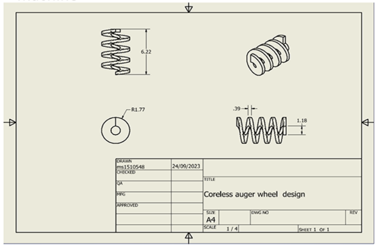


Figure 2: Prototype model of automatic powder dispenser machine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Coreless auger wheel design
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SHEET 1 OF 1

Figure 5: Design of Coreless auger wheel in powder dispenser machine

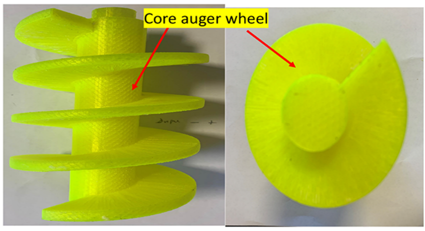
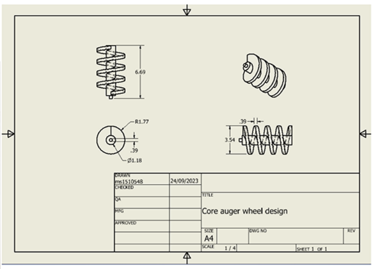

Core auger wheel

Figure 3: Core auger wheel in powder dispenser machine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SHEET 1 OF 1

Figure 6: Design of Core auger wheel in powder dispenser machine

How our research generates IMPACT

Our main research goal is to automate aspects of product testing for an organization which produces powdered food, that is, to have a robot perform repetitive tasks currently done by lab technicians. Lab technicians are required to maintain high levels of concentration while testing samples, in order to deliver accurate test results and minimize sample powder wastage. However, as test frequency increases during the day, concentration levels will fall as a consequence of fatigue and will have a negative effect on production. The purpose of installing a robot in the lab was to increase testing frequency, productivity and reliability. In the process-proving research phase, a robot has been programmed to carry out tasks in a manner comparable to a lab technician. A major bottleneck was identified in the process of managing powder samples. To achieve the project objective of increasing the testing frequencies, an automatic powder dispenser system was developed which is integrated with the robot to perform the task effectively and consistently. In the design phase initially, we designed and developed a solid-core auger wheel (Figure 4) to dispense the powder samples. However, it was found during the implementation phase that the maximum number of samples that could be dispensed without intervention from this model was five (5), with, furthermore, an uneven distribution of powder sample sizes. It was also observed that the powder absorbs moisture whenever it is fed through the machine's hopper. During the run, it would stick to the sides of the wheel, which had an impact on the output flow, exacerbating the problem.

This problem was overcome with the design and development of a coreless auger wheel (Figure 2). In trial runs with a coreless auger wheel, the model performed fourteen (14) dispenses without intervention, with consistent quantity, making the machine more useful. This model can provide more, and more consistent, dispenses per load cycle. Hence the robot can achieve the objective of a higher testing frequency.

Therefore, this research model can be impactful in food and pharma industries where handling of powder samples for testing is a concern. An easy-to-operate, cost-effective automatic powder dispensing machine facilitates flexible, effective research in the area of automated powder handling.

What is our approach to solving the problem?

In solving the problem, we utilized a six-sigma tool where the fishbone diagram method was employed to track the problem origin, differentiating problems into manual, material, machine, environment etc. This approach provided us with more insights into different aspects of the powder-dispensing process and many approaches to solve the problem.

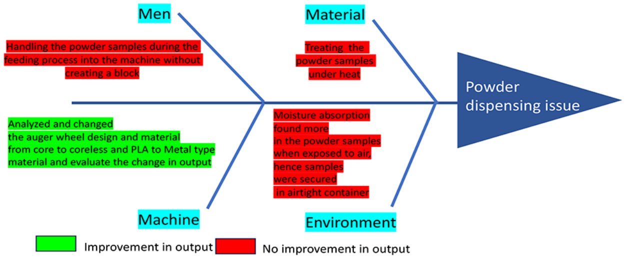

Men
Material
Handling the powder samples during the feeding process into the machine without creating a block
Treating the powder samples under heat
Powder dispensing issue
Analyzed and changed the auger wheel design and material from core to coreless and PLA to Metal type material and evaluate the change in output
Moisture absorption found more in the powder samples when exposed to air, hence samples were secured in airtight container
Machine
Environment
🟩 Improvement in output
🟥 No improvement in output

Figure 7 Fish bone diagram for effect analysis

In this way, breaking the problem statement into segments and applying improved methods in each phase provided us with more knowledge about the process and enabled better problem-solving.

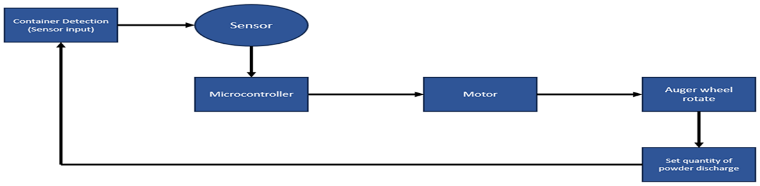

Container Detection (Sensor input)
Sensor
Microcontroller
Motor
Auger wheel rotate
Set quantity of powder discharge

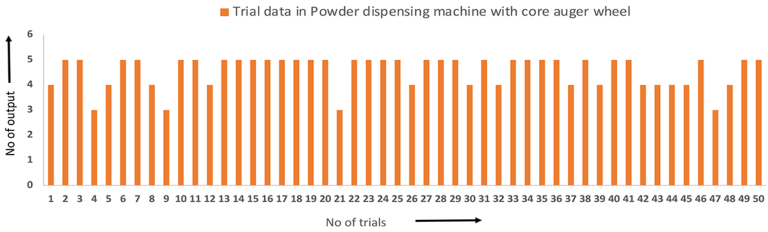
Figure 8: Process flow in powder dispenser machine

Project Team and Key Collaborators

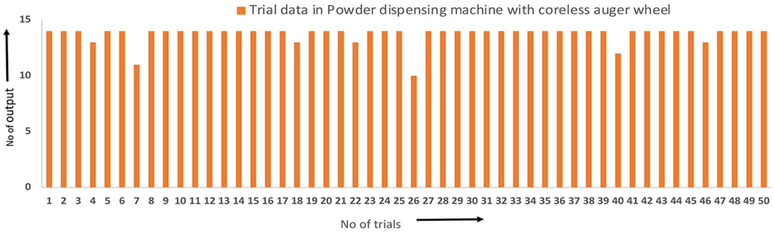
- A food industry team provided food samples to process and prove the concept.
- Enterprise Ireland supported the project with funding.
- Support from MTU technical and academic staff helped in overcoming the project challenges.
- Other researchers in IMaR provided assistance in troubleshooting the issue within the project timeline.

Working across disciplines - Interdisciplinary Considerations

The proposed model may be beneficial in research laboratories for the food and pharmaceutical industries. The handling of powder samples can be made simpler with equipment that is convenient to operate. Additionally, chemical analysis report from chemical department is essential to determine the behaviour of the powder when designing the machine and selecting the material for the part for developing the machine.



Graph1: Output data from core type auger wheel powder dispenser



Graph2: Output data from coreless type auger wheel powder dispenser

Results / Achievements to date

- With a change in the design during the prototyping phase, the capacity of the powder dispenser machine improved from 5 to 14 dispenses without intervention. This was a critical step in removing the limitation in the powder dispenser process and increasing the volume of robot testing.
- The research also benefited from knowledge acquired regarding the powder flow mechanism and the impact of moisture on chemical behaviour.
- The project contributed to the development of an affordable prototype using 3D printing technology.

Enterprise Ireland

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Munster Technological University

Biophotonics@MTU
Shining Light on Life Science Challenges
Biophotonics is the Science of Using Light to Study Life

What's the problem we are addressing ? Why is it important?

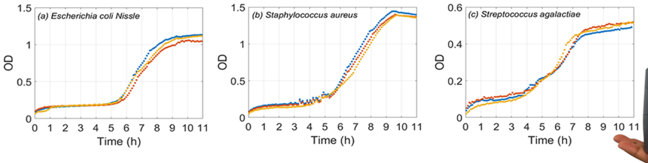
The problem for many biological challenges over the past century has been how to do things faster, better and more efficiently. The Biophotonics@MTU team, combining researchers from Research Centres & Technology Gateways at MTU – CAPPA and Shannon ABC, are identifying ways to use light to more efficiently deliver data to make quicker and more informed decisions in the life sciences. The use of light to probe materials produces immediate data, which can have significant implications for life sciences in bioprocessing (e.g. drug manufacturing), cosmetics, biomass sample analysis or animal disease detection.

How our research generates IMPACT ?

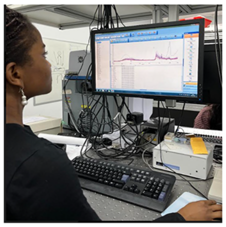
Biophotonics@MTU is researching and identifying new ways to apply photonics capability. This is achieved by leveraging capacity in existing projects to generate new data, applying for new funding based on initial data generated, and by collaborating with industry partners. The outputs from this work ranges from delivering data more rapidly, to fundamental changes in analytical instrumentation. The impact from this is on a range of industries and demographics; examples include screening biomass more rapidly for active compounds, rapid detection of agriculturally relevant pathogens, improvement of existing light based detection methods (ELISA) and assessment of skin health with cosmetics.

Results / Achievements to date

- ***Bioprocessing:*** An in-situ ultraportable wireless continuous optical density monitoring device, ODX, has been developed which can monitor real-time growth of bacteria used in the bioprocessing industry.



Growth curves of (a) *Escherichia coli Nissle* , (b) *Staphylococcus aureus* and (c) *Streptococcus agalactiae* obtained with the ODX device. https://doi.org/10.1021/acs.analchem.9b02628



- ***Cosmetics and Skin Health:*** Using light, we can explore skin cosmetics with FT-IR/FT-NIR spectroscopy to understand how skin bacteria utilise topical cosmetic products to generate by-products (skin microbiome metabolites) which interact with skin protective barrier activities.

- ***Bioeconomy:*** We can screen biomass (e.g. tree bark extract) more rapidly for active compounds.

- ***Animal Disease:*** With light based Raman and Fluorescence, we can probe protozoan parasite pathogens which cause disease in farm and companion animals.

What is our approach to solving the problem?

The importance of photonics 'leaving its technology silo' has been identified as part of a 2020 European Partnership submission to the EU. BioPhotonics@MTU enables this through the opportunity to apply photonics to life sciences, health and aging, and the bioeconomy. Team members from CAPPA and Shannon ABC have regular meetings and identify technological challenges in order to identify opportunities to apply photonics to deliver these solutions.

Project Team and Key Collaborators

Dr Liam Lewis
Dr Michael McAuliffe
Dr Joanna Tierney
Dr. Venkata Vamsi B Yallapragada
Dr Krishnamkumar Chullipalliyalli
Dr Niall Burke
Dr Stephen Hegarty
Dr Killian Barton
Dr Tim Yeomans
Dr William Whelan Curtin
Dr Bridget Breen
Dr Chinna Devarapu
Dr Bernard Boateng
Dr. Milosz Przyjalgowski
Dr Anton Walsh

The leads of this project are Dr Joanna Tierney, Dr Mike McAuliffe and Dr Niall Burke. They are supported by Dr Liam Lewis and Dr Tim Yeomans. The purpose of this project is to grow the core group to include additional research and academic staff, to increase the opportunity to find and solve relevant challenges, and to increase the translation of this discipline to teaching. The group has now grown to 15 members.

Working across disciplines - Interdisciplinary Considerations

The fundamental basics to Biophotonics are physics and biology; these are two quite different scientific disciplines. In order to generate and progress ideas, a clear understanding of the biological problem and potential physics based solution is required. This is facilitated by monthly team meetings and regular visits of researchers across both sites, particularly to the CAPPA site to get a firm understanding of what is possible, and how to achieve it. A repository of research questions has been developed that the team can access, and can be used to form the basis of funding applications.

Contact us:
Biophotonics@MTU.ie

Shannon ABC
applied biotechnology centre

CENTRE FOR ADVANCED PHOTONICS & PROCESS ANALYSIS CAPPA

BioPhotonics @ MTU

TECHNOLOGY GATEWAYS
delivering solutions for industry
an Enterprise Ireland network

MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

Digital resilience for SMEs

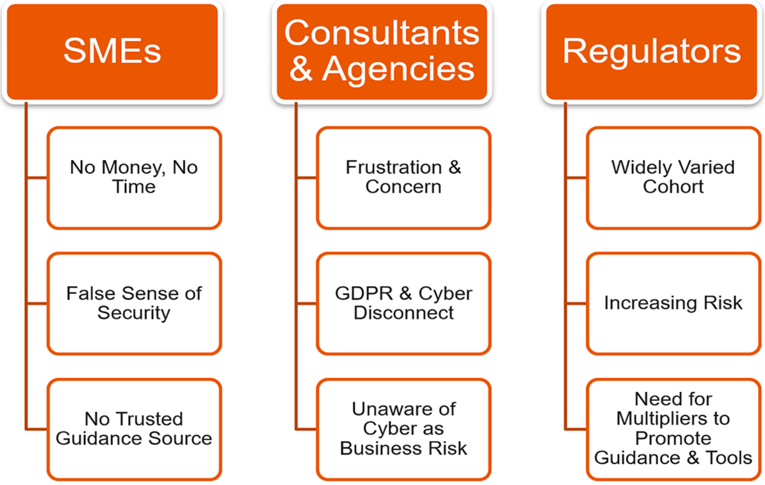
How can we reduce the cybersecurity risk in Irish SMEs through the development of free, accessible, and specifically tailored cybersecurity tools and guidance

Authors: Miriam Curtin, Gillian O'Carroll and Hazel Murray

What's the problem we are addressing ? Why is it important?

The critical issue is the mounting cybersecurity risk within the Irish SME sector. Following rapid digitalization spurred by the Covid-19 pandemic, SMEs now find themselves lacking the awareness and resources needed to combat specific cybersecurity threats. This challenge extends beyond Ireland, resonating throughout the European economy.

Despite the sector's vital contribution to the Irish economy, SMEs face significant hurdles in allocating resources for cybersecurity risk management. This vulnerability not only poses financial jeopardy but also threatens the livelihoods of employees and the stability of suppliers and customers. Urgent action is needed to equip Irish SMEs with accessible, user-friendly cybersecurity tools, empowering them to mitigate this escalating risk.



SMEs
- No Money, No Time
- False Sense of Security
- No Trusted Guidance Source

Consultants & Agencies
- Frustration & Concern
- GDPR & Cyber Disconnect
- Unaware of Cyber as Business Risk

Regulators
- Widely Varied Cohort
- Increasing Risk
- Need for Multipliers to Promote Guidance & Tools

Figure 1: Findings from semi-structured interviews with key stakeholders

How our research generates IMPACT

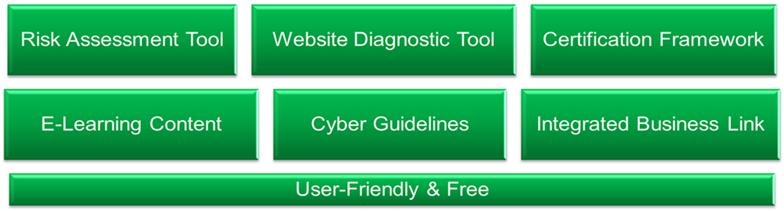
This study aims to significantly enhance the digital resilience of Irish SMEs. It will yield practical tools, including risk profiles and toolkits, tailored to different SME types. This will lead to a reduction in negative outcomes associated with cyber incidents, ultimately contributing to a more robust and resilient economy in Ireland and aligning with the goals of the National Cyber Security Centre. Additionally, this effort will have positive ramifications beyond Ireland, benefiting the wider European Union and supporting global cybersecurity efforts.

Results / Achievements to date

The findings highlight a critical gap in cybersecurity preparedness within the Irish SME sector. It is evident that SMEs are not proportionally investing in digital security, which could jeopardize the long-term sustainability of their businesses. Furthermore, while small business owners demonstrate a strong understanding of GDPR responsibilities, they often fail to perceive cybersecurity risk as an integral part of information security risk. Engaging with SMEs on cybersecurity is also proving to be a challenge, as many view it solely as an isolated IT risk, separate from broader business concerns. Micro Enterprises, with less than 10 employees, emerge as the most vulnerable stakeholder group, facing significant hurdles in implementing sufficient cybersecurity measures. The feedback from SME stakeholders across various levels—local, national, and international—affirms the pressing need for improved cybersecurity risk management tailored specifically for SMEs.

What is our approach to solving the problem?

The approach to tackling the rising cybersecurity risk in Irish SMEs involves multi-pronged approach. It will be centred around the development of tailored training, certification, standards and tools tailored specifically to the needs and context of SMEs. Each solution will be validated by SMEs and piloted via LEOs.



Risk Assessment Tool
Website Diagnostic Tool
Certification Framework
E-Learning Content
Cyber Guidelines
Integrated Business Link
User-Friendly & Free

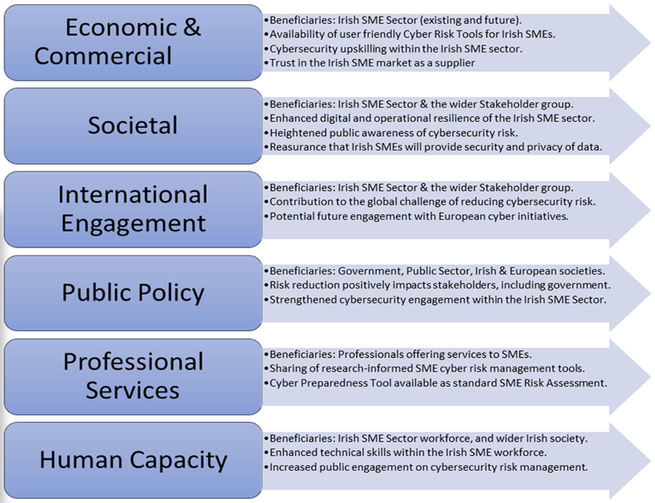
Figure 2: Multi-pronged solutions

Project Team and Key Collaborators

Dr Hazel Murray: Lead Researcher, expert in cyber range technology, providing project leadership and technical expertise. **Ms. Gillian O'Carroll:** Co-Lead Researcher, specializing in project management and Cyber Tool accessibility for non-technical users. **Mr. James Caffrey:** Societal Impact Champion, guiding project for real-world impact and overseeing SME cyber risks. **Ms. Miriam Curtin:** Researcher specialising in education.
Collaboration: Partnering with Local Enterprise Offices (LEOs) to enhance SME engagement and training.
Benefiters: Irish SMEs, through the development of user-friendly, tailored cybersecurity tools.

Working across disciplines - Interdisciplinary Considerations

The research team brings together technical expertise, project management skills, and a focus on societal impact. While the current team primarily consists of cybersecurity experts, the project acknowledges the importance of interdisciplinary collaboration.
In the future, two dedicated researchers with expertise in entrepreneurship will join the team. While the research primarily focuses on cybersecurity, it recognizes the significance of engaging with SME stakeholders and ordinary citizens. Their input will be invaluable in tailoring the Cyber Tools to meet specific needs and ensuring accessibility to a broader audience, bridging the gap between technical complexities and practical requirements. This approach will be integral in designing tools that effectively address the high levels of cybersecurity risk within the Irish SME sector.



Economic & Commercial
- Beneficiaries: Irish SME Sector (existing and future).
- Availability of user friendly Cyber Risk Tools for Irish SMEs.
- Cybersecurity upskilling within the Irish SME sector.
- Trust in the Irish SME market as a supplier

Societal
- Beneficiaries: Irish SME Sector & the wider Stakeholder group.
- Enhanced digital and operational resilience of the Irish SME sector.
- Heightened public awareness of cybersecurity risk.
- Reasurance that Irish SMEs will provide security and privacy of data.

International Engagement
- Beneficiaries: Irish SME Sector & the wider Stakeholder group.
- Contribution to the global challenge of reducing cybersecurity risk.
- Potential future engagement with European cyber initiatives.

Public Policy
- Beneficiaries: Government, Public Sector, Irish & European societies.
- Risk reduction positively impacts stakeholders, including government.
- Strengthened cybersecurity engagement within the Irish SME Sector.

Professional Services
- Beneficiaries: Professionals offering services to SMEs.
- Sharing of research-informed SME cyber risk management tools.
- Cyber Preparedness Tool available as standard SME Risk Assessment.

Human Capacity
- Beneficiaries: Irish SME Sector workforce, and wider Irish society.
- Enhanced technical skills within the Irish SME workforce.
- Increased public engagement on cybersecurity risk management.

Figure 3: Projected societal impacts

Cyberskills, National Cybersecurity Centre, Science Foundation Ireland

Conversatior
with
Professor Roy Sle
TU
Teicneolaíochta na Mumhan
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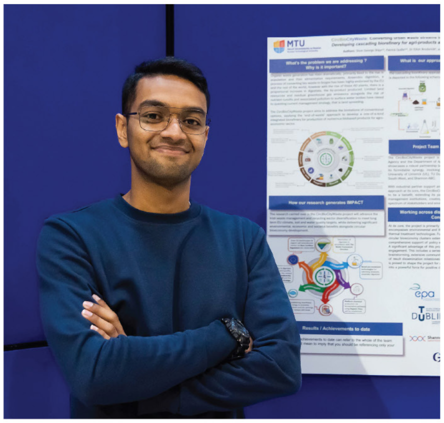
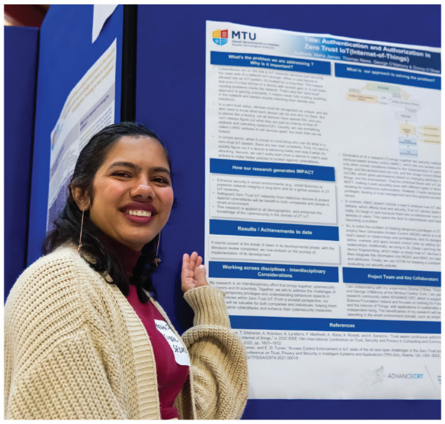

MTU
How our research generates IMPACT
Results / Achievements to date
epa


MTU
Authentication and Authorization in Zero Trust IoT (Internet-of-Things)
How our research generates IMPACT
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BIO SCIENCES & HEALTH

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Munster Technological University

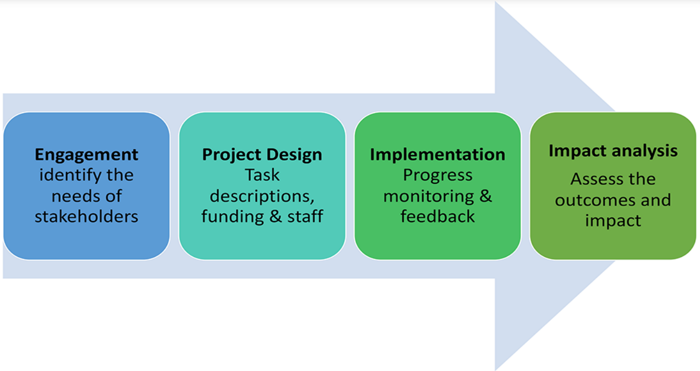
Strategic development of collaborative projects to combat the increasing incidence of non communicable diseases

Authors: Fiona O Halloran, Seán Lacey, Mohammed Hasanuzzaman, Aisling O Brien,
Jessica Neville and Sheresh Zahoor

What's the problem we are addressing ?
Why is it important?

Non communicable diseases (NCD), or chronic diseases, include cancer and diabetes. Globally, NCD and their related conditions kill >40 million people annually and affect all age groups. In Ireland, cancer is the biggest killer and responsible for 30% of deaths every year. It is estimated that >300,000 people are current living with Diabetes in Ireland. The response to reducing the incidence of NCD is multi-faceted, but detection, screening and treatment are key components. As the incidence of NCD continues to rise, developing more efficient and sensitive assays to screen and detect these diseases can support our healthcare services and provide better patient care. In addition, clinical laboratories are 'data-rich' but a lack of resources (people, infrastructure) can limit the ability of clinical teams to analyse stored data to its full potential. Supporting healthcare professionals in collaborative projects that explore clinical data can help identify novel disease biomarkers and data trends of interest, which can have a positive impact on patient management and care

What is our approach to solving the problem?



Engagement
identify the needs of stakeholders

Project Design
Task descriptions, funding & staff

Implementation
Progress monitoring & feedback

Impact analysis
Assess the outcomes and impact

Examples of current projects

Improving Cancer screening and detection

Multiple Myeloma is a blood cancer that accounts for 1% of all cancers, and its incidence is increasing. More sensitive methods are needed to detect disease and monitor patients in remission for residual cancer cells. This project supports the development of a more sensitive Next generation flow (NGF) assay to detect cancer cells and investigates other strategies to support better cancer screening.

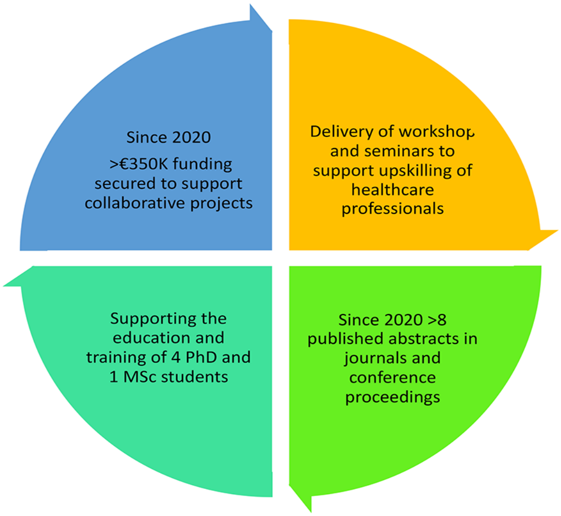
Current clinical practice and novel biomarkers for Diabetes

Better diagnostic strategies for early detection of type 2 diabetes are needed to help reduce the incidence of this disease. This project investigates the potential of microRNA (miRNA) molecules as clinical biomarkers of the disease. It also assesses current clinical practice for diagnosing type 2 and gestational diabetes, to identify if more efficient strategies can be implemented

Risk prediction models for Diabetes

Machine learning (ML) analysis is an emerging trend in human biomonitoring. This project uses ML algorithms to analyse clinical and demographic data from diabetic patients and establish a cause-effect relationship between different variables. This strategy aims to further our understanding of the factors responsible for causing diabetes.

Achievements to date



Since 2020
>€350K funding secured to support collaborative projects

Delivery of workshop and seminars to support upskilling of healthcare professionals

Supporting the education and training of 4 PhD and 1 MSc students

Since 2020 >8 published abstracts in journals and conference proceedings

How our research generates IMPACT

- Improving the sensitivity and efficiency of clinical assays supports healthcare professionals in their ability to detect and diagnose diseases.
- Investigating alternative strategies to identify novel clinical biomarkers of disease has a positive impact on patient care.
- Our projects support better health and well being, aligning with SDG3, and helps develop innovation and infrastructure in our healthcare system, aligning with SDG9

Project Team and Key Collaborators

MTU SLÁINTE group work with healthcare professionals in Cork University Hospital to develop collaborative projects to address the needs of our main stakeholders, the public.

Implementation of project tasks has been supported by technical specialists from diagnostic companies including Roche and Thermofisher.

Aligning with "Creating our Future" our projects focus on supporting better healthcare to improve the diagnosis and treatment of cancer and diabetes. For this, we engage with relevant charities, such as Breakthrough Cancer Research and The Haematology and Education Research Trust

Working across disciplines - Interdisciplinary Considerations

The MTU team includes ***biologists***, ***statisticians*** and ***computer scientists.*** Our projects are designed and implemented in collaboration with Health and Social Care Professionals including ***medical scientists***, ***clinicians*** and ***nutritionists,*** to ensure that project themes are relevant to the needs of the public, keeping patients and their needs at the center of what we do.

breakthrough
CANCER RESEARCH

CUH
Ospidéal Ollscoile Chorcaí
Cork University Hospital

IRISH RESEARCH COUNCIL
An Chomhairle um Thaighde in Éirinn

DIETARY DEAL: Dietary Assessment & Further Development of Biomarkers for All

'It is easy to ask what people eat, but finding an answer can be a daunting task' (Helsing, 1991)

What's the problem we are addressing? Why is it important?

- Accurate measurements of dietary intake are central for health & nutrition research.
- However, the lack of standardised dietary assessment methods & their related research support infrastructure remains a major obstacle to implement concerted & region-specific research & health promotion action plans worldwide (Micha *et al,* 2018).
- Simultaneously, the use of objective measurements of dietary intake can strengthen the estimation of dietary intakes & has the potential to increase the quality of nutrition & lifestyle research (Corella & Ordovas, 2015).

Our EU Joint Programme Initiative funded project 'DIETARY DEAL' (led by MTU) aims to address these issues by:

1) developing an open source researcher-led dietary assessment tool, with machine learning capabilities for harmonisation of dietary data across Europe.

2) Advancing biomarker research in the area of nutritional status & health.

Project Team and Key Collaborators

A transnational collaboration:

- Led at MTU by Dr Janette Walton & Dr Laura Kehoe (NutRI Research Group, Dept. Biological Sciences)
- In collaboration with:
  - Dr Sean McSweeney, Dr Haithem Afli, Dr Brian Murphy & Dr Alison O'Shea (Dept. Computer Science, MTU)
  - Dr Amy Mullee, ATU Ireland
  - Prof Matthias Schulze, DIfE, Germany
  - Prof Alfredo Martínez, IMDEA Food, Spain
  - Prof Alfonso Calle, San Carlos Hospital, Spain
- Supported by a large research team comprising of post-doctoral researchers, research assistants & post-graduate students including Ms Hannah Al-Sehaim (PhD Candidate, Dept. Biological Sciences)

What is our approach to solving the problem?

- A strong collaboration within MTU between the Dept of Biological Sciences & Dept of Computer Science has facilitated an exciting opportunity to solve this problem and develop an open source researcher-led dietary assessment tool.
- Close collaborations & a combination of the individual partners' expertise are key to the success of this project.
  - With over 20 years of experience in national dietary survey research, the team in Biological Sciences are uniquely placed to inform the development of this tool for harmonisation of dietary data across Europe.
- Other strong collaborations within the consortium will screen for interactions between biomarkers of dietary intake with actual dietary consumption to inform further research in this area.

Working across disciplines - Interdisciplinary Considerations

A multi-disciplinary team of experts in:

- Dietary assessment
- Software development & database engineering
- Machine learning & artificial intelligence
- Epidemiology
- Biochemical & biomarker analysis
- Precision nutrition

Results / Achievements to date

- While in the early phases a key achievement to date includes the **strong collaborations** developed & nurtured within the consortium both internally in MTU, nationally & internationally.
- **3 systematic reviews** - prepared/published, advancing the complex field of dietary assessment & biomarker research.
- **Attendance & dissemination** of findings at **national & international conferences** by project team members including the principal investigators & postgraduate students.
- A notable result to date includes the **extensive engagement with end-users** to inform the development of the open source dietary assessment tool for research & policy across Europe (feedback from 12 countries across Europe).

How our research generates IMPACT

- **Intellectual Property:** The open source dietary assessment tool will be openly available for use under licencing agreements.
- Further impacts include:

Policy & Regulation:

Evidence-based regulation & policy on nutrition & food safety at regional, national & EU level by local government agencies & EU bodies.

Consumer, citizen and societal needs:

Development of science-based healthy eating advice for consumers to advance national/European goals for sustainability & health.

Scientific capacity & capability of partner institutions:

Training of postgraduate & early-stage researchers & further development of research collaborations nationally & in the EU.

Research capacity:

Further development of collaborations to enhance the partners' strong capability for involvement in transnational funding programmes (e.g. Horizon Europe).

Authors: Dr Janette Walton & Dr Laura Kehoe, Department of Biological Sciences

National Dietary Surveys in Ireland: research for policy, industry & society

What's the problem we are addressing? Why is it important?

- Approximately 65% of deaths and 79% of illnesses globally are attributed to non-communicable diseases (NCDs) such as cardiovascular diseases, diabetes, cancers & chronic respiratory diseases with significant costs to the economy & society as a whole (WCRF, 2014).
- Foods, diets, nutritional status & lifestyle factors are important determinants of NCDs.
- Understanding the patterns & distributions of dietary & lifestyle habits is critical to inform & establish dietary priorities & improvement goals for individuals & populations.
- Furthermore, within the EU, there is a legal requirement for each country to monitor its food supply from a safety perspective.
- National dietary surveys are performed to evaluate compliance with food/nutrient intake requirements, associations with markers of health & exposure to potentially harmful dietary components/ contaminants in the food supply.

Project Team and Key Collaborators

A multi-institutional team:

- Led at MTU by Dr Janette Walton & Dr Laura Kehoe (NutRI Research Group)
- In collaboration with Prof Breige McNulty (UCD), Prof Albert Flynn & Prof Kevin Cashman (UCC) & Prof John Kearney (TU Dublin)
- Supported by a large research team comprising of post-doctoral researchers, research assistants & post-graduate students.

- Ongoing active collaborations with other HEIs, regulatory bodies, policy makers and the food & health industry

Funded by the Irish Department of Agriculture, Food & the Marine under their competitive research funding programme

What is our approach to solving the problem?

- **In Ireland, the National Dietary Surveys research team (www.iuna.net) have been responsible for the monitoring of the dietary & lifestyle habits and food supply of the population for over 25 years.**

- Evidence based guidance available at European & global level for the conduction of national dietary surveys (EFSA, 2014)
- The Irish National Dietary Surveys are acknowledged globally as ***state of the art***, in part due to the experience & expertise of the team as both data collectors & end-users.
- Since 1997, the team have conducted over 8 national dietary surveys across Ireland of pre-school children, school-aged children, teenagers, adults & older adults (1-90y).
- Data collected includes:
  - Habitual food & beverage consumption
  - Physical body measurements (e.g. weight, height, body fat)
  - Lifestyle characteristics (demographics, physical activity levels, attitudes to food & health)
  - Biomarkers of nutritional/health status

Working across disciplines - Interdisciplinary Considerations

Regular ongoing collaborations nationally & internationally with:

- Dietary assessment/exposure experts
- Food choice experts
- Biostatisticians
- Computer scientists
- Experts in biochemical and biomarker analysis
- Environmental experts (Green house gases & other markers)

Results / Achievements to date

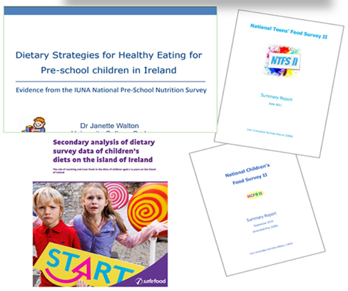
8 surveys completed to date (over 6500 participants)
Since 2010:

- Leveraged >€20m (both exchequer & non-exchequer funding)
- Approximately 50 post-graduate students
- >100 peer-reviewed manuscripts & >200 conference abstracts

How our research generates IMPACT

Evidence based research for national & international policy

Stakeholder facing reports



Dietary Strategies for Healthy Eating for Pre-school children in Ireland

Evidence from the IUNA National Pre-School Nutrition Survey

Dr Janette Walton

National Teens' Food Survey II

NTFS II

Summary Report

Secondary analysis of dietary survey data of children's diets on the island of Ireland

START

safefood

National Children's Food Survey II

NCFS II

Summary Report

Food based dietary guidelines

British Journal of Nutrition (2023), 129, 2011–2024 doi:10.1017/S0007114522002781

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Food and nutrient intakes and compliance with recommendations in school-aged children in Ireland: findings from the National Children's Food Survey II (2017–2018) and changes since 2003–2004.

Laura Kehoe[1*], Maria Buffini[2], Breige A. McNulty[2], John M. Kearney[3], Albert Flynn[1] and Janette Walton[4]

Food Safety Authority of Ireland

SCIENTIFIC COMMITTEE REPORT

2023

Vitamin D: Scientific Recommendations for 5 to 65 Year Olds Living in Ireland

SCIENTIFIC COMMITTEE REPORT

2021

Scientific Recommendations for Food-Based Dietary Guidelines for Older Adults in Ireland

Food safety – exposure assessment

European Food Safety Authority

Food Safety Authority of Ireland

REPORT OF THE SCIENTIFIC COMMITTEE OF THE FOOD SAFETY AUTHORITY OF IRELAND

2018

Total Diet Study 2014–2016: Assessment of dietary exposure to fluoride in adults and children in Ireland

Original Articles

Dietary intake of four artificial sweeteners by Irish pre-school children

Danika M. Martyn, Anne P. Nugent, Breige A. McNulty, Emer O'Reilly, Christina Tlustos, Janette Walton, ...show all

Pages 592-602 | Received 11 Nov 2015, Accepted 07 Feb 2016, Published online: 04 Mar 2016

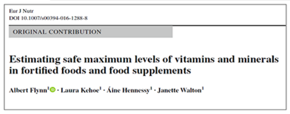
Food safety – fortified foods & food supplements

European Journal of Nutrition
https://doi.org/10.1007/s00394-019-02111-4

ORIGINAL CONTRIBUTION

Modelling the impact of mandatory folic acid fortification of bread or flour in Ireland on the risk of occurrence of NTD-affected pregnancies in women of childbearing age and on risk of masking vitamin B_{12} deficiency in older adults

Laura Kehoe[1] · Janette Walton[1,2] · Sinead M. Hopkins[3] · Breige A. McNulty[1] · Anne P. Nugent[3,4] · Albert Flynn[1]



Eur J Nutr
DOI 10.1007/s00394-016-1288-8

ORIGINAL CONTRIBUTION

Estimating safe maximum levels of vitamins and minerals in fortified foods and food supplements

Albert Flynn[1] · Laura Kehoe[1] · Áine Hennessy[1] · Janette Walton[1]

Commercial & societal outreach & impact

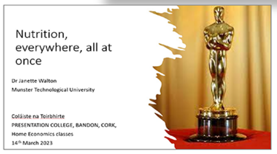
Informing marketing & new product development for food & health industry

Article

Fresh Beef and Lamb Consumption in Relation to Nutrient Intakes and Markers of Nutrition and Health Status among the Population Aged 5–90 Years in Ireland

Laura Kehoe[1,2,†], Emma O'Sullivan[1,†], Chris Cocking[2], Breige A. McNulty[3], Anne P. Nugent[3,4], Kevin D. Cashman[2], Albert Flynn[2] and Janette Walton[1,*]

Public outreach



Nutrition, everywhere, all at once

Dr Janette Walton
Munster Technological University

Coláiste na Toirbhirte
PRESENTATION COLLEGE, BANDON, CORK,
Home Economics classes
14th March 2023

National Food Consumption Surveys in Ireland

National Adult Nutrition Survey (NANS II)

Transitioning towards sustainable and healthy eating webinar: Science Week 2022

Dr Janette Walton
Department of Biological Sciences
Munster Technological University

Succeeding Together

www.mtu.ie

Informing health care professionals e.g. pharmacists, dieticians, GPs

Volume 6 Issue 4 Winter 2021

PROFESSIONAL NUTRITION & DIETETIC REVIEW

Irish teens

Diet, lifestyle and weight over time

IPN IRISH PHARMACY NEWS

THE INDEPENDENT VOICE OF PHARMACY

Ageing Well: *Nutrition Considerations for Older Adults*

General diet & lifestyle considerations for older adults

Written by Dr Laura Kehoe, PhD, ANutr

Authors: Dr Janette Walton & Dr Laura Kehoe, Department of Biological Sciences

MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

Physical Activity to support Individuals with an Enduring Mental Health Difficulty

Authors: Shannon Aisling Forde, Tara Coppinger and Susan Rea

What's the problem we are addressing ? Why is it important?

- ☐ An enduring mental health difficulty (EMHD) is a mental illness with a severe and persistent nature that can include bipolar disorder, schizophrenia, other psychosis, personality disorders or depression[1]
- ☐ Research shows clinical benefit in response to physical activity (PA) regardless of intensity[2,3] and, although limited, there is growing evidence to support the use of some digital technologies in clinically diagnosed populations[4]
- ☐ PA can be low for this cohort due to a variety of obstacles; including medication side effects, EMHD symptoms, and a lack of motivation and support[2]
- ☐ This research will design and evaluate appropriate digital PA intervention(s) via Public Patient Involvement (PPI) for a specific range of EMHD's; for those within a residential setting.

Systematic Literature Review = 21 articles

PPI and co-design for the development of the toolkit.

Acceptability and feasibility of the toolkit with a focus on maintaining PA long term

How our research generates IMPACT

Short Term

- Increase PA levels
- Increase digital literacy
-Increase social connectedness
- Decrease psychiatric symptoms

Medium Term

- Improve cardiorespiratory fitness
-Decrease BMI
- Increase PA motivation

Long Term

- Encourage and sustain PA
-Create a solution for a societal change
-Reduce mental health stigma

Results / Achievements to date

- ☐ The systematic literature review (SLR) is currently being finalised.
- ☐ The SLR has highlighted the use of numerous digital PA tools in interventions and for differing periods of time but that none have focused on maintaining PA long-term in this population.
- ☐ **SLR** findings suggest a toolkit approach (physical copy and a digital application accessible on a smartphone/ tablet), aimed at both clinicians and service users, may be worth exploring to help maintain PA participation long-term in individuals with EMHD in a residential setting.
- ☐ Collaborating and exploring potential research synergies with the 'Move More Toolkit' team from Loughborough University, UK to adopt the toolkit in an Irish residential setting.

What is our approach to solving the problem?

- ☐ **Objective 1:** Examine the current PA levels of individuals with an EMHD within a residential care setting.
- ☐ **Objective 2:** Determine barriers and facilitators to optimal PA for individuals with an EMHD within a residential care setting.
- ☐ **Objective 3:** Identify which digital technology tool/s would be most suitable for use to promote PA for individuals with an EMHD in a residential care setting.
- ☐ **Objective 4:** Design and evaluate appropriate digital intervention(s) via a PPI and co-design approach, while understanding the user experience and evaluating whether or not the intervention(s) can increase and maintain PA over time.

Project Team and Key Collaborators

Project Team and Key Collaborators

HSE mental health service providers

Clinicians within the HSE services

HSE mental health service users

Dept. of Sports, Leisure and Childhood Studies-MTU

NIMBUS research Centre-MTU

Working across disciplines - Interdisciplinary Considerations

- ☐ To try and address this societal challenge, this project incorporates a multidisciplinary, PPI, co-design, and human rights-based approach. This study effort is consistent with the work of the wider Aclú project, which aims to enhance health outcomes for people living with EMHD via PA, nutrition, and digital technology; all while using a human rights-based approach.
- ☐ PPI is, "research carried out 'with' or 'by' members of the public rather than 'to', 'about' or 'for' them'"[5]. The PPI group will include individuals with an EMHD, their carers and HSE mental health clinicians. Their input will assist with survey design, focus group discussions, as well as intervention design and delivery.
- ☐ The NIMBUS centre will provide expertise in digital platforms and will support the co-design of digital enabled PA supports.

References
1.City Hackney Health (2018). Adults severe and enduring mental ill health 2018. https://cityhackneyhealth.org.uk/search-publications/
2.Ho PA, Dahle DN, Noordsy DL (2018). Why Do People With Schizophrenia Exercise? A Mixed Methods Analysis Among Community Dwelling Regular Exercisers. Front Psychiatry;9:596. doi:10.3389/fpsyt.2018.00596
3.Vancampfort D, Rosenbaum S, Probst M, Connaughton J, Du Plessis C, Yamamoto T, Stubbs B. (2016) What are the top 10 physical activity research questions in schizophrenia? Disability and Rehabilitation, Available from: https://doi.org/10.3109/09638288.2015.1116622
4.Hollis, C., Falconer, C.J., Martin, J.L., Whittington, C., Stockton, S., Glazebrook, C., & Davies, E.B. (2017). Annual research review: Digital health interventions for children and young people with mental health problems-a systematic and meta-review. Journal of Child Psychology and Psychiatry, 58, 474–503.
5.Health Service Executive Research and Development. (2021). Knowledge Translation, Dissemination, and Impact: A Practical Guide for Researchers. Guide No 8: Patient and Public Involvement in HSE Research. Research and Development, Health Service Executive

Science Foundation Ireland sfi For what's next

ADVANCECRT

Empowering Recovery in Enduring Mental Illness
ACLÚ

Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

Title: Re-evaluating reasonable accommodation policies for dyslexic students in higher education in view of the research

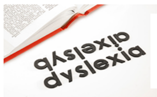
Research Question: Are reasonable accommodation policies for dyslexic students in higher education fit for purpose after Covid-19?

Author: Lucy Crowe (MTU, Kerry)

What's the problem we are addressing ? Why is it important?

Dyslexia is a common learning difficulty affecting around 10 percent of the population (Dyslexia Association of Ireland, 2023). Despite its prevalence, the need for a greater understanding of dyslexia within higher education is highlighted in a qualitative study by Jacobs et al.,(2022). The body of research demonstrates that dyslexic students face significantly more learning and assessment challenges with third-level study than their non-dyslexic peers (Niolaki et al., 2020; Ball et al., 2011; Hughes et al., 2011; Jacobs et al., 2022). Individuals with dyslexia generally spend much longer at learning tasks than their non-dyslexic peers. They must concentrate harder to achieve normal levels of cognitive performance (Nicolson & Fawcett, 2011), are more likely to leave their studies during their first year (Richardson & Wydell, 2003) and tend to obtain lower marks compared to non-dyslexic students (Griful-Freixenet et al., 2017; Richardson, 2015). Many studies also report mental health issues among individuals with dyslexia including anxiety, low self-esteem and self-confidence. According to Jordan et al., (2014) mental health issues may arise for students with dyslexia due to academic anxiety and feeling different relative to their peers.

The gap in the literature around student voice on the research topic has produced the research problem. Empowering dyslexic students to speak about their lived experiences of higher education to people who have power and influence may give rise to a reevaluation of existing policies on reasonable adjustments for dyslexic students in higher education.



This is the Open Dyslexia font. Allegedly, it was designed so that the letters have a 'gravity' to them which helps to anchor them to the baseline and thus prevent them jumping about on the page (this being one of the ways that dyslexia can show itself). I'm not so sure that it's working.

How our research generates IMPACT

The body of research demonstrates that students with dyslexia perform less well academically and are more likely to experience symptoms of depression and anxiety compared to non-dyslexic peers (Griful-Freixenet et al., 2017; Richardson, 2015; Carroll & Iles 2006; Riddick et al., 1999). This research project is being undertaken to give a voice to a vulnerable and underrepresented group regarding their lived experiences of higher education in Ireland. Gaining valuable feedback and insights from dyslexic students about their experiences aims to enhance knowledge and increase awareness about the nature of dyslexia and how it impacts on students' well-being and academic success. Listening to the student voice, challenging mindsets, perceptions and the discourse around dyslexia within higher education may give rise to a reevaluation of existing policies on reasonable accommodation in the aftermath of Covid 19.

This research aligns with HE policies on equality, diversity, and inclusion (EDI). These are underpinned by national & EU law as well as international agreements to which Ireland is a signatory.

Results / Achievements to date

The research will be undertaken under the direction and supervision of the Institute of Education at DCU as part of the researcher's Ed.D. To date, the researcher has explored core theories, concepts, policy and practice in the field of special and inclusive education and completed mandatory assignments on research methods related to the research topic as well as policy analysis on the Irish government's National Access Plan 2022-2028.

What is our approach to solving the problem?

The research aims to give a voice to students with dyslexia in HEIs regarding their lived experiences using a qualitative research approach to data collection. The data gathering will require students to participate in a focus group.

The goal of a focus group is "to find out as much as possible about participants' experiences and feelings on a given topic (Morgan,1993, p.7) Research shows that consultation with students can deliver deeper collaborative learning cultures and their voices need to be heard, listened to and acted upon in policy changes (Flynn and Hayes, 2021).

Project Team and Key Collaborators

The researcher is an experienced lecturer in MTU Kerry with a demonstrated history of teaching and assessment in higher education. The researcher works across faculties within the Kerry campus and is responsible for teaching and assessing students on a range of undergraduate programs in the School of Business and Social Sciences.

The research will be undertaken under the supervision of DCU's Institute of Education
MTU's Disability Support Services will assist the researcher in the recruitment of participants for this study.
MTU's support and counselling services will be involved as the participants in this study are considered potentially vulnerable.

Working across disciplines - Interdisciplinary Considerations

Dyslexia affects people worldwide, regardless of culture or nationality. The importance of research in this field cannot be overstated as it aims to increase understanding of a naturally occurring difference that affects a significant portion of the population.

This research study will add to the small body of existing qualitative research devoted to the educational experiences of students with dyslexia in higher education. Despite progress in recognizing the rights of neurodiverse students, recent studies highlight persistent barriers faced by dyslexic students in higher education and the deleterious consequences the academic environment can have for these individuals. (Jacobs et al., 2022; Clouder et al., 2020). In view of increasing numbers of neurodiverse students across all disciplines within Irish higher education (AHEAD, 2022) empowering students to talk about their experiences and listening to the student voice has never been more important.

HUMAN
RIGHTS
HAS
EVERY

DCU

MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

Development of technologies and strategies for the prevention of pressure ulcers

Authors: Dawn Farrell, Dominika Lisiecka, Steven Darby, Derek Whelan

What's the problem we are addressing ? Why is it important?

Pressure ulcers are a significant debilitating issue particularly experienced by those with disability or impaired mobility and are prevalent in a variety of acute and community settings. The prevalence of pressure ulcers in Ireland is estimated to be 16% in hospital settings (Gallagher et al. 2008).
Pressure ulcers develop due to a combination of prolonged skin loading and environmental and biologic factors that lead to deep tissue damage. If this tissue damage persists it can lead to breakdown of the skin (Figure 1) and development of an open sore.

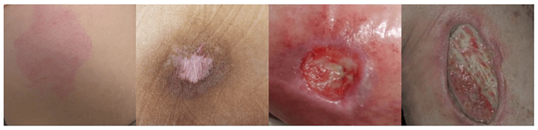


Figure 1: stages of pressure ulcer development (Betul Ay et al 2022)

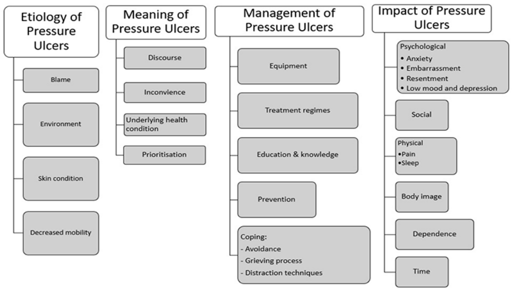
Pressure ulcers have a profound negative impact on all aspects of individuals daily lives, and in severe cases can even result in death. They require intensive healthcare resources to treat and can take many weeks/months to heal.

What is our approach to solving the problem?

Our team our focusing on two approaches to reduce impact of pressure ulcers:

1. To understand the lived experience of people with pressure ulcers in Ireland
2. Development of technological approaches for early detection of pressure ulcers

A qualitative evidence synthesis (figure 2) undertaken has shown that there are no studies of the lived experience of pressure ulcers from an Irish context. Understanding both the physical and physiological impacts and how people interact with the healthcare services is key to reducing the burden of pressure ulcers.



Etiology of Pressure Ulcers
- Blame
- Environment
- Skin condition
- Decreased mobility

Meaning of Pressure Ulcers
- Discourse
- Inconvience
- Underlying health condition
- Prioritisation

Management of Pressure Ulcers
- Equipment
- Treatment regimes
- Education & knowledge
- Prevention
- Coping:
  - Avoidance
  - Grieving process
  - Distraction techniques

Impact of Pressure Ulcers
- Psychological
  - Anxiety
  - Embarrassment
  - Resentment
  - Low mood and depression
- Social
- Physical
  - Pain
  - Sleep
- Body image
- Dependence
- Time

Figure 2: Key findings from qualitative evidence synthesis

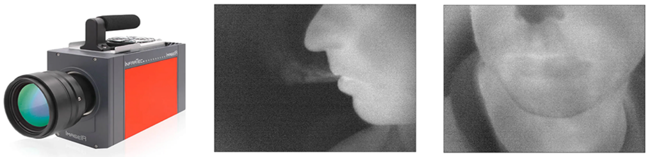
The ongoing study, in collaboration with Crann Centre, seeks to understand the issues in management and treatment of pressure ulcers from both a patient perspective and the healthcare providers perspective.

Development of technological approaches for early detection of pressure ulcers: Early detection of tissue damage is vital to prevent progression into pressure ulcer. In clinical practice, risk assessment tools are used to evaluate patients, however, the predicative validity of these scales is only moderate. Studies have shown an increase in CO_2 under mechanical loading associated with tissue damage and pressure ulcer formation (Mirtaheri, Gjøvaag et al. 2015). However, its clinical use as a predictive biomarker for development of pressure ulcers has not been well established.

How our research generates IMPACT

The Ireland 2040 Report highlight access to quality healthcare services as a national priority. This study will provide valuable information on how care practitioners and services centres can best respond to the needs of this cohort. This will better inform policy decisions in community care and hospital settings using an evidence-based approach.
Development of new technologies for prevention of pressure ulcers have the potential to have significant effect on the quality of life of patients, a reduction of the healthcare burden and can have impacts at a national and global level.

Results / Achievements to date



We have conducted initial feasibility study to determine if existing thermal imaging camera technology could be utilised to visualise CO_2 accumulation for the detection of tissue damage and to support validation studies of CO_2 as a clinical marker. In the above images a 4.2µm filter is used with a mid infrared camera to see directly the CO2 in breath. This system was however not sensitive enough to image CO_2 within porcine samples.

- Change of approach to development of wearable CO_2 sensor to capture and detect CO_2 gas admitted from the skin.
- Qualitative study ongoing to better understand the lived experience of people with pressure ulcers

Project Team and Key Collaborators

Multidisciplinary Team Consisting of Health Sciences, Engineering and Physical Sciences

Steven Darby
CAPPA

Dominika Lisiecka
Dept of Nursing

Dawn Farrell
Dept of Nursing

Derek Whelan
Dept of Mechanical Biomedical Engineering

In collaboration with: crann Solutions for families with neuro-physical disabilities

Working across disciplines - Interdisciplinary Considerations

The problems facing people who suffer with pressure ulcers are complex and multifaceted and require advice and input from a wide variety of perspectives from engineering to scientific to nursing and caregiving.
We have formed a multidisciplinary collaboration spanning different departments, research groups and campuses. We are also working with the Crann Centre who provide valuable insight and validation of our approach.
The key to generating a solution is a better understanding of the end user and we aim to do this through our study on the lived experience of pressure ulcers.

crann
Solutions for families with
neuro-physical disabilities

CENTRE FOR ADVANCED PHOTONICS & PROCESS ANALYSIS CAPPA

MTU
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Munster Technological University

HER-SELF

Highlighting pathways to Empower Rural women to have Sustainable & Equitable Livelihoods in Farming

Authors: Dr. MaryAnne Hurley [1], Dr. Martina Roche [2], Ass. Prof. Áine Macken-Walsh [3], Dr. Noirin Mac Namara [2], Alice Hand [1]

What's the problem we are addressing ? Why is it important?

The UN committed to seventeen Sustainable Development Goals (United Nations, 2015), five focuses on gender equality setting the target of achieving gender equality and empowering women and girls everywhere by 2030. Seven years later, large gender gaps remain across the world. Irish data from the Census of Agriculture 2020 highlights that women are underrepresented as farm holders, farm workers and many undocumented women working in the agricultural sector, making valuable contributions every day to family farms who are essentially 'invisible'. To track and surpass gender equality commitments at EU and national level the visibility, equality and status of women in agriculture is crucial to the successful creation, implementation and evaluation of future strategies.

How our research generates IMPACT

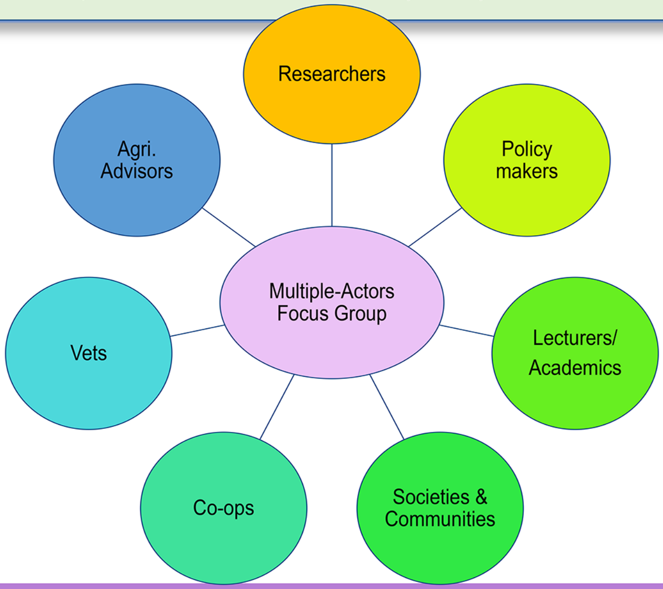
- Establishing a position on women in farming and the agriculture sector and providing evidence for future policy interventions to enhance the role of women in the sector in the future.
- Providing insights into the lives of women farmers and workers in the agricultural sector of all ages, including barriers and enabling factors faced by women throughout their career paths in the agricultural sector.
- Future guidance for policy reform and implementation in the agri-industry across all agri-sectors, prioritizing inclusivity and gender equality for all women going forward.
- To further identify any geographical differences by region or county in the participation levels, incomes and experiences of women involved in agriculture.

Results / Achievements to date

- Achievements to Date:
  - Online Stakeholder group carried out with stakeholders across multiple agricultural sectors.
  - Review of existing datasets, literature and policies.
  - Publications in Agriland and the Irish Farmers Journal
  - Established the multi actor stakeholders group with over 20 participants.
  - Began recruitment of farmers for farming focus groups.
  - Established connection with the Women in Agriculture stakeholders group, policy reformers for gender equality in Irish Agriculture.

What is our approach to solving the problem?

- Datasets, such as the Census of Agriculture 2020 and National Farm Survey, along with literature surrounding gender issues within the agriculture industry will be reviewed to gain an insight to the current (and ongoing) challenges faced by women farmers and farm workers in all sectors of agriculture.
- Geographical datasets will also be analyzed through mapping software (ArcMap), with data gathered from sources such as CSO, OSI, etc.
- Gendered focus groups will be carried out online and in person to analyze existing data on farm income, farm payments and capital investment in farms, and to support effective knowledge sharing and collaboration (Macken-Walsh, Á., 2021).
  - Agricultural Stakeholders – those with appropriate expertise and knowledge of the agricultural sector.
  - Farmers/ Farmworkers – Part-time/ full-time workers on farms or farmland owners.
  - Multiple-Actors – those who have day-to-day contact with farmers



Researchers

Agri. Advisors

Policy makers

Multiple-Actors Focus Group

Vets

Lecturers/ Academics

Co-ops

Societies & Communities

Project Team and Key Collaborators

MTU, Maynooth University, Teagasc, Farmers, Farm workers, CSO, DAFM, Women in Agriculture Group, Irish Farmers Association, Agricultural Science Association, GRASS Ceiling, Alltech Ireland, ABP Food Group, Brady Group, Carbery, FLIARA, Association of Irish Farmhouse Cheesemakers, Irish Organic Association, Macra na Feirme, Slow Food Ireland, The Organic Trust, Equality, Diversity and Inclusion (MTU), Student Representative (Agricultural Sciences), Kerry Group

Working across disciplines - Interdisciplinary Considerations

- Engagement with stakeholders across different agricultural sectors, e.g., tillage, dairy, beef, sheep, policy, co-ops, academic.
- Collaboration with the CSO for data sources, e.g., number of farms owned by women, economic data, geographical data, etc.

Maynooth University
National University of Ireland Maynooth

teagasc
Agriculture and Food Development Authority

An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

Skin Shield Science

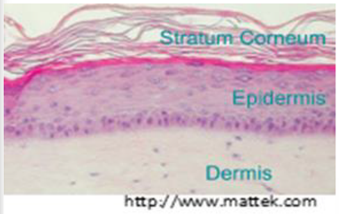
Improving your Skin Shield as your First Line of Defence

What's the problem we are addressing ? Why is it important?

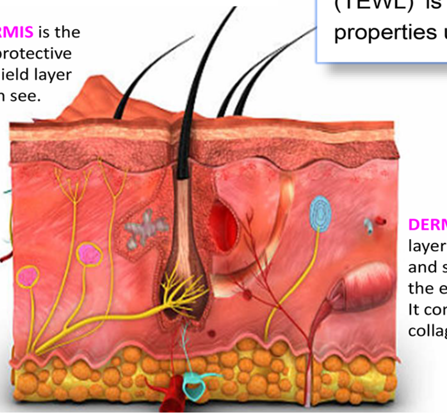
Human skin is the largest organ in the body and serves as our protective shield against the outside environment. Our skin is composed of three primary layers, the epidermis, dermis, and hypodermis. The protective barrier shield of skin resides in the outer layer of the epidermis, the stratum corneum.

A compromised skin barrier shield plays a major role in many skin conditions such as dermatitis, dry skin, aged skin, and delayed wound healing.

There is an increasing demand by skin care companies for new knowledge to better understand the skin barrier which is being driven by their customers who show greater awareness about the origin of their skin care products and product efficacy in supporting a protective skin barrier.



EPIDERMIS is the outer protective Skin Shield layer you can see.



DERMIS skin layer supports and strengthens the epidermis. It contains collagen.

HYPODERMIS cushions and insulates your body and provides nutrients to the skin

What is our approach to solving the problem?

We perform *in-vitro* (laboratory based) testing and research of skin care products and new skin care ingredients with skin cell models. We can examine the effects of new ingredients on skin renewal, quality of skin barrier, anti-oxidant, skin firmness and pro-aging benefits. Using Courage+Khazaka (C+K) Germany, non-invasive skin probes, we can measure skin parameters such as epidermal hydration and moisturisation and dermal elasticity. Transepidermal water loss (TEWL) is widely accepted in dermatology to measure skin barrier properties using a TEWAMETER®.

Project Team and Key Collaborators

The skin science research team of Dr Joanna Tierney in Shannon ABC, MTU with Drs Aleksandra Augustyniak, Bridget Breen, Orlaith Brennan (RCSI), Niall Burke, Ashley Sullivan, and Tim Yeomans work together to advance the state-of-the-art in skin care knowledge, translate this scientific discipline to teaching through course development and to continue to support skin care companies in product research and development.

How our research generates IMPACT ?

Our research is generating impact with skin care companies being able to differentiate their skin care product efficacy with scientific information garnered from research conducted on their products in our laboratory based skin cell culture models without the use of animal testing which can generate a mind-set change in terms of consumer perception.

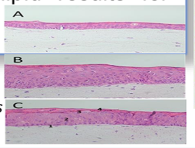
TEWL with a TEWAMETER® measures your skin barrier shield.

Working across disciplines - Interdisciplinary Considerations

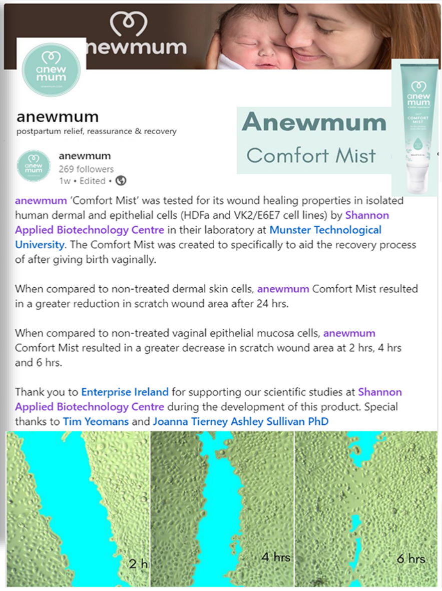
The skin science research team is thoroughly interdisciplinary working across the disciplines of biofabrication, biophotonics, cell biology, chemistry, inflammation, microbiology, molecular biology and physics.

Results / Achievements to date

- ❖ Supported a variety of skin care companies in product research and development from postpartum wound healing to the benefits of topical ingredients in skin care formulations.
- ❖ Active skin research with SMEs and postgraduates (Ph.D., M.Sc.) with the latest skin research technologies in 3D skin cell models and non-invasive skin probes (Courage + Khazaka (C+K), Germany).
- ❖ Generated biomimetic cell membranes as skin barrier models, and 3D human epidermal-dermal skin constructs on biological scaffolds fabricated from natural biomaterials.
- ❖ Skin microbiome and plant lipid results for improved skin barrier shields.



Generation of 3D Skin Shield Cell Models



anewmum
postpartum relief, reassurance & recovery

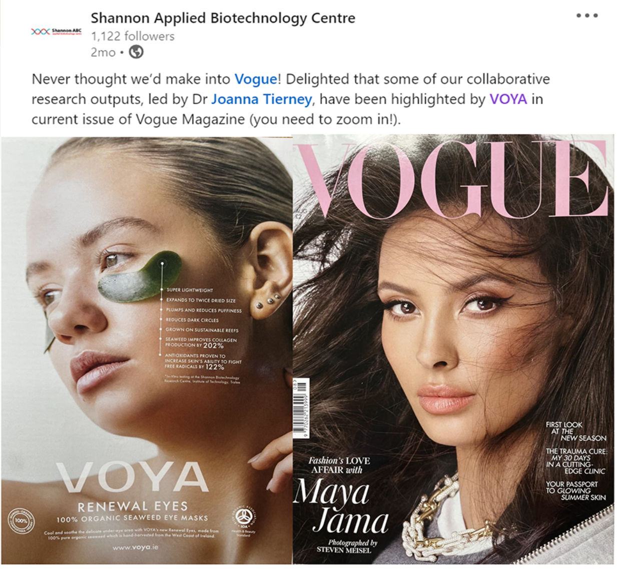
anewmum
269 followers
1w • Edited •

anewmum 'Comfort Mist' was tested for its wound healing properties in isolated human dermal and epithelial cells (HDFa and VK2/E6E7 cell lines) by Shannon Applied Biotechnology Centre in their laboratory at Munster Technological University. The Comfort Mist was created to specifically to aid the recovery process of after giving birth vaginally.

When compared to non-treated dermal skin cells, anewmum Comfort Mist resulted in a greater reduction in scratch wound area after 24 hrs.

When compared to non-treated vaginal epithelial mucosa cells, anewmum Comfort Mist resulted in a greater decrease in scratch wound area at 2 hrs, 4 hrs and 6 hrs.

Thank you to Enterprise Ireland for supporting our scientific studies at Shannon Applied Biotechnology Centre during the development of this product. Special thanks to Tim Yeomans and Joanna Tierney Ashley Sullivan PhD



Shannon Applied Biotechnology Centre
1,122 followers
2mo •

Never thought we'd make into Vogue! Delighted that some of our collaborative research outputs, led by Dr Joanna Tierney, have been highlighted by VOYA in current issue of Vogue Magazine (you need to zoom in!).

Impact of our Skin Research for SMEs in print and social media

Shannon ABC
applied biotechnology centre

Enterprise Ireland

Author:
Joanna.Tierney@mtu.ie

Dissolvable Polymeric Microneedles As An Effective, Painless And Promising Alternative To Parenteral Drug Delivery Methods: A Mechanical Analysis Comparative Approach

What if … administering medications was easier and painless?

What's the problem we are addressing ? Why is it important?

PARENTERAL DRUG DELIVERY METHODS

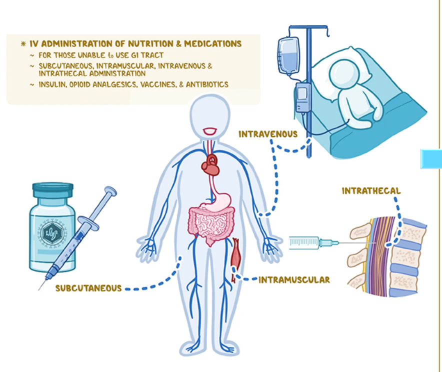

* IV ADMINISTRATION OF NUTRITION & MEDICATIONS
~ FOR THOSE UNABLE to USE GI TRACT
~ SUBCUTANEOUS, INTRAMUSCULAR, INTRAVENOUS & INTRATHECAL ADMINISTRATION
~ INSULIN, OPIOID ANALGESICS, VACCINES, & ANTIBIOTICS
INTRAVENOUS
INTRATHECAL
SUBCUTANEOUS
INTRAMUSCULAR

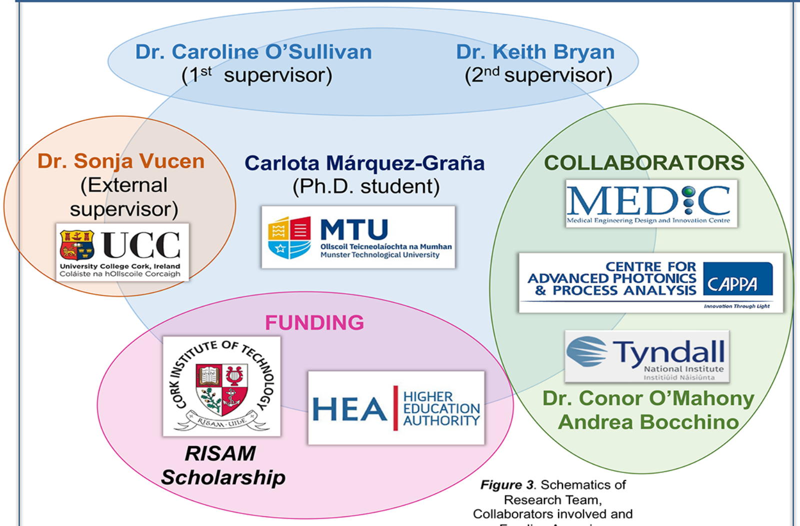
Figure 1. Parenteral Drug Delivery Methods (Guo et al., 2023)

Figure 2. Some Of The Disadvantages Of Using Parenteral Drug Delivery Methods

CONS:

- Adverse Metabolic Reactions
- Vasovagal Syndrome, Pain, Fear
- Potential For Infection
- Cold Chain Transport And Storage
- Low Efficiency, High Dosage
- Specific Training
- First Pass Metabolism
- Disposal Of Medical Waste, Etc.

Project Team and Key Collaborators



Dr. Caroline O'Sullivan
(1^{st} supervisor)

Dr. Keith Bryan
(2^{nd} supervisor)

Dr. Sonja Vucen
(External supervisor)

Carlota Márquez-Graña
(Ph.D. student)

COLLABORATORS

Dr. Conor O'Mahony
Andrea Bocchino

FUNDING

RISAM Scholarship

Figure 3. Schematics of Research Team, Collaborators involved and Funding Agencies

This project aligns with the theme ***" Enhancing A Human Centred Approach To Health And Social Care"*** improving patient-centred approach in drug delivery.

What is our approach to solving the problem?

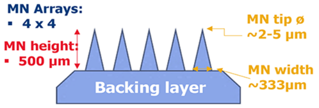


Figure 4. Schematics of a MN patch

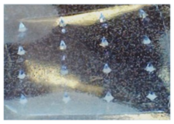


Figure 5. Polymeric MN patch fabricated by MTU group

MICRONEEDLE (MN) TECHNOLOGY

- **Advantages**: Controlled delivery rate, higher efficiency in drug dosage, decrease in bacterial infections, painless, ease of application, not cold chain storage or transport, many types of active compounds and vaccines.
- **Uses**: beauty treatments, sensing, drug delivery in the skin, etc.
- **Materials**: metals, ceramics, sugars, **polymers**, etc.
- **Types**: hollow, solid, coated, hydrogel, porous, or **dissolvable**.

MATERIALS

PLGA 50:50 RG502H 30% w/v

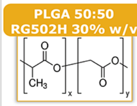


Figure 6. PLGA Chemical formula

PVP K-30 40%w/v

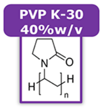
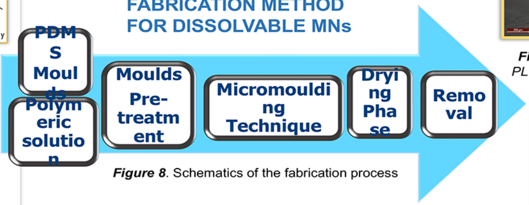


Figure 7. PVP Chemical formula

FABRICATION METHOD FOR DISSOLVABLE MNs



PDMS Moulds

Polymeric solution

Moulds Pre-treatment

Micromoulding Technique

Drying Phase

Removal

Figure 8. Schematics of the fabrication process

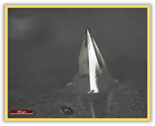


Figure 9. Picture of a PLGA MN fabricated by MTU group

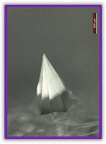


Figure 10. Picture of a PVP MN fabricated by MTU group

How our research generates IMPACT

- **Higher availability** in the administration of medications worldwide.
- **Higher patient compliance, adherence and willingness** to **receive medication**.
- Higher efficiency in drug dosage requiring **lower doses**.
- Controlled **drug release rate.**
- **Local administration** of a treatment.
- **Lower costs** for medications in their manufacturing process.
- **Intended population:** older people, people who require drug control, people with disabilities, children, treatment of addictions, contraception, vaccines, communities in third world countries.
- **Less medical waste**→ less environmental contamination → **lower carbon footprint.**

Working across disciplines - Interdisciplinary Considerations

Team:
✓ Industrial Eng. ✓ Mechanical Eng.
✓ Industrial Chemist ✓ Pharmacist

Further collaborations:
✓ Computer Eng. (AI) ✓ Patients
✓ Chemical Eng. ✓ Medical Staff

Results / Achievements to date

FABRICATION SCORING

MATERIAL	SCORING out of 64
PLGA R502H	59±5.75 (Score 4- 83%)
PVP K-30	64±0.00 (Score 4-100%)

- Successful, repeatable, reliable and standardized **fabrication process** of biodegradable polymeric MNs.
- **Comparison** between 2 polymeric materials (PVP and PLGA) regarding mechanical properties.
- **Deep understanding** in polymeric **MNs behaviour** under mechanical compression.

SHEAR TESTS

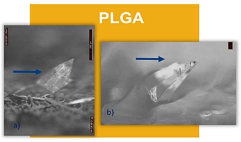


Figure 11. PLGA transverse compression test at: a) ½ height; b) tip

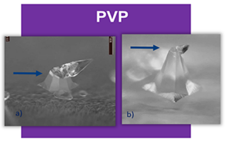


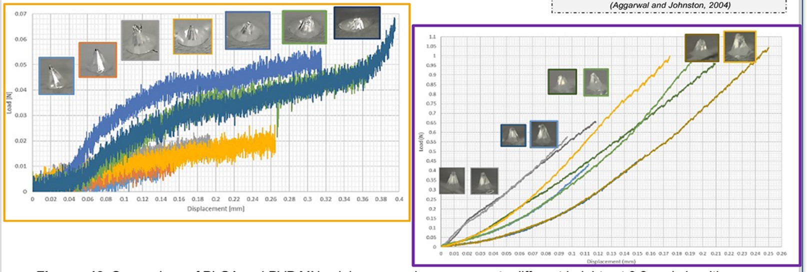
Figure 12. PVP transverse compression test at: a) ½ height; b) tip

F ∝ 1/speed
(0.01 N difference)

F ∝ speed
(0.08 N difference)

AXIAL COMPRESSION TESTS

*Force skin resistance (axial) = 0.03mN
(Aggarwal and Johnston, 2004)



Figures 13: Comparison of PLGA and PVP MN axial compression curves up to different heights at 0.2mm/min with pictures of the MN behaviour: Yellow: PLGA ; Purple: PVP

Aggarwal, P., Johnston, C.R., (2004) Geometrical effects in mechanical characterizing of microneedle for biomedical applications. *Sens. Actuat. B: Chem.* 102, 226–234; doi: *10.1016/j.snb.2004.04.024*

Guo, L., Miao, E. and Reynolds, J. (2023) *Parenteral route: What is it, methods of administration, advantages, disadvantages, and more*, *Osmosis*. Edited by A. Haag, K. LaFayette, and Stacy Johnson. Available at: https://www.osmosis.org/answers/parenteral-route (Accessed: 26 September 2023).

C. Márquez-Graña [1,4] , K. Bryan [2], S. Vucen [3], C. O'Mahony [4] , C. O'Sullivan [1]
[1] Process, Energy and Transport Department, Munster Technological University, Cork, Ireland
[2] Mechanical, Biomedical and Manufacturing Department, Munster Technological University, Cork, Ireland
[3] School of Pharmacy, University College Cork, Cork, Ireland
[4] Tyndall National Institute, University College Cork, Cork, Ireland

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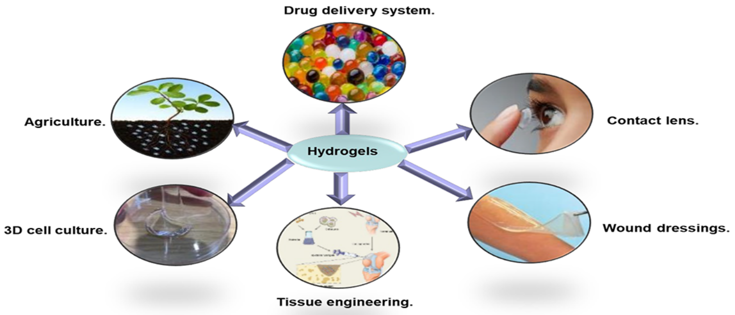
Munster Technological University

Characterization of a novel Hydrogel for *in-vitro* vascular applications

Authors: Wisdom Shadrach, Tim Yeomans, Joanna Tierney, Niall Burke

What's the problem we are addressing ? Why is it important?

- ❖ Cardiovascular disorders (CVD) are known to account for around one-third of mortality and morbidity across the world, and as such there is continued demand to advance novel medical devices and therapies.
- ❖ More robust testing platforms for preclinical characterization of these medical devices and technologies, and the exciting new world of hydrogel offer potential in creating advanced testing platform.
- ❖ A robust preclinical testing platform will lead to more reliable per-clinical findings and this correlate to better and efficient vascular therapies/medical devices, reduce treatment failure, save the pharma industry cost/time and help improve health and well-being of all.



What is our approach to solving the problem?

Single cell type culture → **Double cell type culture** → **Triple cell type culture**

- ❖ Incorporating a triple human vascular cell culture into medical device testing polymer
- ❖ This approach is unique as it seeks to closely mimic the cellular composition and arrangement in human vasculature.

Project Team and Key Collaborators

Key Partner → met medical & engineering technologies; Shannon ABC Applied Biotechnology Centre

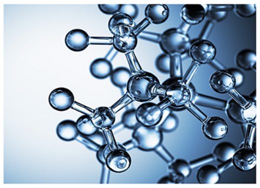
Target Application → **Preclinical testing of medical devices**

How our research generates IMPACT

- Short Term: Advance knowledge on the use of Hydrogels as scaffold material for vascular cell culture applications.
- Medium Term: Provide a robust alternative vascular testing platform for preclinical industrial efficacy testing.
- Long Term: Reduce the use of animal models for testing of vascular medical devices and therapies

Working across disciplines - Interdisciplinary Considerations

Currently the interdisciplinary collaboration involved in this project includes:



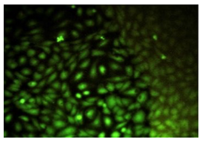
Polymer Engineering

→

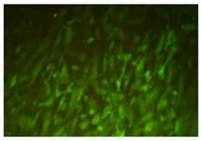
Cell culture scientist

Results / Achievements to date

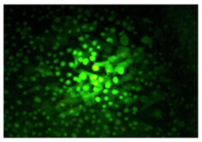
Single cell type culture → **Double cell type culture** → **Triple cell type culture**



Single cell type culture on hydrogel.

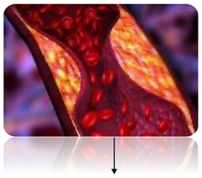


Single cell type culture on hydrogel.

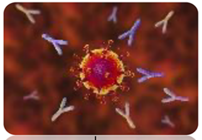


Double cell type culture on hydrogel.

Hydrogel culture model was used for the following purpose thus far.



❖Creating an in-vitro vascular disease model.



❖Observing vascular cells immune response

❖Drug testing platform .

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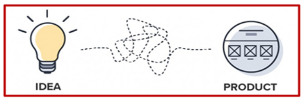
Munster Technological University

Cell Culture for IMPACT

Authors: Niall Burke, Ashley Sullivan, Aleksandra Augustyniak, Dhanyamol George, Joanna Tierney, Tim Yeomans

What's the problem we are addressing ? Why is it important?

R&D in the life sciences and biotechnological industry is time consuming and expensive. Companies tend to have limited access to the relevant equipment and expertise around biological testing models and require an ethical, time- and cost-efficient solutions. The use of mammalian cell culture can be a powerful tool for de-risking product development by testing for biological efficacy of potential ingredients and extracts in a physiologically relevant manner. Cell culture-based methods are used to predict biological responses to products and ingredients of interest which can provide translational information to help improve products for various sectors including pharmaceutical, food, skincare and health.

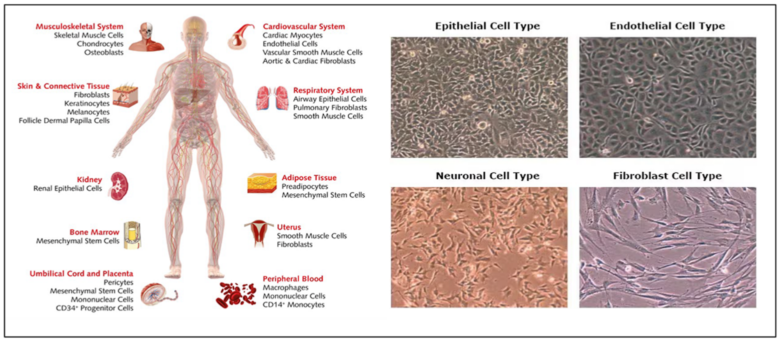

IDEA
PRODUCT

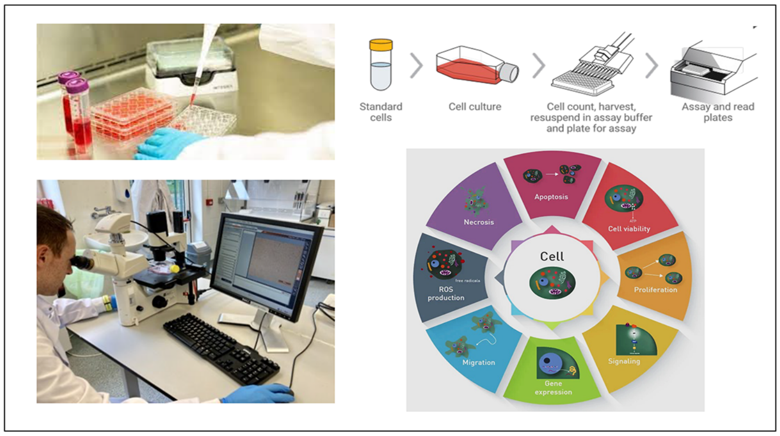
Solution required:

NOT TESTED ON ANIMALS
SAVINGS

What is our approach to solving the problem?

Using human and animal cell lines that represent different tissue types, we can employ various bioassays to help to determine efficacies of interest for many products or their ingredients; this allows us to tailor the experimental approach to each individual company and product of interest. We use well established and scientifically validated protocols, incorporating control samples of known efficacy alongside competitor products to provide the most market relevant data as possible Examples of commonly used bioassays include measuring for cytotoxicity, antioxidant, anti-inflammatory, wound healing properties.


Musculoskeletal System
Skeletal Muscle Cells
Chondrocytes
Osteoblasts
Cardiovascular System
Cardiac Myocytes
Endothelial Cells
Vascular Smooth Muscle Cells
Aortic & Cardiac Fibroblasts
Skin & Connective Tissue
Fibroblasts
Keratinocytes
Melanocytes
Follicle Dermal Papilla Cells
Respiratory System
Airway Epithelial Cells
Pulmonary Fibroblasts
Smooth Muscle Cells
Kidney
Renal Epithelial Cells
Adipose Tissue
Preadipocytes
Mesenchymal Stem Cells
Bone Marrow
Mesenchymal Stem Cells
Uterus
Smooth Muscle Cells
Fibroblasts
Umbilical Cord and Placenta
Pericytes
Mesenchymal Stem Cells
Mononuclear Cells
CD34⁺ Progenitor Cells
Peripheral Blood
Macrophages
Mononuclear Cells
CD14⁺ Monocytes
Epithelial Cell Type
Endothelial Cell Type
Neuronal Cell Type
Fibroblast Cell Type


Standard cells
Cell culture
Cell count, harvest, resuspend in assay buffer and plate for assay
Assay and read plates
Cell
Apoptosis
Cell viability
ATP
Proliferation
Signaling
Gene expression
Migration
ROS production
free radicals
Necrosis

Project Team and Key Collaborators

MTU Kerry Cell Culture Research Team: Dr. Tim Yeomans, Dr. Joanna Tierney. Dr. Niall Burke. Dr. Aleksandra Augustyniak. Dr Ashley Sullivan. Dhanyamol George. Shannon ABC and CAPPA (Enterprise Ireland Technology Gateways) at MTU, Shannon ABC at Technological University of Shannon (TUS) Limerick.

Shannon ABC applied biotechnology centre
CENTRE FOR ADVANCED PHOTONICS & PROCESS ANALYSIS CAPPA
TUS Technological University of the Shannon: Midlands Midwest Ollscoil Teicneolaíochta na Sionainne: Lár Tíre Iarthar Láir

How our research generates IMPACT

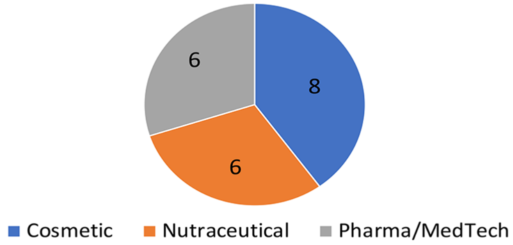
Cell culture models provide valuable screening tools to enable companies to make informed decisions regarding the performance and impact of their ingredients or products. They facilitate applied research for various sectors helping to provide new solutions to industrial R&D challenges. The data generated from cell culture models can strongly contribute to product development, generate new IP, and through published work contribute knowledge to the broader scientific community, all of which ultimately add value to Irish products for both national and international markets.

Working across disciplines - Interdisciplinary Considerations

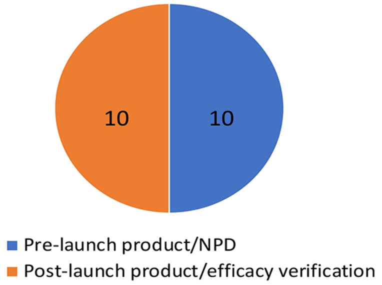
CAPPA and Tyndall (biophotonics), TUS Limerick (analytical biochemistry, microbiology, SEM imaging), Irish SMEs from various sectors including food, health, pharmaceutical, cosmetic, agriculture, veterinary/companion animal care, marine).

Results / Achievements to date

Cell culture projects delivered in last 3 years by sector (total value €280,000)



Stage of product life cycle tested



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Munster Technological University

BioWILL- Exploring the benefits of Willow bark extracts for skincare

Authors: Arnold Marisa, Tim Yeomans, Niall Burke

What's the problem we are addressing ? Why is it important?

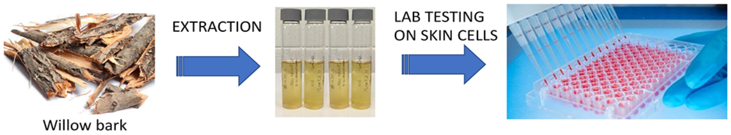
- ❑ BioWILL concentrates on a circular economy and production chain where waste generated is fed back into the production chain. Presently there is no extractive-based cascade biorefinery in the EU: the installation of a refinery such as this has significant economic potential.
- ❑ BioWILL focuses on high value natural extractives for skincare applications, while using the bark-free pulp for manufacturing food packaging materials, with any waste and residues being utilised for biogas and biofertilizers.

How our research generates IMPACT

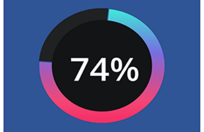
- ❑ BioWILL aims to create a biorefinery model in Northwest Europe region using willow. Demonstrations will show how integrating these technologies can improve efficiency, setting a high standard.
- ❑ Through thorough analysis in various areas, like the market, regulations, finances, technology, and environment, a comprehensive "toolkit" including Life Cycle Assessments and business models will be created. This toolkit will then be shared with the public through a widespread communication effort.

Results / Achievements to date

- ❑ 39 different willow tree varieties have been successfully grown.
- ❑ High value natural medicinal components have been identified in the willow bark extracts.
- ❑ Laboratory biological efficacy studies on human skin cells have shown willow bark extracts to exhibit protective effects such as antioxidant, wound healing and anti-inflammatory properties.
- ❑ The remaining willow pulp fraction has potential for use in the production of biofertilizers and biofuels.

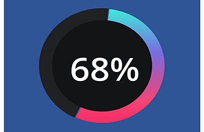

Willow bark
EXTRACTION
LAB TESTING
ON SKIN CELLS

Anti-inflammatory



S.dasyclados, S.Purpurea, Terra Nova, Endurance, Endeavour, Resolution, Cheviot, Tora (0.1, 0.01, 0.001, 0.0001mg/ml - $p<0.05$)

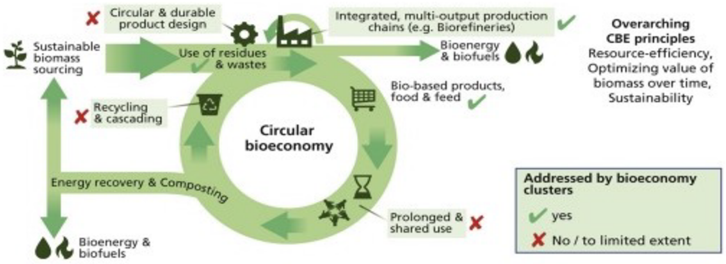
Anti-oxidant activity

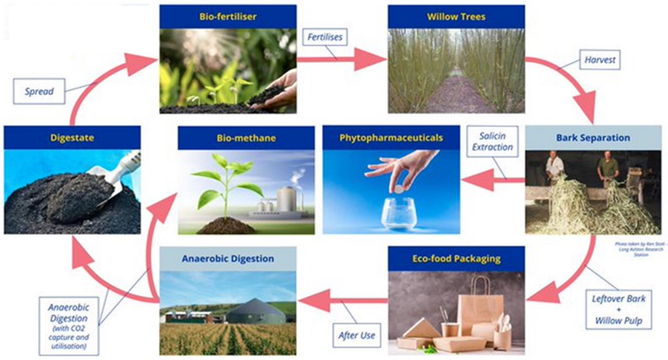


S.dasyclados, S.Purpurea, Terra Nova, Endurance, Endeavour, Resolution, Cheviot, Tora (0.1, 0.01, 0.001, 0.0001mg/ml - $p<0.05$)

Willow bark extracts product cream

What is our approach to solving the problem?


Circular & durable product design
Integrated, multi-output production chains (e.g. Biorefineries)
Sustainable biomass sourcing
Use of residues & wastes
Bioenergy & biofuels
Bio-based products, food & feed
Recycling & cascading
Circular bioeconomy
Energy recovery & Composting
Prolonged & shared use
Bioenergy & biofuels
Overarching CBE principles
Resource-efficiency, Optimizing value of biomass over time, Sustainability
Addressed by bioeconomy clusters
✓ yes
✗ No / to limited extent


Bio-fertiliser
Fertilises
Willow Trees
Harvest
Spread
Digestate
Bio-methane
Phytopharmaceuticals
Salicin Extraction
Bark Separation
Photo taken by Ken Stott - Long Ashton Research Station
Anaerobic Digestion
Eco-food Packaging
Leftover Bark + Willow Pulp
Anaerobic Digestion (with CO2 capture and utilisation)
After Use

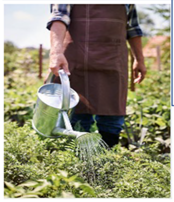
Project Team and Key Collaborators

- ❑ BioWILL consists of 10 project partners in four countries across Northwest Europe (Belgium, France, Ireland and United Kingdom).
- ❑ The BioWILL consortium comprises the following partners and sub-partner organisations:

University of Limerick Ollscoil Luimnigh
afbi Agri-Food & Biosciences Institute
cellulac
Prifysgol Bangor University
Epitheal
Agriland
Helicon
ELO European Landowners' Organization
Gas Networks Ireland
Materia Nova
UCC
Crops for Energy
MTU

Working across disciplines - Interdisciplinary Considerations

Farmers as sources of growing Willow tree



Irish farmers journal news : ' A new research project is aiming to develop a range of new product from willow…'

Medicine - Arthritis treatment

Anti-inflammatory properties of Willow bark extract

Skin care and therapy products

Protection from UV light and harsh environments

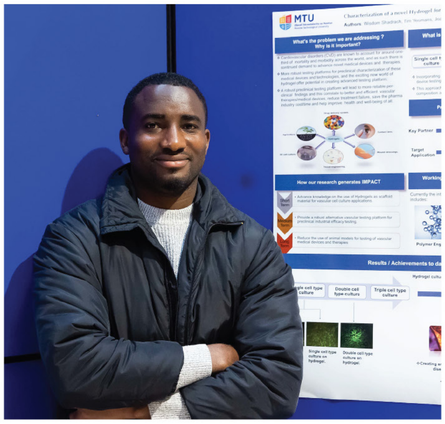
Recyclable packaging materials

The willow pulp produces recyclable trays, plates, folks, spoons, cups, etc. It will be also used for biofuel and fertilizers production.

Conversation
with
Professor Roy Sleator

Looking for a company to demonstrate our new circular business model for beverage packing
Academia
Crowdhelix
Industry
MTU

24
25


MTU

ENERGY, CLIMATE & SUSTAINABILITY, MANUFACTURING MATERIALS

Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

ARCSAR: Arctic and North Atlantic Security and Emergency Preparedness Network

Author: Simon Patterson, Halpin Centre for Research and Innovation,
National Maritime College of Ireland

What's the problem we are addressing ?
Why is it important?

he new polar silk road is a term for the emerging trade routes along the rctic region as the ice melts due to climate change. The latest studies redict that the Arctic will have ice-free summers by 2050, which will ncrease the accessibility of the region for shipping and commerce.

HE ARCSAR NETWORK addresses the Arctic and North-Atlantic (ANA) egion, preparing to cope with the security and safety threats that will result om increased commercial activity in the region including traffic through the orthern passages, cruise traffic, and offshore oil and gas activity.

'SAR Queen' AW101 helicopter from 330 Squadron, Norway conducting a rescue operation during the ARCSAR LIVEX22 exercise

How our research generates IMPACT

- A total of 18 events including three tabletop exercises and a LIVEX have enhanced and evaluated the effectiveness of cross-border and local coordination and collaboration in mass-rescue operations.
- Lessons learned from these exercises have been evaluated in the participant organisations, and improvements have been made both in the cruise industry capability and the SAR authority coordination based on the findings.
- A major report on innovation priorities, best practices, and action plan for security and standardisation for practitioners and other actors in the Arctic and North-Atlantic region is expected to have a significant policy impact.
- ARCSAR has established a database of major exercises and incidents in the Arctic region, ensuring that lessons are learned from these events.

Results / Achievements to date

>100 member network
5 Policy Briefing Papers
1 Peer-Reviewed Publication
18 International Events
An Online Innovation Arena
3 Emergency Response Table-Top Exercises
1 Major International Live SAR Exercise LIVEX22
4 Multinational Stakeholder Workshops

What is our approach to solving the problem?

- The project has created a network of security and emergency practitioners in the Arctic and North Atlantic regions, involving various actors and stakeholders.
- ARCSAR is exploring the needs, challenges and opportunities for improving security and emergency capabilities, competence and cooperation.
- ARCSAR is monitoring and disseminating relevant innovation and research in the field.

Project Team and Key Collaborators

ARCSAR is an International Collaboration between Joint Rescue Control Centres, Coast Guards, Universities, Expedition Cruise Industry, Technology companies and other Practitioners. Coordinated by JRCC-Northern Norway, the project consist of 20 partners from 12 countries: Norway, Iceland, Faroe Islands, UK, Ireland, Italy, USA, Germany, Finland, Sweden, New Zealand and Canada.

ARCSAR Partners and Network

Working across disciplines - Interdisciplinary Considerations

The ARCSAR network is a live, constantly growing community that brings together an interdisciplinary group of SAR authorities, indigenous people, academia, SMEs, governments and other organizations within the ARCTIC search and rescue domain. All in one place.

ARCSAR LIVEX22 Catastrophe exercise, Svalbard , Aug2022

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 786571.

MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

AI-ARC - Artificial Intelligence Based Virtual Control Room for the Arctic

Author: Dr Sarah Milne, Halpin Centre for Research and Innovation, National Maritime College of Ireland

What's the problem we are addressing ? Why is it important?

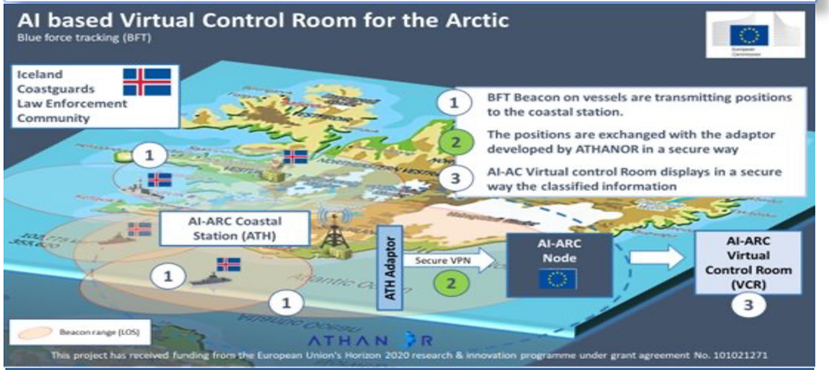
Climate change and global warming is melting Arctic sea ice at a rapid rate, while at the same time, opening up new shipping routes. An increase in commercial shipping, fishing and cruise vessels in the Arctic will lead to more emergencies and security incidents in the region. But the distances between Search and Rescue (SAR) bases are very long, and greater collaboration will be need between Coast Guards and Civilian Mariners, to rescue people and respond to incidents.

There are more than 200 vessels operating in Arctic waters every minute

003
COAST GUARD

How our research generates IMPACT

In a maritime emergency, the first to respond on the scene may not be the Coast Guard but another vessel of opportunity in the area. The AI-ARC system has created an innovative solution that provides a step-by-step virtual assistance model that can aid civilian mariners with participating in a Wide Area Search (WAS) for a missing vessel or a man overboard. Through its VCR, AI-ARC will also lead to increased information sharing, rescue-assets coordination and collaboration amongst Coast guards from different countries during an international emergency. Although in the short and medium term the project is focused on the Arctic and Baltic maritime regions, it is expected that in the long term, AI-ARC will be commercialized and could be adopted as a global maritime solution.



AI based Virtual Control Room for the Arctic
Blue force tracking (BFT)

1. BFT Beacon on vessels are transmitting positions to the coastal station.
2. The positions are exchanged with the adaptor developed by ATHANOR in a secure way
3. AI-AC Virtual control Room displays in a secure way the classified information

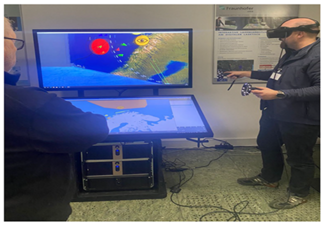
This project has received funding from the European Union's Horizon 2020 research & innovation programme under grant agreement No. 101021271

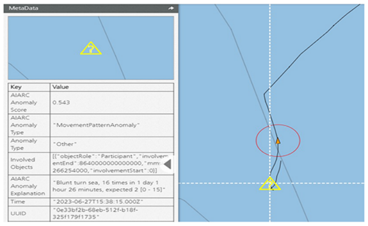
Results / Achievements to date

To date, the AI-ARC technical partners have all the AI services running in the AI-ARC system in preparation for the Baltic Demonstration that will take place 20-21st Sept. 2023, focusing on showing how the AI-ARC system can detect anomalies such as illegal fishing, smuggling or threats to critical underwater infrastructure. The Arctic Demonstration (16-20th Oct 2023) will be hosted by the Icelandic Coast Guard and demonstrate a live Search and Rescue Exercise mission utilizing the AI-ARC system to demonstrate video streaming on the AI-ARC platform, and multi-location online collaboration amongst Coast Guards of different nations during a SAR mission.

What is our approach to solving the problem?

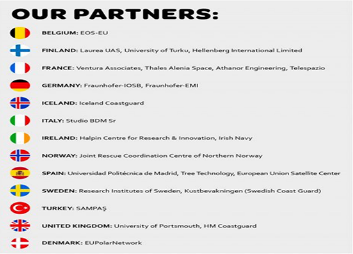
The aim of AI-ARC project (Sept 2021 – Feb 2024) is to create an innovative Artificial Intelligence (AI) based platform and collaboration space, known as the Virtual Control Room (VCR), that provides maritime actors with powerful situational awareness for decision-making and safety, without increasing workload. The digital map table (DigLT) from Fraunhofer IOSB in Germany is **a software system for shared situation visualization and analysis.** Using the DigLT, AI-ARC will provide real-time information sharing to end users across the Arctic maritime region. Over the course of 30 months, AI-ARC has used AI, machine learning and virtual reality to flag detected anomalies and provide threat or risk assessments according to users' predefined needs.





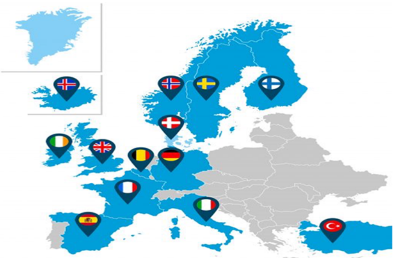
Project Team and Key Collaborators

The AI-ARC Consortium is led by Laurea University of Applied Sciences, Finland, and includes 22 partners from 12 different countries including Halpin at the NMCI, MTU. Partners include Coast Guards, Rescue Control Centre's from 5 countries, Universities, Research Centers, Commercial Companies and the European Security Organization,. Other important stakeholders include the European Fisheries Management Agency and the European Maritime Security Agency. The AI-ARC solution will be most valuable for Coast and Boarder Guard Authorities, private communities, and private enterprises such as the fishing and cruise industries and commercial shipping. By enhancing capabilities of these end-users, AI-ARC helps improve the management of EU bordesr, build secure societies and protect the freedom and security of Europe and its citizens.



OUR PARTNERS:

- **BELGIUM:** EOS-EU
- **FINLAND:** Laurea UAS, University of Turku, Hellenberg International Limited
- **FRANCE:** Ventura Associates, Thales Alenia Space, Athanor Engineering, Telespazio
- **GERMANY:** Fraunhofer-IOSB, Fraunhofer-EMI
- **ICELAND:** Iceland Coastguard
- **ITALY:** Studio BDM Sr
- **IRELAND:** Halpin Centre for Research & Innovation, Irish Navy
- **NORWAY:** Joint Rescue Coordination Centre of Northern Norway
- **SPAIN:** Universidad Politécnica de Madrid, Tree Technology, European Union Satellite Center
- **SWEDEN:** Research Institutes of Sweden, Kustbevakningen (Swedish Coast Guard)
- **TURKEY:** SAMPAŞ
- **UNITED KINGDOM:** University of Portsmouth, HM Coastguard
- **DENMARK:** EUPolarNetwork



Working across disciplines - Interdisciplinary Considerations

The AI-ARC project utilizes interdisciplinary research with software engineers, maritime end-users, business and communications experts and social policy analysts working together. One important aspect of this research project is our engagement with Search and Rescue practitioners i.e. Arctic Coast guard partners and civilian mariner end users. We have collaborated with other research organisations in Germany, Sweden, Norway and Finland. As work-package leaders, our role has been pivotal to capture end-user requirements and functional specifications, through leading workshops with the team of partners.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No.101021271

STREAM – Sensor Technologies for Remote Environmental Aquatic Monitoring

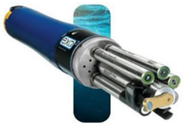
Authors: Mike Griew, Paul Shanahan (Halpin Research Centre),
Ambrose Furey, Naghmeh Kamali (MTU Mass Spectrometry Group)

What's the problem we are addressing ? Why is it important?

Coastal communities face ever-increasing environmental pressure from frequent severe weather events and escalating setbacks to aquaculture industries. Trends indicate substantial challenges coastal communities already face will mount in future.

To mitigate climate change impacts underlying ecological processes need to be better understood, knowledge founded on analysis of high-grained environmental data. But water quality data is extremely expensive.

Industry-standard sensors are prohibitively costly to procure and deploy hence mostly used by regulatory enforcement agencies for spot sampling in specific locations or in narrowly focused academic research.



EXO Multi-Sensor Sonde

Hydrolabs Multi-Parameter Sonde

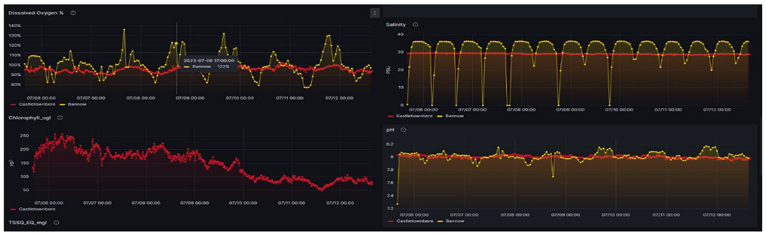
Contamination from harmful marine biotoxins is inferred from the presence of micro-organisms and from build-up in edible animal tissues rather than sampling. Supporting weather data is sparse, generally obtained from relatively low spatial and temporal resolution remote sense sources and a haphazard network of weather reporting stations.

Insufficient data is being collected to allow trends, local hot spots and overall patterns to be modelled for Irish and Welsh coastal and estuarine environments - the key to developing a resilient response to consequences of climate change.

How our research generates IMPACT

- By bolstering national water quality monitoring programs, increasing the frequency and spatial resolution of data.
- By giving local and national planning agencies access to data upon which more appropriate decisions can be based, and to give the public data with which to pressure agencies for action.
- By helping aquaculture industries (fish and mussel farms, oyster farms, seaweed harvesters) to refine stock management strategies, mitigate disease outbreaks and reduce feed waste, and to save harvests prior to harmful algal bloom outbreaks and reduce down-time afterwards.
- To help water supply management agencies deliver pin-point responses to sudden severe weather events, localizing impacts and minimizing duration and cost of recovery action.
- By empowering the public to micro-plan recreational activities and manage outdoor events, enhancing safety and minimizing disruption due to weather outbreaks.
- By providing an additional layer of weather data to the national weather forecasting service.

Results / Achievements to date



STREAM Website Live Sonde Data Feed

The STREAM website provides public access to a range of live sonde and weather data feeds from multiple locations in the project catchment. STREAM servers provide access to weather radar feeds from three locations, support live data from the MTU SEAMOTE water column temperature sensing system and host SCADA control of MTU biotoxin preconcentration and collection apparatus. MTU deployed a sonde and conducted marine biotoxin tracking campaigns aboard the BIM diving training barge moored at Castlegownbere during the summers of 2021 and 2022.

What is our approach to solving the problem?

STREAM leverages cutting-edge material and nano-engineering science and harnesses state-of-the-art wireless embedded micro-electronics to innovate cost-disruptive aquatic sensor technologies.

The set of sensors developed in STREAM not only matches capabilities of industry-standard sondes but also extends the range of available data. Affordable STREAM monitoring arrays measure and disseminate real-time water temperature, nutrient and oxygen content, phytoplankton density and biotoxin concentrations in coastal and estuarine environments at hitherto unattainable temporal and spatial resolution accompanied by supporting weather data.

Project Team and Key Collaborators

STREAM is a collaboration between South East Technological University (SETU), Swansea University (SU) and MTU.

SETU is responsible for:

- Development of optical sensors and electronic platforms in the Pharmaceutical and Molecular Biotechnology Research Center (PMBRC) Smart Systems Development laboratory.
- Data processing and hosting the STREAM website and data storage and dissemination portals by the Walton Institute.

SETU monitoring platform in Wexford harbour

SU is responsible for:

- Fabrication of sensor technologies at the Welsh Centre for Printing and Coating (WCPC), a world leader in applied printing with functional materials,
- Testing sensor technologies developed by STREAM in the Centre for Sustainable Aquatic Research (CSAR) controlled recirculating aquaculture system. CSAR has been a Centre of Excellence in this field since 2003.

SU Printed pH and Dissolved Oxygen Sensor

SU Sensor Hub

MTU is responsible for:

- Development of an innovative sensor deployment platform and marine toxin capture technologies by the Halpin Research Centre, with analytical chemistry expertise provided by MTU Mass Spectrometry Group (MSG),
- Biotoxin sampling expertise and toxicology analysis provided by the MSG.

SU CSAR Algae Lab

MTU Water Column Temperature Sensing System

MTU Marine Biotoxin Preconcentration and Collection Device

MTU Seawater Contaminant Spot Sampler

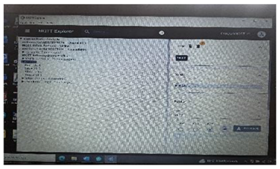
MTU Autonomous Aquatic Sensor Deployment System

MTU Mass Spectrometer

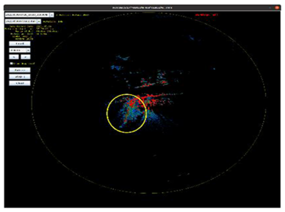
STREAM is supported by Waterford County Council, Wexford County Council, Bord Iascaigh Mhara, Met Eireann, and the Irish Naval Service.

Working across disciplines - Interdisciplinary Considerations

STREAM brings together material scientists, analytical chemists, mechatronics engineers and computer network engineers.



MTU SEAMOTE Live GSM Data Feed



MTU Precipitation Radar Feed

European Union
European Regional Development Fund
EU Funds: Ireland Wales Programme 2014-2020
Tionól Réigiúnach an Deiscirt
Southern Regional Assembly

MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

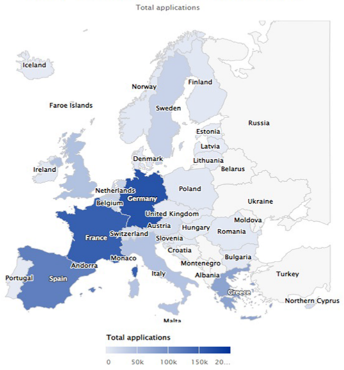
ITFlows
Predicting Migration flows in the European Union

Authors: Maria Looney & Paul Shanahan

What's the problem we are addressing ? Why is it important?

Migration into the European Union is a constant. Many migrants risk their lives traveling to the EU in small overcrowded boats. Many of the Migrants travel to the EU from African and the Middle East. Following dangerous routes to Europe, many are escaping war persecution (Religious, Gender, Ethnic etc.) and environmental disasters; some driven by climate change. Migrants need safer passage to Europe and need to be helped and encouraged into integrating in the countries that they settle in, and not be marginalized.
It is important that migrants integrate and contribute to a stronger diverse Europe and not become disenfranchised and a source of tension with EU countries' communities

Figure 4: Total numbers of asylum applications, 2019


Total applications
Iceland
Norway
Finland
Faroe Islands
Sweden
Russia
Estonia
Latvia
Denmark
Lithuania
Ireland
Belarus
Netherlands
Poland
Germany
Belgium
Ukraine
United Kingdom
Moldova
Austria
Hungary
Romania
France
Switzerland
Slovenia
Croatia
Bulgaria
Monaco
Montenegro
Andorra
Albania
Turkey
Portugal
Spain
Italy
Greece
Northern Cyprus
Malta
Total applications
0
50k
100k
150k
20...

How our research generates IMPACT

On 3 February 2023 we tested and validated the EUMigraTool (EMT) with the project Users Board through a live use case: migration from Mali to the EU. The Mali War is an ongoing armed conflict that started in January 2012 between the northern and southern parts of Mali in Africa. After two short periods of cease-fires, the fighting continued over the year, destabilising the state.
Using the EMT, we analysed a real scenario in three different stages: (a) the flee from Mali to the neighbouring countries; (b) Mali citizens' asylum applications in the EU; and (c) reception of migrants in specific countries, namely in France and Germany. On average, Users Board members found the EMT information on prediction of asylum application very useful, and they also found the EMT suitable for their organisation. They also expressed they would recommend the tool to other organisations. Finally, it is interesting to add that the most frequent adjectives used by the members of the Users Board in association with the EMT have been: 'useful, interesting, ergonomic and powerful'.

Results / Achievements to date

In the first quarter of 2023 ITFlows released the final version of the EUMigra Tool. This was followed up with the development of the EUMigra Tool User Guide. ITFlows has produced 40 deliverable reports including reports on the Impact of family migration and family reunification. In these reports we see that the large number of people migrating to OECD countries between 2014-2018 led to worries about family migration and large numbers of asylum applications - leading some countries to restrict family reunification programmes.

What is our approach to solving the problem?

ITFlows predicts migration flows into the EU, provides tools to manage the migrant flows, as well as reducing the risks of tensions between migrants and EU citizens.

ITFlows' EUMigra Tool will help the flow of migrants and allocate resources according to where they are needed. The tool will also provide knowledge to manage the irregular arrival of migrants to the EU

Project Team and Key Collaborators

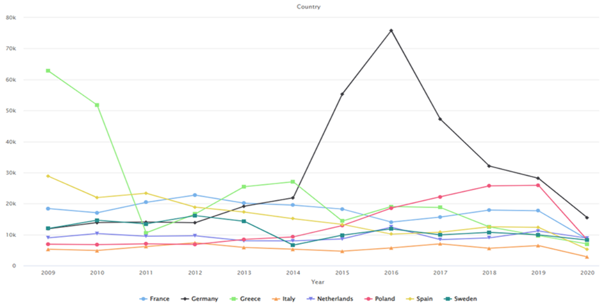
The lead project partner is the Universidad Autonoma De Barcelona (UAB), who are responsible for coordinating the project.
The Center for Research and Technology Hellas (CERTH) developed the EUMigra tool.
Oxfam Italy and The Red Cross Italy provided access to migrants, to capture their experience of migrating to Europe and discover what were the root causes of their migration.
MTU are the communications and dissemination leaders and coordinate the project newsletter.

Working across disciplines - Interdisciplinary Considerations

ITFlows has 14 partner organisations across 9 European countries, with universities, research centres, charities and public policy bodies all working together for the benefit of the project. The charities working on the project enabled the researchers to have access to migrants, and their reports were used to influence the types of operations that the EUMigra Tool is able to perform.

Predicting migration flows
EU Migra Tool
Detecting risks of tensions related to migration

Figure 20: Total number of third-country nationals returned following an order to leave



European Commission
Horizon 2020
European Union funding
for Research & Innovation

MTU Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

DEVELOPING A MEDITERRANEAN AND BLACK SEA SECURITY NETWORK OF PRACTITIONERS ACROSS EUROPEAN UNION MEMBER AND BORDER STATES

MEDEA Mediterranean & Black Sea Security Practitioners' Network

www.medea-project.eu/home-4/about/

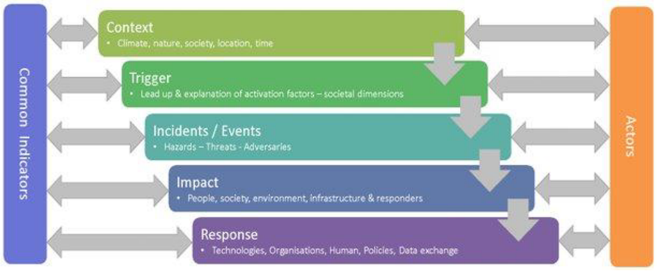
Mediterranean practitioners' network & capacity building for effective response to emerging security challenges

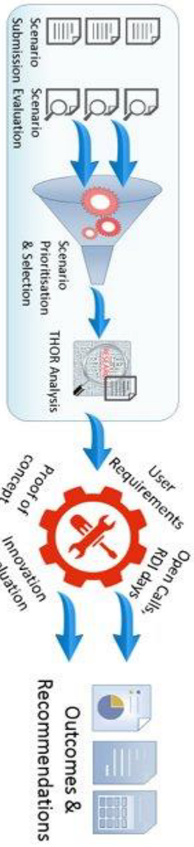
What's the problem we are addressing ? Why is it important? ❶

MEDEA focussed on challenges identified between European Union Mediterranean countries like cross border crime, border security and migration management. Lost knowledge undermines **Early Warning**, **Reactive Capacity**, and **Anticipatory Readiness** of organisations tasked with provision of security & resilience.

Therefore the main focus was on building and **improving cross-border cooperation and collaboration.**

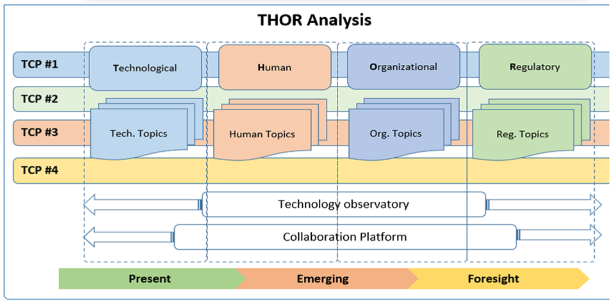
What is our approach to solving the problem? ❷


Common Indicators
Context
Climate, nature, society, location, time
Trigger
Lead up & explanation of activation factors – societal dimensions
Incidents / Events
Hazards – Threats - Adversaries
Impact
People, society, environment, infrastructure & responders
Response
Technologies, Organisations, Human, Policies, Data exchange
Actors


Scenario Submission
Scenario Evaluation
Scenario Prioritisation & Selection
THOR Analysis
User Requirements
Open Calls, RDI days
Innovation Evaluation
Proof of concept
Outcomes & Recommendations

We used Scenario-based assessment of **present, emerging & future** threats to highlight gaps in security capability and services. The aim was to better facilitate preparedness and development of an agile, effective response across MEDEA countries

How our research generates IMPACT ❸


THOR Analysis
TCP #1
TCP #2
TCP #3
TCP #4
Technological
Human
Organizational
Regulatory
Tech. Topics
Human Topics
Org. Topics
Reg. Topics
Technology observatory
Collaboration Platform
Present
Emerging
Foresight

1. Improve collaboration among institutions and actors from different disciplines
2. Define Mediterranean and Black Sea regional security priorities
3. Build a scenario-driven technology roadmap
4. Structure new policies resulting from such interoperability and collaboration
5. Tackling security and societal challenges, common in the Mediterranean and Black Sea region
6. Provide a link between practitioners and the policy makers at national and EU level

Results / Achievements to date ❹

1. Completion of a series of RDI and Practitioner focused workshops & events

2. Sets of scenarios developed in 4 areas, including future incidents and security response protocols

(1) The Management of Migration Flows and Asylum Seekers
(2) Border Management
(3) Fight Against Cross-border Crime and Terrorism
(4) Natural Hazards and Technological Accidents

3. Generation of capability gaps resulting from practitioner consultation

4. Policy brief recommendations outlining outputs of MEDEA 5 year activities

Working across disciplines - Interdisciplinary Considerations ❺

The MEDEA project consortium is made up of multidisciplinary and interdisciplinary organisations incl: security practitioners, police forces and research entities. Project contributors also include EU cross-border security and coastguard agencies EUROPOL and FRONTEX. The diverse nature of the expertise has ensuredvery successful and well-attended collaboration events.

Project Team and Key Collaborators

KEMEA (Greece)	LEA
EOS (Spain)	EUROPOL
ISDEFE (Spain)	MDN
FUNDEA (Spain)	EUC
MTU (Ireland)	ELAS
DGAP (Germany)	HMOD
GUCI (Spain)	FRONTEX
IRIS	

MEDEA is a project that has received funding from the European Union's Horizon 2020 - Research and Innovation Framework Programme **H2020-SEC-21-GM-2016-2017**, under grant agreement no **787111.**

European Commission

Building with Wood: Is Cross-Laminated Timber Fire-Safe?

Project Twitter: @MODCONS_project

What's the problem we are addressing ? Why is it important?

- Population of Ireland will grow by 1 million by 2040 requiring 550,000 new homes and supporting infrastructure.
- Supply of raw material from Irish forests is predicted to double in the next 15 years. This presents both a challenge and an opportunity.
- **Challenge:** to design, develop and test a sustainable modular timber building solution to support national needs.
- **Opportunity:** avoid the use of traditional construction material such as concrete which contribute to around 7-8% of green house gases.
- Cross-laminated timber (CLT) is an important sustainable building product and is gaining popularity due to its many advantages including quick construction, sustainability, durability etc.
- However, the use of CLT has raised concerns because of its combustible nature.
- This research aimed to test and analyse CLT elements under exposure to fire in the main MTU test furnace as shown in Fig 1.

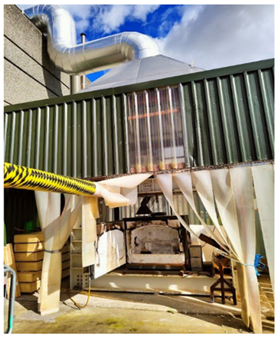


Fig 1. Main furnace

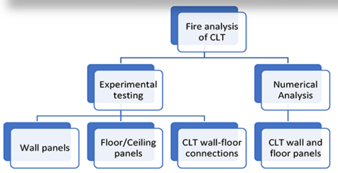
How our research generates IMPACT

- The project will provide a strong foundation for developing and testing a sustainable building solution using Irish timber to support national needs, while creating export opportunities in the sector.
- The current Irish Building Regulations restrict the application of combustible materials, such as wood, in buildings exceeding a height of 10 meters. This research endeavors to establish the basis for revising this building regulation.
- This research will contribute to the existing knowledge and available database on the use of Irish timber as a structural material.
- The outcomes of the project will contribute to future sustainable construction and will allow testing to determine the most efficient and fire resisting connection types. The research will also contribute to a general increased understanding of CLT behaviour under fire conditions, from both testing and finite element analysis.

Working across disciplines - Interdisciplinary Considerations

- The project brings together a diverse team of experts from both industry and academia, specializing in structural engineering, fire design, and acoustics which are integral part of designing a modular timber building.
- The experts collaborate as a cohesive unit, facilitating the exchange of information and progress through frequent meetings and site visits.
- The project incorporates testing of specimens provided by an esteemed international industry partner. The results from these tests are analyzed alongside locally produced specimens, enhancing our comprehensive understanding of modular timber building construction.

What is our approach to solving the problem?



Fire analysis of CLT

Experimental testing

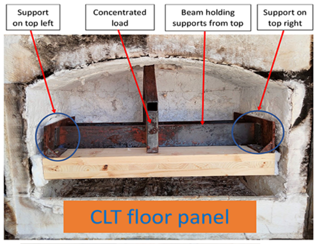
Numerical Analysis

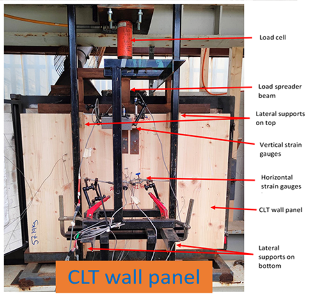
Wall panels

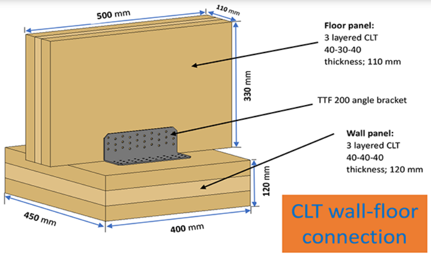
Floor/Ceiling panels

CLT wall-floor connections

CLT wall and floor panels







- Preforming experimental fire testing on Irish-grown CLT elements.
- Measure the charring rates and fire resistance of CLT panels when exposed to standard fire.
- Investigate different protective strategies to enhance the fire performance of CLT elements.
- Perform finite element (FE) analysis to validate numerical model with experimental results for CLT elements manufactured from Irish-grown Sitka spruce.
- Analyse CLT wall-floor connections to investigate the influence of the length and number of fasteners on its shear capacity.

Project Team and Key Collaborators

The MODCONS Project is funded by the Department of Agriculture, Food and the Marine's Competitive Research Funding Programmes. Project Ref: 2019R471

Project team

Munster Technological University	University of Galway
Des Walsh	Prof Annette M. Harte
Kieran Ruane	Dr. Parick McGetrick
Andrew Macilwraith	Dr. Conan O'Ceallaigh
Muhammad Yasir	Rimjhim Kashyap

Results / Achievements to date

- Measured the charring rates of Irish Sitka spruce CLT panels, which closely matches the one-dimensional charring rate of 0.65 mm/min as given in the EN1995-1-2.
- FE models were developed and validated with experimental results as shown in Fig 2. The validated FE models can be used to analyse a series of different fire loading conditions, panel lay-ups and protective measures for C16 Grade material and will serve as a useful tool to improve the safety and reliability of timber structures subject to fire loading.
- CLT panels produced under inadequate pressure during manufacturing can negatively affect their performance when exposed to fire.
- The experimental testing in this study shows that protective claddings can significantly delay the onset of charring of CLT panels, but joints in the protective cladding system reduce the fire performance of the wall system and should be considered during design.
- CLT wall panels protected with different claddings on fire exposed side delayed the charring of the panels by up to 44 min as shown in Fig 3.
- Project results published in highly ranked journals as well as presented in both national and international conferences.

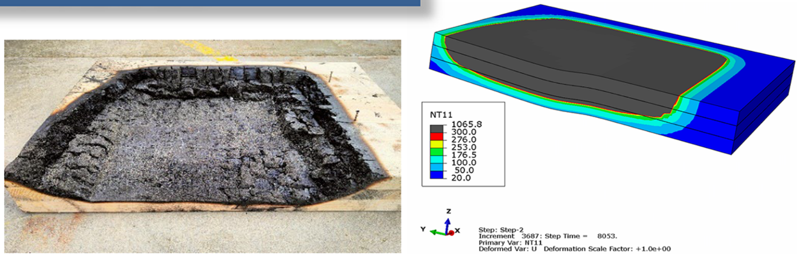

NT11
1065.8
300.0
276.0
253.0
176.5
100.0
50.0
20.0
Z
Y
X
Step: Step-2
Increment 3687: Step Time = 8053.
Primary Var: NT11
Deformed Var: U Deformation Scale Factor: +1.0e+00

Figure 2. CLT wall panel after test a. Experiment b. FE (Grey colour shows the charred wood

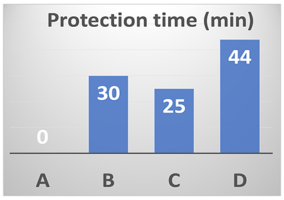


Fig 3. Delay in charring of CLT panels

Legend Fig 3:
A: No protective cladding
B: 15 mm gypsum Fireline plasterboard with no joints
C: 15 mm gypsum Fireline plasterboard with joints
D: 12.5 mm gypsum Fireline plasterboard and 25 mm plywood board.

Authors: **Muhammad Yasir** (PhD Student), Kieran Ruane, Andrew Macilwraith, Des Walsh, Dr. Vesna Jacksic

MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

Digitisation of the Irish Construction Industry

What's the problem we are addressing ? Why is it important?

The Build Digital Project (BDP) seeks to transform the Irish construction and built environment sectors by enabling all stakeholders, particularly SMEs, clients, and suppliers, to develop, maintain, and continuously improve their capabilities as digitally enabled, standards-based, agile, collaborative, and sustainable participants in the delivery of *Project Ireland 2040*.

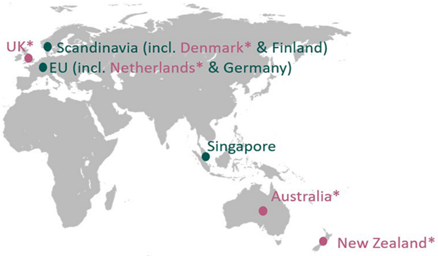
The primary pillars of the BDP align well to address key challenges facing the sector in terms of digital transformation, namely, leadership and culture change, capability and capacity of the workforce, the need for common standards, and appropriate procurement strategies, while also being cognisant of sustainably and the circular economy.

Digital Leadership & Cultural Change
Digital Standards
Digital Education & Training
Digital Procurement
Sustainability & Circular Economy

What is our approach to solving the problem?

In order to inform our approach and identify key learnings for Ireland in the context of digital transformation within the construction sector, a study of international best practice was undertaken. These countries were selected for various reasons including the level of digital maturity, the scale of the built environment sector and geographic spread.

In addition, a number of strategic supports, including toolkits, will be developed to address challenges in terms of knowledge, skills and attitudes within industry. Exemplar projects will be identified in order to raise awareness and build an appetite within the stakeholder community.


UK*
Scandinavia (incl. Denmark* & Finland)
EU (incl. Netherlands* & Germany)
Singapore
Australia*
New Zealand*

How our research generates IMPACT

The success of the Build Digital Project will be ensured through ongoing, sector-wide, significant collaboration between the quintuple innovation helix of industry, academia, government, society, and the environment. The project's team of innovators and academic leaders will work collectively with representatives of over 20 identified "*Voices-of-Customer*" groups from across the regions, scales, sub-sectors, and disciplines of the Irish construction market. Participants in the project will assist in the identification of pain points and specific challenges. They will support the co-creation of solutions appropriate to the Irish market and the sector's global ambitions.

The project is structured around 5 pillars of interconnected activities, each of which will work with experts in that area to adapt international and national best practice to transform Irish construction. Supports in the form of tool kits, guidance, exemplars, and templates will be produced by each pillar, with full interoperability and cognisant of the needs of all stakeholders, particularly SMEs, clients, and suppliers. These supports will be distributed and made available openly through the Irish Build Digital Exchange Hub.

Project Team and Key Collaborators

Ollscoil Teicneolaíochta Bhaile Átha Cliath
TU Dublin
Technological University Dublin

MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

SETU
Ollscoil Teicneolaíochta an Oirdheiscirt
South East Technological University

ATU
Ollscoil Teicneolaíochta an Atlantaigh
Atlantic Technological University

UCD Dublin
University College Dublin

Working across disciplines - Interdisciplinary Considerations

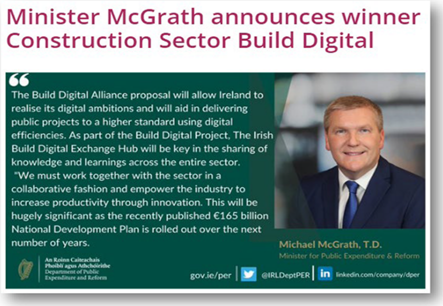
The Build Digital Project is working with a consortium of experts from across the full spectrum of built environment stakeholders. This approach seeks to ensure that the barriers facing the Irish construction industry are addressed through the effective collaboration and consideration of all who are involved in, and will be benefiting from, the digital transformation of the sector.

Deliverables Timeline for Pillar #1 – Digital Leadership & Cultural Change

Year 1 (2022)	Year 2 (2023)	Year 3 (2024)	Year 4 (2025)	Year 5 (2026)
National annual survey developed and launched (Year 1)	National annual survey results and report updated and published (Year 2)	National annual survey results and report updated and published (Year 3)	National annual survey results and report updated and published (Year 4)	National annual survey results and report updated and published (Year 5)
International best practice report published		International Best practice updated and republished		
Existing toolkits identified and evaluated	Prototype of toolkit developed and tested	Enterprise gap analysis toolkit Beta tested	Enterprise gap analysis toolkit published	
Workshop facilitated to support design of a toolkit for enterprise gap analysis	Existing toolkits for enterprise strategy implementation identified and evaluated	Prototype of toolkit for enterprise strategy implementation developed and tested	Enterprise strategy implementation toolkit beta tested	Enterprise strategy implementation toolkit launched and published

Achievements to date

Grant Funding: €2.5 Million over 5 Years (2022-2026)


Minister McGrath announces winner Construction Sector Build Digital

The Build Digital Alliance proposal will allow Ireland to realise its digital ambitions and will aid in delivering public projects to a higher standard using digital efficiencies. As part of the Build Digital Project, The Irish Build Digital Exchange Hub will be key in the sharing of knowledge and learnings across the entire sector. "We must work together with the sector in a collaborative fashion and empower the industry to increase productivity through innovation. This will be hugely significant as the recently published €165 billion National Development Plan is rolled out over the next number of years.

Michael McGrath, T.D.
Minister for Public Expenditure & Reform

An Roinn Caiteachais Phoiblí agus Athchóirithe
Department of Public Expenditure and Reform
gov.ie/per | @IRLDeptPER | linkedin.com/company/dper

Study of International Best Practice

Build Digital
Integrated Project Outcome
Digital Leadership & Cultural Change
International Information Management and BIM Best Practice Report

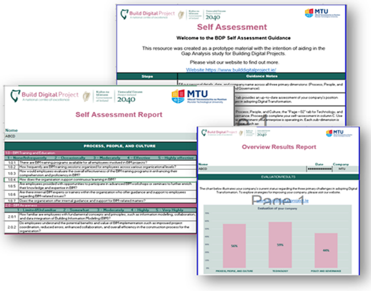
National Annual Survey

Build Digital
Integrated Project Outcome
Annual Survey 2022 Report

Exemplar Case Studies

BUILD DIGITAL PROJECT
CASE STUDY
National Estates Information Systems
NEIS
Introduction
Background
The 6 modules of the NEIS Project

Prototype of Enterprise Gap Analysis Toolkit


Self Assessment
Welcome to the BDP Self Assessment Guidance
Self Assessment Report
Overview Results Report

Authors: Rahat Ullah, Adhban Farea, Dr. Michal Otreba, Ted McKenna, Sean Carroll, Jason Collins, Eoghan Horgan, Dr. Joe Harrington

SIRIG
SUSTAINABLE INFRASTRUCTURE RESEARCH & INNOVATION GROUP

Build Digital Project
A national centre of excellence

Tionscadal Éireann
Project Ireland
2040

MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

Dredged Sediment as a Resource in a Circular Economy

What's the problem we are addressing ? Why is it important?

- Dredge sediment is one of the largest solid waste streams in Europe with currently an insufficient amount of beneficial use implemented; disposal remains the primary fate.
- Dredged sediment has the potential to be used as a 'raw' material, supplementing or replacing natural virgin resources, for infrastructural development and 'Building With Nature' solutions.
- Climate change with the increased erosion and flood risk in the water environment will involve increasing implementation of mitigation measures; some can be provided by sediment.

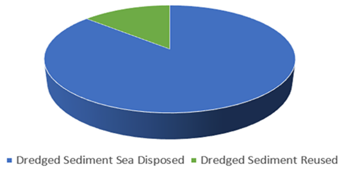


Figure 1 – Dredged Sediment Management in Western Europe

What is our approach to solving the problem?

- SIRIG has worked on this challenge for many years.
- The most recent work is through the EU Interreg SURICATES (Sediment Uses as Resources In Circular And Territorial EconomieS) project which aims to increase sediment use for erosion & flood protection providing new large-scale solutions.
- The SURICATES project aims to enhance flood resilience of civil infrastructure using dredged sediment.
- The SURICATES project has delivered innovative solutions for dredge sediment through application at a number of pilot sites.
- Four integrated decision support tools (GIS, Direct Cost, Economic and Environmental) have been developed to support the dredge sediment management decision making process and the stakeholder community.
- This work has been undertaken in collaboration with industry.

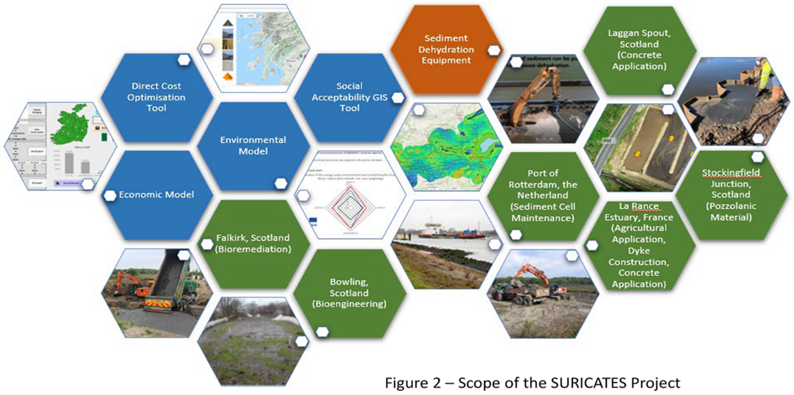

Direct Cost Optimisation Tool
Economic Model
Environmental Model
Social Acceptability GIS Tool
Sediment Dehydration Equipment
Falkirk, Scotland (Bioremediation)
Bowling, Scotland (Bioengineering)
Port of Rotterdam, the Netherland (Sediment Cell Maintenance)
Laggan Spout, Scotland (Concrete Application)
La Rance Estuary, France (Agricultural Application, Dyke Construction, Concrete Application)
Stockingfield Junction, Scotland (Pozzolanic Material)

Figure 2 – Scope of the SURICATES Project

Project Team and Key Collaborators

- The SURICATES Project Team consists of 12 partners across 4 countries (Ireland, Scotland, France and the Netherlands) & 7 associated partners. The partners include Commercial Ports, Waterway Authorities, SMEs and Universities.
- MTU has led the Work Package involving development of an integrated suite of decision support tools. These tools have been applied to a number of real sites including Castletowbere and Fenit Harbours in Ireland, the Port of Rotterdam and a number of sites owned by Scottish Canals.

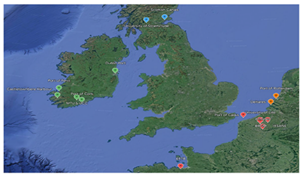


Figure 3 – SURICATES Project Partners

Working across disciplines - Interdisciplinary Considerations

- Sediment management applications inherently involve cross-disciplinary teams.
- The SURICATES project team includes Engineers (MTU, University de Douai & University of Strathclyde), Geochemists (Deltares & the French Geological Survey), Social Scientists and Geographers (University of Lille), Waterway Operators (Scottish Canals) and Business Development (iXsane).
- The integrated models developed address social, broader economic and environmental aspects of sediment management projects.

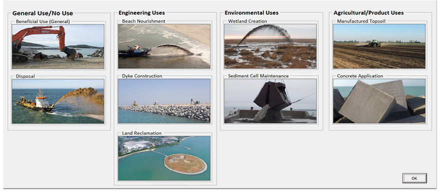

General Use/No Use
Beneficial Use (General)
Disposal
Engineering Uses
Beach Nourishment
Dyke Construction
Land Reclamation
Environmental Uses
Wetland Creation
Sediment Cell Maintenance
Agricultural/Product Uses
Manufactured Topsoil
Concrete Application
OK

Figure 4 – Economic Model for sediment applications developed by MTU

How our research generates IMPACT

- The SURICATES project has successfully demonstrated the potential through pilot projects and tools development for sediment reuse for erosion and flood protection; project details have been widely disseminated. The SURICATES tools have been applied to a range of real sediment projects.
- In an Irish context SIRIG has developed the *Guidelines for Dredged Sediment Reuse in Ireland*, funded by the Environment Protection Agency (Harrington & Smith, 2013).

Figure 5 – Castletownbere Harbour dredging, Ireland

Results / Achievements to date

- The SURICATES project has used 300k tonnes of dredged sediment in innovative sediment management pilot applications including for dyke construction, estuary sediment cell maintenance, agricultural applications, bioengineering, creation of pozzolanic material and concrete.
- This on-going research work in SIRIG has informed the ports and dredging industry in Ireland and raised awareness of the potential for reuse of sediments to meet the needs of the Circular Economy.

Figure 6 – *Ecodelta* dredger at the Port of Rotterdam

Authors: Dr. Joe Harrington, Brano Batel

Interreg
North-West Europe
SURICATES

SIRIG

Classification of Decommissioned Wind Turbine Blades for Re-Purposing

Authors: Mitra Abed[1], Kieran Ruane[1], Paul Leahy[2], Vesna Jaksic[1]
[1] Munster Technological University. [2] University College Cork

What's the problem we are addressing ? Why is it important?

In recent years the importance of growing renewable energy infrastructure worldwide has intensified. However, it is estimated that increasing demand for wind energy generation will lead to around 43 million tones of wind turbine blade (WTB) waste by 2050. The typical life cycle of a WTB is 25 years, after which their reuse (repowering), repurposing or recycling is considered.

The current research indicates that knowledge of the residual strength of the decommissioned blades is essential for repurposing. However, information on WTB original design (i.e., geometry and material distribution) is usually unavailable. For this reason, it is important to have a site-based procedure which will enable early selection of decommissioned blades with repurposing potential (Figure 1).

Damages on blades can affect the life-cycle and productivity of wind turbines as well as increasing costs of maintenance and monitoring. Thus, the importance of regular inspection of blades is obvious to detect deterioration and prevent failure.

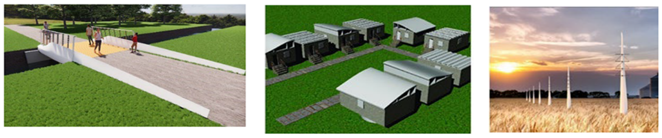
How our research generates IMPACT

Therefore, it is expected that the wind industry is facing around 1000 decommissioned onshore WTBs in Ireland by 2030. European wind industry committed to find solutions for recycling or repurposing of decommissioned WTBs after the end-of-life. Landfill of decommissioned WTBs will be banned in Europe by 2025. Repurposing decommissioned blades has both environmental and economical impacts as recycling of aged WTBs is not economically beneficial. In this regard, the importance of regular inspection of specific parts of blades accounting for condition ratings and severity of damage is inevitable. In this way, the appropriate application of each part of the blade can be determined for repurposing projects. This research contains detailed methodology enabling utilization of the wind energy sector waste in second life use, thereby contributing to the sustainable living. Consequently, the social impact will be felt by everyone.

Results / Achievements to date

Decommissioned WTB's (in whole or part) can be utilized in civil, structural, mechanical, agricultural, etc. projects. This has been demonstrated by research completed to date. Several investigations proved the acceptable performance of decommissioned blades for use in infrastructural projects such as BladeBridge (Figure 2-a), roof of a single-story masonry house (Figure 2-b), or as a transmission pole (BladePole) (Figure 2-c). Developing a systematic approach to analyzing WTB and developing decision support tools focused on decommissioning will be a critical piece in the management of Ireland's existing fleet of wind turbines. Research in this area could have an impact on the economy (new investment and job creation and reduction of LCOE), policies, environment (sustainable decommissioning) and society (developing the circular economy and supporting renewable energy and cost savings for customers).

The assessment method is developed based on categorizing visual blade defects which are rated 1 to 5 (minor damage –superficial-ultimate damage –catastrophic etc.) combined with assessing the condition of specific blade segments. The segments classified as Root Zone, Transition Zone, Aerodynamic Zone (Leading Edge/ Spar Cap (High and Low-Pressure Sides) / Trailing Edge) and Tip zone.



a) BladeBridge b) Blade Roof c) BladePole

Figure 2- Repurposing of decommissioned WTBs in infrastructural projects

What is our approach to solving the problem?

The reliable way of characterizing blades is to undertake destructive laboratory tests, full scale structural testing, and material characterization. Material tests, such as Burn-out tests according to ASTM D2584 [3] are used to characterize the layup of FRP layers and compute the fiber volume fraction. Tension and compression tests, in accordance with ASTM D3039 [4] and ASTM D3410 [5] are used to measure the final tensile and compressive strength of FRP material.

Since there is high volume of decommissioned blades it is not feasible to undertake destructive laboratory testing for each blade. Hence, the development of a procedure of on-site condition rating of WTBs for the purpose of their early classification for repurposing potential is the topic of this research.

Project Team and Key Collaborators

This work is part of A comprehensive decision support tool for end-of-life wind turbines of Ireland: Lifetime Extension, Decommissioning, Repowering, Repurposing [WindLEDeRR] project, which is funded by Sustainable Energy Authority of Ireland (SEAI): National Energy Research Development and Demonstration (RD&D) Funding Programme 2021 [Project ref.: 21/RDD/601].

The project conducts by UCD and is a collaborative study between universities in Ireland. MTU is leading the WP6 project. The main objective of WP6 is to develop a decision-making tool for repurposing decommissioned WTBs in other applications.

Working across disciplines - Interdisciplinary Considerations

The investigation concentrates on the development of the procedure for decommissioned wind turbine blade assessment to facilitate blade repurposing for specific purposes. The procedure contains comprehensive methodology enabling the utilization of the wind power sector waste in a subsequent use. All the methodologies suggested in this undertaking will operate with the data gathered from investigation on repurposing of wind turbine blades to provide valuable knowledge about further application, which will confer advantage to the society. Repurposing wind turbine blades presents several interdisciplinary considerations that involve engineering, environmental sustainability, economics, and social factors. Interdisciplinary Collaboration that involves multiple disciplines is vital in effectively addressing these concerns and developing sustainable, economically strategies for repurposing WTBs. Some of the disciplines that are related to repurposing are: Material Composition and Recycling, Transportation and Installation, Assessment of Environmental Impact, Economic Viability, Lifecycle Assessment, Public Perception and Acceptance.

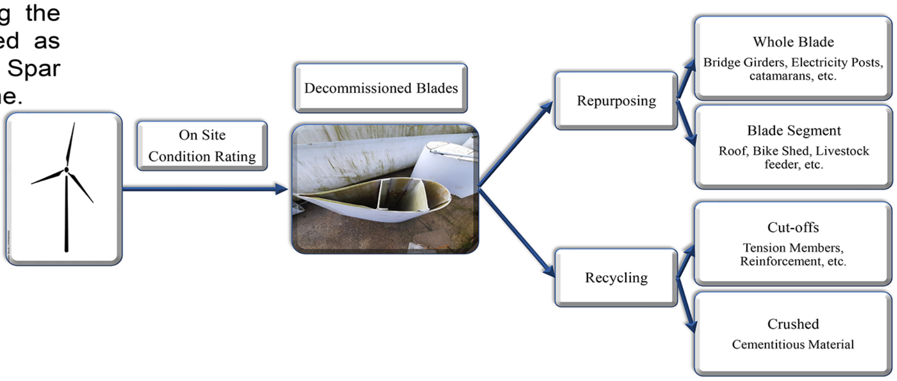

On Site
Condition Rating
Decommissioned Blades
Repurposing
Recycling
Whole Blade
Bridge Girders, Electricity Posts, catamarans, etc.
Blade Segment
Roof, Bike Shed, Livestock feeder, etc.
Cut-offs
Tension Members, Reinforcement, etc.
Crushed
Cementitious Material

Figure 1. Re-Purposing of Decommissioned Turbine Blades in Infrastructural Projects

Monitoring, Modelling and Analysis of River Sediment Transport Processes for Improving Sediment Management

What is the Problem We are Addressing? Why is it Important?

- Excess fine sediment contributes to various problems impacting on river water quality and functions (Ji, 2017).
- Fine sediment is linked to many pressures that negatively impact on the ecological status of Irish rivers, including forestry, hydromorphology and agriculture (O' Boyle *et al*., 2019).
- We are addressing important gaps in the knowledge of sediment behaviour in river catchments; this information can help improve functioning and management of river systems.

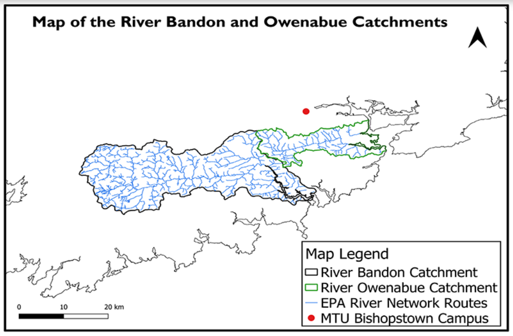


Figure 1. Map of the River Bandon and Owenabue Catchments.*Made with QGIS

How our Research Will Generate IMPACT

- The findings of this research provide important information for stakeholders concerned with sediment management and associated issues in surface waters such as water quality, fisheries, flood risk management, channel maintenance and port maintenance.
- Addressing crucial gaps in our knowledge of sediment transport processes, monitoring and the ability of models to contribute to both our understanding and management of sediment in river catchments.

Figure 2. Field photos of river monitoring station (left) and other field sampling site (right) in the Owenabue Catchment.

Results / Achievements to date

Research by members of the SIRIG group has addressed some key areas relating to sediment transport through study of the Rivers Bandon and Owenabue, including:

- Suspended sediment transport event analysis (Harrington and Harrington, 2012).
- Sediment rating curve models for estimating sediment loads (Harrington and Harrington, 2013).
- Suspended sediment and nutrient transport (Harrington and Harrington, 2014).
- Modelling sediment concentration for storm events (García and Harrington, 2019).
- Channel bank erosion risk characterization and study of bedload transport (Harrington *et al.,* 2020).
- Modelling catchment soil erosion and sediment transport (Crowley *et al.,* 2022).

What is Our Approach to Solving the Problem?

- Our approach involves a combination of field- and model-based applications to help answer important questions about sediment transport behaviour in river catchments.
- SIRIG has continuous, long-term sediment monitoring campaigns in the River Owenabue (117 km²) and the River Bandon (608 km²) Catchments, representing medium and large agriculture-dominated catchments, respectively.
- These are high-quality long-term datasets in an Irish context that provide a strong basis for impactful research; such datasets are uncommon in an Irish context.

Project Team and Key Collaborators

- This research is being carried out by the Sustainable Infrastructure, Research and Innovation Group (**SIRIG**) at MTU.
- In recent years there has been collaboration with different institutions, private companies and relevant authorities including researchers at UCD (through the DAFM-funded HydroSED project), the University de Cartagena and ByrneLooby Consultants through work funded by the OPW.

Working Across Disciplines - Interdisciplinary Considerations

- The complexity and variety of processes governing sediment transport as well as sediment-related impacts on the aquatic environment demands inter-disciplinary knowledge and expertise.
- These disciplines include engineering, physics, hydrology, environmental science, ecology, mathematics, geomorphology, geography, social science and economics.
- Sediment research in SIRIG has consistently sought discussion and input from different stakeholders at various levels to contribute to this research effort. **Example:** SIRIG members are involved in the DAFM-funded HydroSED project which is investigating hydrological and sediment impacts of forestry operations in Ireland. This project has involved an open workshop with stakeholders in Irish forestry including forest managers and forestry operators to develop a better understanding of the challenges that they face in forest management.

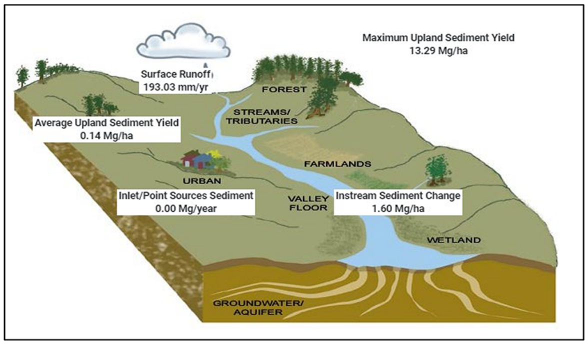


Figure 3. Illustration of SWAT+ sediment modelling (ongoing) in the Owenabue Catchment.*Produced by SWAT+ Check.

Authors: Rodhraí Crowley, Branislav Batel, Leonard O' Driscoll, Dr. Juan García, Dr. Juan Manuel García Guerrero, Dr. Joe Harrington

MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

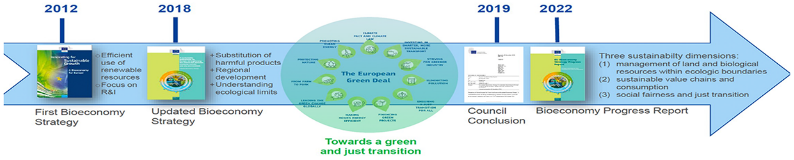
A European comparative study of circular bioeconomy governance strategies and good governance practices for supporting local operators and innovation developers in the circular bioeconomy

Authors: James Gaffey (MTU), Tracey O'Connor (MTU), Robert Ludgate (MTU), Efstratios Stylianidis (AUTh), Maria Partalidou (AUTh), Dimitrios Natos (AUTh), Asterios Theofilou (AUTh), Alexandros Skondras (AUTh),

What's the problem we are addressing ? Why is it important?

The circular bioeconomy involves using renewable biological resources sustainably to produce food, energy, and industrial goods. It also exploits the untapped potential of biological waste, residual materials and wastewater following a cascading use. The European Bioeconomy Strategy was launched as the main governance framework to inspire the deployment of policies in the Member States in 2013. Regional authorities in Europe currently pursue strategies to promote and expand their bioeconomy's. 194 regions in EU-27 have a strategic framework for bioeconomy in place or are in the process of doing so. Due to its cross-sectoral nature, the political support to the bioeconomy currently spans from being set as a multi-sectoral governance model, to be embedded in circular economy roadmaps or other policies.

The analysis of different types of circular bioeconomy governance models and the identification of good practice to be used as examples for replication is important to this continued development of regional circular bioeconomy's.


2012
2018
2019
2022
Efficient use of renewable resources
Focus on R&I
+Substitution of harmful products
+Regional development
+Understanding ecological limits
The European Green Deal
Three sustainabilty dimensions:
(1) management of land and biological resources within ecologic boundaries
(2) sustainable value chains and consumption
(3) social fairness and just transition
First Bioeconomy Strategy
Updated Bioeconomy Strategy
Council Conclusion
Bioeconomy Progress Report
Towards a green and just transition

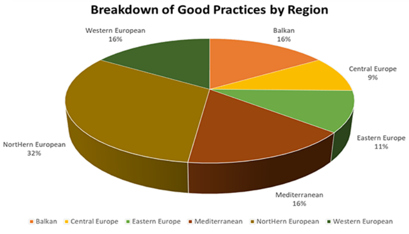
How our research generates IMPACT

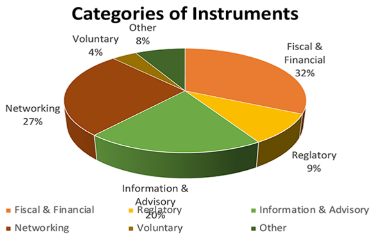
This research within the ROBIN project has resulted with two comprehensive deliverables that developed a defined typology but also resulted in an extensive set of case studies and examples in both governance models and practices that regional decision makers across the EU27 can use to replicate these success stories to develop their own regional circular bioeconomy's. A set of tools to address these improvement areas and support the new governance models and structures will also be developed within the ROBIN project.

Results / Achievements to date

The results presented an overview of regional circular bioeconomy governance strategies and models in the EU-27 and a typology of regional bioeconomy governance models, based on a sample of 20 case studies. The typology distinguishes four bio-based transformation paths and two main governance functions, enabling governance and constraining governance. Our results corroborate previous findings that many regions have set the goal of developing and expanding their bioeconomy's and local governments are providing comprehensive political support to their bioeconomy's to achieve this goal. Currently, regions are highly active in addressing this enabling governance challenge.

Out of 75 good practices identified by the different ROBIN partners – 10 were identified for further case study elaboration & provide ideas and inspiration for regions across Europe.





What is our approach to solving the problem?

A typology was developed to classify the list of good practices of regional governments supporting local operators and innovation developers via appropriate business models and social measures based on an in-depth research of policy documents, previous Horizon projects, JRC reports and academic papers along with data collection survey through the ROBIN consortium. This typology was used when analysing circular bioeconomy good practice enablers along with a further data collection survey of consortium partners to identify a list of examples that were further developed to a more in-depth list of case studies.

Project Team and Key Collaborators

The CircBIO research group at MTU are part of a consortium from across the EU, which includes Q-Plan International (GR), CTA (ES), White Research (BE), Pedal Consulting (SI), Steinbeis (DE), ZSK (SK), AUTh (GR), Region of Central Macedonia (GR), IFA (ES), BPRO (DE), and The Southern Regional Assembly in Ireland.

By setting-up Multi-Actor Regional Constellations engaging key quadruple helix stakeholders to co-create and work alongside novel governance structures, well-embedded within existing organisational structures of our regions and mandated to coordinate and execute circular bioeconomy strategies with and for the entire actor ecosystem.

Three themes from the Creating Our Future Report are addressed:
Improving Policymaking and the Political System
Supporting Innovation in Farming and Food
Embedding Climate Action Across Society.

Working across disciplines - Interdisciplinary Considerations

- ROBIN explores multi-actor needs to foster cooperation among key players for collaborative governance towards regional bioeconomy development and understand the factors, drivers, barriers and motivations that influence their involvement is such schemes.
- The ROBIN project works across the education / research and government sectors and includes policy makers, scientists, social scientists, economists and digital / technology experts.

Horizon Europe
THE NEXT EU RESEARCH & INNOVATION PROGRAMME (2021 – 2027)
European Commission

Farm Zero C - Developing a net zero emissions dairy farm

Authors: Theresa Rubhara[1], Pat Doody[2], James Gaffey[1] – 1: CircBIO, MTU, Tralee, Kerry; 2: IMAR, MTU, Tralee, Kerry.
Contributing partners: BiOrbic (lead), Carbery (Industry lead), TCD, UCD, Teagasc, Grassa.

What's the problem we are addressing? Why is it important?

Ireland faces an enormous challenge of reducing Greenhouse Gas (GHG) emissions from its agricultural sector. Agriculture currently contributes the largest share of Ireland's GHGs, with **38% of national emissions** arising in agriculture in 2021. To address this, the government have placed challenging sectoral targets aimed at reducing agri-related emissions by **25% by 2030**, helping to meet the government's target of 51% emissions reduction by 2030, on the path to achieving net zero emissions by 2050 across the economy. At the same time, agriculture is the backbone of Ireland's rural economy, employing over 100,000 people directly, with large indirect socio-economic benefits for these regions. Providing Irish farmers with models which are economically viable but provide sustainable pathways forward are critical to ensuring that these socio-economic benefits continue to be realised.

What is our approach to solving the problem?

Farm Zero C's Holistic Approach

Farm Zero C (FZC) is working to develop a **world's first economically viable, climate neutral, dairy farm** at Shinagh Farm in Bandon Co. Cork. To achieve this the project is adopting a holistic approach (Figure 1), implementing strategies to target different environmental challenges that exist on the farm. Strategies include those related to soil carbon sequestration (measuring sequestration potential), grassland management (e.g., bio-fertilizers and sustainable grass mixtures, such as clover and multispecies swards), animal diet (e.g., native concentrates diet, methane-reducing additives), renewable energy (solar, wind), bioeconomy (grass biorefinery and anaerobic digestion) and biodiversity (e.g., mapping and increasing on-farm natural habitats). Based on the output data from the demonstration activities FZC is assessing the environmental and economic impacts of these strategies and developing tools to improve the uptake of the FZC model within the wider farming community, including a climate neutral app and platform which will used by farmers to replicate the FZC model on their farms.

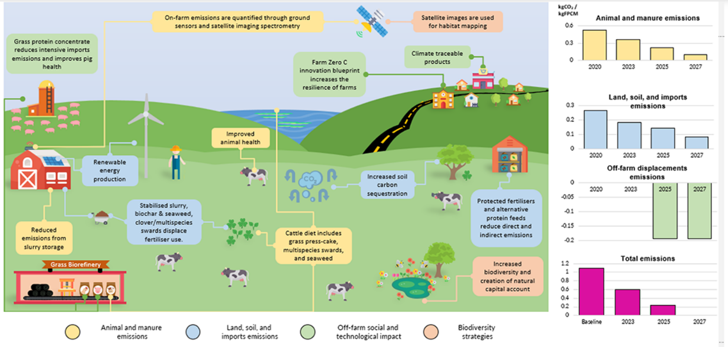

On-farm emissions are quantified through ground sensors and satellite imaging spectrometry
Satellite images are used for habitat mapping
Grass protein concentrate reduces intensive imports emissions and improves pig health
Farm Zero C innovation blueprint increases the resilience of farms
Climate traceable products
Improved animal health
Renewable energy production
Increased soil carbon sequestration
CO_2
Stabilised slurry, biochar & seaweed, clover/multispecies swards displace fertiliser use.
Protected fertilisers and alternative protein feeds reduce direct and indirect emissions
Reduced emissions from slurry storage
Cattle diet includes grass press-cake, multispecies swards, and seaweed
Grass Biorefinery
Increased biodiversity and creation of natural capital account
Animal and manure emissions
Land, soil, and imports emissions
Off-farm social and technological impact
Biodiversity strategies
kgCO₂ / kgFPCM
Animal and manure emissions
0.6
0.3
0
2020
2023
2025
2027
Land, soil, and imports emissions
0.3
0.2
0.1
0
Off-farm displacements emissions
-0.05
-0.1
-0.15
-0.2
Total emissions
1.2
1
0.8
0.6
0.4
0.2
Baseline

Figure 1. FZC holistic model for achieving net zero emissions

Results / Achievements to date

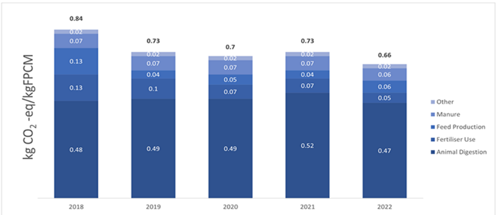


Table 1. FZC GHG Emissions Reduction 2018-2022

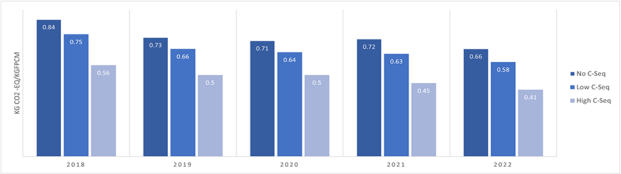


Table 2. FZC projections 2018-2022 when CO_2 sequestration included

To date the project has achieved a **22% reduction** of GHG emissions (CO_2equivalent) since 2018 (Table 1 and 2). Currently soil carbon data is being collected on the farm (via sampling and Eddy Flux tower), to indicate how much CO_2 is being sequestered in soil. The farm has converted to a native ingredients diet with 40-50% lower carbon footprint versus imported ingredients like soya. We have demonstrated a reduction by over 50% methane emitted from stored slurry, using additives. Through inclusion of clover and multispecies swards on our paddocks, and the use of bio-stimulants, we have reduced the application of chemical nitrogen fertilisers by over 40% to date. We have improved farm biodiversity by extending hedgerows, creating wetland habitats, introducing native trees and providing owl and bat boxes. We have implemented a new solar and battery storage system which is part of the new microgeneration programme, provided energy to the milking parlour while exporting energy to the grid. We have test 3 new methane-reducing animal diet additives and analysing results currently. We have conducted a grass biorefinery trial, in which we were able to extract protein from grass to feed pigs, replacing 50% of soybean meal in pig diets, while upholding milk productivity in cows. Through further work in scaling these solutions across the farm, expanding displacement opportunities off-farm (e.g., supply of solar energy to grid and protein to pig farms) along with carbon sequestration opportunities, we expected to achieve **climate neutrality by 2027**. Importantly, almost all FZC strategies are showing cost-saving opportunities for farmers according to our economic modelling.

How our research generates IMPACT

FZC is aiming to create a blue-print for targeting climate neutrality in Irish agriculture. In particular, we aim to target the primary GHG emission challenges of Irish agriculture, namely methane emissions (animal diets and slurry) and nitrous oxide (soil and fertilisers). To achieve impact, the model needs to become widespread. FZC places emphasis on replication, developing tools which empower farmers to replicate this model on their own farms. This includes a climate neutral app, which provides farmers information on the environmental hotspots on their farm, and a social innovation blueprint to guide farmers to our potential solutions, allowing open access to technical, economic and environmental information concerning our mitigation strategies.

Working across disciplines - Interdisciplinary Considerations

FZC is an academic and industry collaboration between researchers, industry and farmers, and bringing together expertise in areas such as agronomy, animal nutrition, bioeconomy and biorefinery, renewable energy, soil and water management, climate modelling agricultural economics, biodiversity and natural capital, food and feed production, ICT technologies and many more.

Project Team and Key Collaborators

Farm Zero C was selected as the winning project under SFI's inaugural Zero Emissions Challenge (Future Innovators Prize) in 2021, receiving €2.5 million to implement our model for developing a net zero emissions dairy farm. Our collaborators include BiOrbic, Carbery, MTU, Teagasc, UCD, TCD, Shinagh Estates, and GRASSA. Building on this work, UCD and MTU have recently received a further €3 million to implement Ireland's first integrated green biorefinery and anaerobic digestion unit on the farm. This will be used to develop off-farm displacement opportunities to reduce emissions.

FARM ZERO C
Farming for a sustainable future

MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

Identifying environmentally sustainable and scalable feedstocks for circular bioeconomy

Authors: Carmen Girón Domínguez[1], George Bishop[2], David Styles[2], James Gaffey[1] – 1: CircBIO, MTU, Tralee, Kerry, Ireland; 2: UG, Galway, Ireland

What's the problem we are addressing? Why is it important?

Planetary and ecological boundaries (PEB) are critical limits for environmental impact. These allow for a certain degree of environmental change before catastrophic consequences for the environment and humanity manifest.
The European Commission works towards acknowledging and understanding PEB while creating systems to monitor and mease global resources to ensure that resource consumption is kept withing these boundaries and could help to establish a **sustainable bio-based resource exploitation**.

What is our approach to solving the problem?

MAPPING BIOMASS ARISINGS

For the first time in Ireland, it's being developed a bio-based resources database that maps arisings and flows at national and county level in Ireland. Primary biomass, by-product, co-product and residue streams have been identified. The database gathers feedstock tonnage, hectarage, yield the ratio of co-products and side streams generated from primary biomass and its biochemical composition.

Bio-ERA tool

This innovative tool provides an early screening of environmental risks associated with increasing the demand for a specific feedstock. The methodology was informed by consequential life cycle thinking based on seven environmental aspects, followed by a structured approach that culminated in an overall environmental risk score for each of the seven environmental aspects based on two key factors: the **Probability of risk occurrence and the Severity of consequences.**

Risk Table and the scores assigned to each level of environmental risk

Probability	Severity of Consequences: Low	Severity of Consequences: Medium	Severity of Consequences: High
High	Medium Risk	High Risk	High Risk
Medium	Low Risk	Medium Risk	High Risk
Low	Low Risk	Low Risk	Medium Risk

	Score
High Risk	3
Medium Risk	2
Low Risk	1

Results / Achievements to date

Case study of an early-stage upstream environmental risk assessment for bioethanol production from alternative agricultural feedstocks in Ireland

From the bio-based resources database:
-Feedstocks suited to first generation (with a high concentration of carbohydrates) and second generation (lignocellulosic biomass) bioethanol production have been chosen.
-Wheat grain, straw from barley, spent mushroom compost (SMC), barley spent grain (BSG) from beer production, willow, Miscanthus, and apple pruning residues (APR).
-Biomass availability (tonnage) per region, dry matter (DM) content, gross calorific value (GCV), carbohydrates (Ch.) and total lignin, and constraints, i.e., availability is limited by environmental or economic factors.

Risk of environmental impact assessment of the bio-based resources :
-Wheat grain had the greatest relative environmental risk associated with increasing the supply for bioethanol production.
-Increasing demand for wheat grain was associated with high environmental risks linked to production inputs and GHG emissions, air- and water-quality, indirect land use change and soil carbon loss (being a tillage crop)
-Apple pruning residues had the lowest risk.
-As a waste product, apple residues are unlikely to drive any additional production activities and are therefore associated with low environmental risk.
-Various by-products were associated with intermediate risks because their appropriation could lead to substitution effects that incur additional biomass production somewhere in the market.

BBF \ Availability & Composition	N&W (t)	S (t)	E&M (t)	DM	GCV	Ch.	TL	Constrained feedstock?
Barley straw	25,335.68	422,633.77	316,781.39	87.9	14.7	66.6	19.9	Yes
SMC	215,543.05	75,090.66	50,400.68	31.2	3.8	66.6	19.9	Yes
Wheat grain	7,404.38	149,109.83	91,059.56	87.0	15.8	84.5	1.1	No
BSG	5,495.63	91,674.56	68,713.85	91.0	19.7	90.8	5.4	Yes
Willow	1,356.48	674.10	5,536.89	93.2	19.5	52.6	27.0	No
Miscanthus	117.70	4,547.00	1,262.30	92.4	18.5	53.0	23.4	No
APR	36.86	372.73	217.66	43.3	17.3	11.1	17.0	Yes

Table 1. Availability and key biochemical composition (in (%W/W) of the BBFs selected.

BBF	Type	PFRI	Production GHG emissions	ILUC	Terrestrial C	Landscape Diversity	Air Quality	Water Quality	Overall Environmental Risk (/21)
Barley Straw	LVBP	2	2	2	2	2	2	2	14
SMC	LVBP	2	2	2	2	2	2	2	14
Wheat grain	DP	3	3	3	3	2	3	3	20
BSG	LVBP	2	2	2	2	2	2	2	14
Willow	DP	2	2	3	1	1	2	2	13
Miscanthus	DP	2	2	3	1	1	2	2	13
APR	W	1	1	1	2	1	1	1	8

Table 2. Potential environmental risk associated with the selected bio-based resources.

How our research generates IMPACT

With these two decision-support tools, **any organisation** could assess the potential viability and environmental risk associated with specific bio-based resources in a local context, and thus identify more sustainable bio-based value chain development.

Working across disciplines - Interdisciplinary Considerations

Agriculture, Marine, Forestry and Waste sectors' stakeholders from Industry, Academia, Government and Social networks has been interviewed and will keep being a key part for the development of the project to achieve the highest quality outcomes possible for Ireland.

Project Team and Key Collaborators

InformBio will support preparations for a bioeconomy observatory for a sustainable and circular bioeconomy. With help from Teagasc, University of Galway (UG) and Central Statistics Office (CSO) and MTU will lead the project to research how to provide a clear roadmap towards a sustainable bioeconomy for Ireland, considering economic, social and environmental aspects, as well as Key Stakeholders Input.

InformBio
Integrated Framework for Mapping, Modelling and Monitoring Ireland's Bioeconomy

Ollscoil na Gaillimhe
University of Galway

An Phríomh-Oifig Staidrimh
Central Statistics Office

Teagasc
Agriculture and Food Development Authority

An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

Bioeconomy boost for rural sub-Saharan Africa

Adapting bio-based technologies to local conditions in rural sub-Saharan African regions can diversify local economic opportunities and support sustainable community development

What's the problem we are addressing ? Why is it important?

Sub-Saharan African communities face multiple livelihood challenges, including agri-food systems that are under pressure to sustain a growing population, in the context of **environmental change**, including climate change, and **rising fuel and food prices** due to global conflict and other global market prices shocks, e.g. the Covid-19 pandemic For the more than 60% of sub-Saharan Africans who are smallholder farmers, **agri-food systems** are not just sources of income. They are vital for **sustainable livelihoods**, including food security, sanitation, and access to education and healthcare, and can drive **inclusive, locally-led sustainable development within rural communities**.

How our research generates IMPACT

We aim to support the deployment of the bioeconomy in rural areas in four sub-Saharan African countries: **Senegal, Ghana, Uganda and Côte d'Ivoire**, through the development of bio-based solutions and value chains with a circular approach to drive the cascading use of local resources and diversify the income of farmers.

During the four-year term of the project:

- **small-scale bio-based technologies** will be adapted to local needs and context, and piloted in the target regions,
- technology pilot cases will be supported by **laboratory analysis and field trials** of the resulting bio-based products with the target consumers, e.g. farmers and rural households, to evaluate replicability and potential impact,
- technologies and products will be **demonstrated to local producers and businesses** in the relevant value chains,
- interested businesses will be supported to **develop plans to integrate the technologies and products within their business activities**,
- Local, regional and national policy-makers and public bodies will be engaged to **support and deploy the bioeconomy in their areas of jurisdiction**.

Results / Achievements to date

- Local needs and agri-food system analysis
- Co-definition of suitable bio-based technologies and feedstocks
- Development and adaptation of eight bio-based technologies: *green biorefinery, pyrolysis, hydrothermal carbonisation, briquetting, pelletising, bioplastics and bio-composite production*.
- Development and laboratory testing of bioplastics and biocomposites
- Field trials underway of animal feed (*sheep, rabbits*) and biochar-based soil amendment (*greenhouse and field trials*)
- Co-design of inclusive and sustainable business models
- BIO4Africa Business Accelerator workshops initiated with 20 local businesses

Figures: a) Biorefinery technology, KRC; **b)** pelletizing technology, INP-HB; **c)** 5L biofermentor for bioplastic production, INP-HB; **d)** empty palm fruit from UASZ being processed for biocomposite production; **e)** pyrolysis kiln model being constructed by SavaNet and INP-HB; **f)** hydrothermal carbonization equipment, UASZ

What is our approach to solving the problem?

BIO4Africa will empower smallholder farmers to generate **new sources of income** by creating value from locally available biomass, utilising **agricultural and food processing residues** in a **circular, bio-based approach** to economic development. Our focus is on developing simple, small-scale and robust **bio-based technologies** adapted to local needs and contexts, including biomass types. These will support farmers and local businesses to sustainably produce a **variety of higher value bio-based products** from agriculture and food processing residues (*animal feed, fertiliser, pollutant absorbents, construction materials, packaging, solid fuel for cooking and catalysts for biogas production*). Products developed through this project will further contribute to sustainable local community development, by addressing **food production, household energy, and health** needs, e.g. *bio-based soil improvement, cooking fuel, and water filtration products*.

Circular bioeconomy approaches offer opportunities for income generation from agricultural and food processing residues, e.g. corn cobs, while also guiding fossil fuel-free pathways for sustainable community development, e.g. *reducing waste directly and over the product life cycle, displacing fossil-based products such as plastics with bio-based alternatives, and developing novel products, e.g. forage-based protein extracts*. Developing and strengthening circular bio-based value chains in sub-Saharan Africa can support rural communities to access **ecologically and socially sustainable economic opportunities**.

Project Team and Key Collaborators

Côte d'Ivoire: Institut National Polytechnique Félix Houphouet-Boigny (INP-HB)

Denmark: Food and Bio-Cluster Denmark

France: RAGT Energie SAS & Centre de coopération Internationale en Recherche Agronomique pour le Développement

Ireland: Celignis Ltd. & Munster Technological University

Ghana: Savannah Young Famers Network (SavaNet), 0km Nomads, Agri-Business Innovation Hub

Greece: Q-Plan International Advisors PC, Draxis Environmental SA

Kenya: Eastern Africa Farmers' Federation Society

Netherlands: Stichting IHE Delft Institute for Water Education, Grassa BV

Senegal: Université Assane Seck De Ziguinchor (UASZ), SCPL SA, Association d'Appui aux Initiatives de Paix et de Développement, Energeco Afrique, GIE Country Farm

Spain: Barcelona Plataforma Empresarial SL, Fundacion Corporacion Tecnologica de Andalucia, Sustainable Innovations Europe SL

Uganda: Kabarole Research and Resource Centre (KRC), African Forum for Agricultural Advisory Services

United Kingdom: African Agricultural Technology Foundation

Working across disciplines - Interdisciplinary Considerations

The BIO4Africa project involves scientists from physical, chemical, biological and social sciences, agricultural and environmental scientists, engineers, technology developers, rural and sustainable development specialists, and community and farming organizations. The project partners work with local women, farmers, agri-food and fuel businesses, and policy-makers in Senegal, Ghana, Uganda and Côte d'Ivoire to achieve the aims of the project.

www.bio4africa.eu

Authors: Tracey O'Connor, Aleksandra Augustyniak, James Gaffey & Helena McMahon
Circular Bioeconomy Research Group, MTU

Funded by the EU's Horizon 2020 Research & Innovation programme, grant agreement No. 101000762
Funded by the European Union

CircBioCityWaste: Converting urban waste streams into value-added products

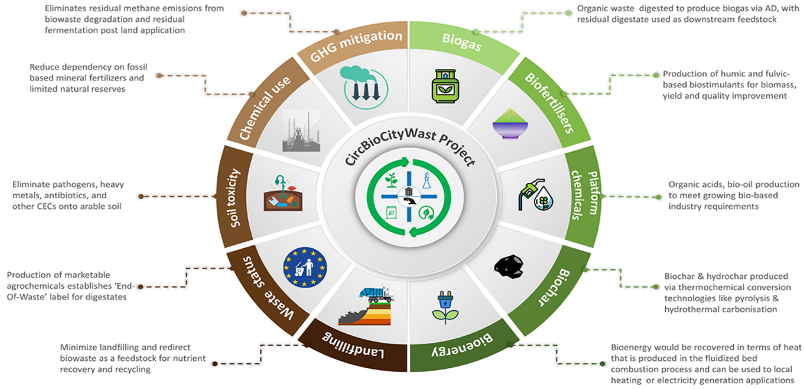
Developing cascading biorefinery for agri-products and bio-waste valorization

Authors: Shon George Shiju[a,b], Patrick Quille[a,b], Dr Eilish Broderick[a], and Dr Gaurav Rajauria[c*]

What's the problem we are addressing ? Why is it important?

Organic waste generation has risen dramatically, primarily liked to the rise in population and their alimentation requirements. Anaerobic digestion, a process of converting bio-waste to biogas has been highly endorsed by the EU and the rest of the world, however with the rise of these AD plants, there is a proportional increase in digestate, the by-product produced. Limited land resources and residual greenhouse gas emissions alongside the risk of nutrient runoffs and associated pollution to surface water bodies have raised to questing current management strategy, that is land spreading.

The CircBioCityWaste project aims to address the limitations of conventional options, applying the 'end-of-waste' approach to develop a one-of-a-kind integrated biorefinery for production of numerous biobased products for agro-economic sector.


CircBioCityWast Project
GHG mitigation
Biogas
Biofertilisers
Platform chemicals
Biochar
Bioenergy
Landfilling
Waste status
Soil toxicity
Chemical use

Eliminates residual methane emissions from biowaste degradation and residual fermentation post land application

Reduce dependency on fossil based mineral fertilizers and limited natural reserves

Eliminate pathogens, heavy metals, antibiotics, and other CECs onto arable soil

Production of marketable agrochemicals establishes 'End-Of-Waste' label for digestates

Minimize landfilling and redirect biowaste as a feedstock for nutrient recovery and recycling

Organic waste digested to produce biogas via AD, with residual digestate used as downstream feedstock

Production of humic and fulvic-based biostimulants for biomass, yield and quality improvement

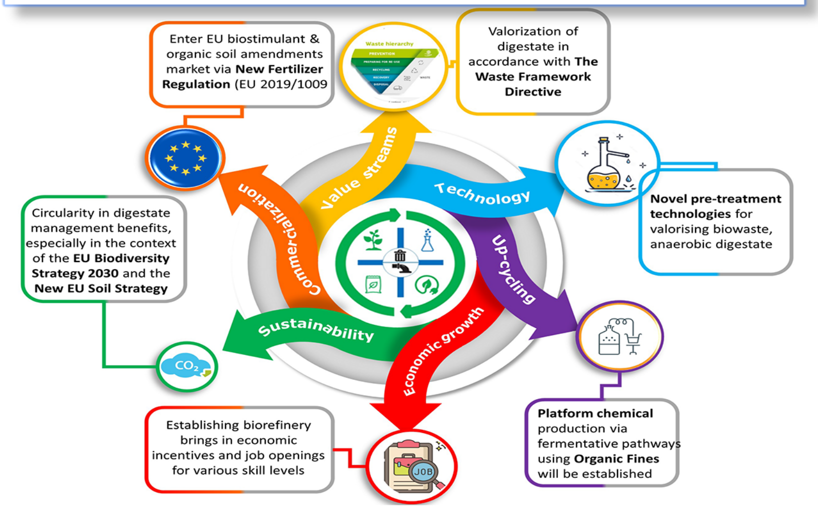
Organic acids, bio-oil production to meet growing bio-based industry requirements

Biochar & hydrochar produced via thermochemical conversion technologies like pyrolysis & hydrothermal carbonisation

Bioenergy would be recovered in terms of heat that is produced in the fluidized bed combustion process and can be used to local heating or electricity generation applications

How our research generates IMPACT

The research carried over in the CircBioCityWaste project will advance the Irish waste management and recycling sector diversification to meet long term EU climate, soil and water quality targets, while delivering significant environmental, economic and societal benefits alongside circular bioeconomy development.


Value streams
Technology
Up-cycling
Economic growth
Sustainability
Commercialization
Waste hierarchy
PREVENTION
PREPARING FOR RE-USE
RECYCLING
RECOVERY
DISPOSAL
WASTE
CO_2
JOB

Enter EU biostimulant & organic soil amendments market via **New Fertilizer Regulation** (EU 2019/1009

Valorization of digestate in accordance with **The Waste Framework Directive**

Novel pre-treatment technologies for valorising biowaste, anaerobic digestate

Platform chemical production via fermentative pathways using **Organic Fines** will be established

Establishing biorefinery brings in economic incentives and job openings for various skill levels

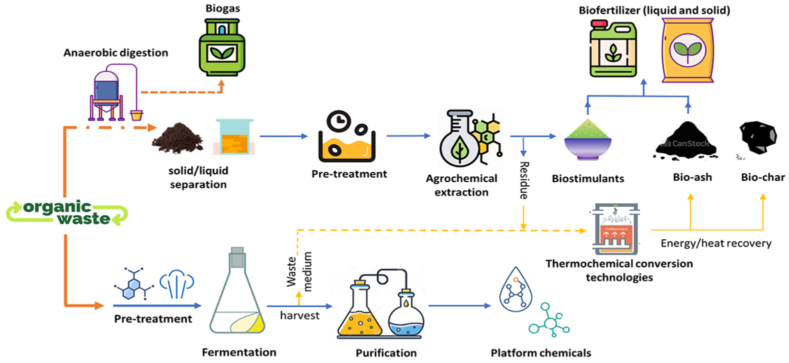
Circularity in digestate management benefits, especially in the context of the **EU Biodiversity Strategy 2030** and the **New EU Soil Strategy**

Results / Achievements to date

Your results and achievements to date can refer to the whole of the team effort and does not mean to imply that you should be referencing only your own specific work.

What is our approach to solving the problem?

The cascading biorefinery approach to biowaste and digestate management is depicted in the following schematics.


organic waste
Anaerobic digestion
Biogas
solid/liquid separation
Pre-treatment
Agrochemical extraction
Residue
Biostimulants
Bio-ash
Bio-char
Biofertilizer (liquid and solid)
Thermochemical conversion technologies
Energy/heat recovery
Pre-treatment
Fermentation
harvest
Waste medium
Purification
Platform chemicals

Project Team and Key Collaborators

The CircBioCityWaste project is funded by the Environmental Protection Agency and the Department of Agriculture, Food & the Marine. The project showcases a robust partnership between academia and industry, highlighting its formidable synergy, involving Munster Technological University (MTU), University of Limerick (UL), TU Dublin, Glanua, Circular Bioeconomy Cluster South-West, and Shannon ABC.

With industrial partner support and a meticulously designed problem-solving approach at its core, the CircBioCityWaste project upon completion promises to be a benefit, extending its paybacks from primary producers to waste management institutions, creating a positive ripple effect across the entire spectrum of stakeholders and environmental wellbeing.

Working across disciplines - Interdisciplinary Considerations

At its core, the project is primarily focused on a multi-faceted approach that encompasses environmental and lifecycle assessment engineering, plant and thermal treatment technologies. Furthermore, its close collaboration with circular bioeconomy clusters extends its reach to benefit from the comprehensive support of policy experts and social scientists.

A significant advantage of this project lies in its dedication to stakeholder engagement. This includes a series of public awareness workshops, members brainstorming, extensive community outreach initiatives, and the integration of result dissemination milestones into its framework. This holistic approach is poised to shape the project for optimal outcomes, ensuring that it evolves into a powerful force for positive change.

MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

DesignforIU: Comparison of certified versus operational performance of energy efficient technologies

What's the problem we are addressing? Why is it important?

The DesignforIU project was funded by the Sustainable Energy Authority of Ireland (SEAI) under the 2018 RD&D call and began in 2019. The aim of the project was to monitor the operational performance of technologies in comparison to the certified performance for one heating season and determine if an "in-use" factor is required for the technology, and if this can be incorporated in the Non-Domestic Energy Assessment Procedure (NEAP) or Dwelling Energy Assessment Procedure (DEAP) methodologies. The DesignforIU project focused on the monitoring and analysis of four residential case studies that incorporated Air Source and Exhaust Air Heat Pumps (ASHP, EAHP) as well as Mechanical ventilation Heat Recovery (MVHR) systems in their designs. Two non-residential systems were assessed, one ASHP and one MVHR. Monitoring on this project took place from December of 2019 to December of 2020 for the most part.

How our research generates IMPACT

The use of energy efficient technologies are an integral part of Ireland's decarbonisation goals in many industries. The adequate evaluation of their performance is necessary to verify CO_2 and financial savings. This research highlights the performance gap between certified performance and in-use performance. A better understanding of this discrepancy will allow for more accurate predictions of real-world performance.

What is our approach to solving the problem?

The study involved field based empirical monitoring of performance metrics for different systems in a number of real buildings. Table 1 provides summary details for each building.

Table 1: Summary details for buildings assessed as part of DesignForIU.

Metric	Units	RES-1	RES-2	RES-3	RES-4	NON RES-1	NON RES-2
Year of construction	-	2015^	2014^	2018	2015-2017*	2013	2019
Location	-	Cork, Urban	Cork, Rural	Tipperary, Rural	Cork, Suburban	Cork, Suburban	Cork, Suburban
Archetype	-	Detached	Detached	Detached	Semi Detached	Office	Office
No. Storeys	-	2	2	1	3	1	1
Building Type	-	New Build	New Build	Retrofit	New Build	Retrofit	Retrofit
Floor Area	m^2	287^	256^	183	170	223	165
Energy rating	-	A1	A1	A3	A3/A2*	A3	NA
Heating delivery	-	Underfloor/air	Underfloor/air	Underfloor	Radiators	Radiators	Radiators
Ventilation type	-	MV & NV purge vent	MV & NV purge vent	MV, with some NV openings	NV only	NV	MV

*Values are estimated based on search of BER database for buildings with relevant floor area and number of stories

^ Values taken from Passive House Planning Package

Seasonal Performance Factors (SPF) were calculated for each system from measurement data at various boundaries (H2, H4 etc) in accordance with EN14511, EN14825, EN16147 and EN15316 to allow comparison with both the manufacturers rated performance and the national energy rating performance assessment.

Table 2: Quoted manufacturer performance details for energy efficient technologies in each building.

Metric	Units	RES-1	RES-2	RES-3	RES-4	NON RES-1	NON RES-2
Manufacturer	_	B**	B**	C*, E*	D*	A	D
Heat pump/MVHR ID	_	AWHP-1, EAHP-1	EAHP-2	AWHP-2	AWHP-3	AWHP-4	MVHR-3
AWHP system type	_	Mono	-	Mono	Split	Mono	NA
Refrigerant	_	R410A, R134A	R134A	R410A	R410A	R410A	NA
AWHP rated capacity	kW	5.2	-	8.5	5.3	28	NA
EAHP rated capacity	kW	2.4	2.4	-	-		
DHW AEC	-/kWh	1081	1081	1031	-		
AWHP SCOP/AEC	-/kWh	5.15/1464	-	4.35/3903	3.22/3369	-	NA
Heat exchanger	_	Counterflow (Polystyrene)	Counterflow (Polystyrene)	Plate (Polystyrene)	NA	NA	Crossflow Total Heat (paper)
MVHR quoted HRE	%	88	88	86	-	NA	83-88
MVHR quoted SFP	W/l/s; Wh/m^3	_;0.4	_;0.4	1.37+;0.38+	-	NA	757 W/(m^3/s)

*Heat pump manufacturer | *MVHR manufacturer | + Values indicated for home with seven rooms

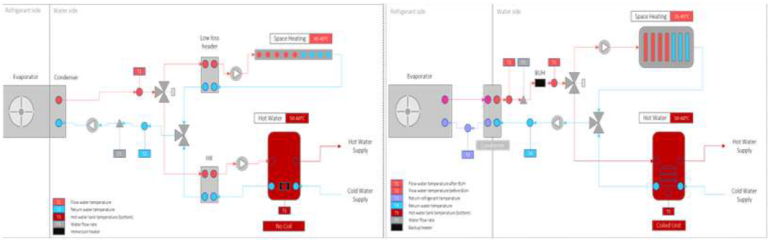


Figure 1: Illustrative system level schematic of monobloc system used in AWHP-2 of case study RES-3 (Left) and split system used in AWHP-3 of case study RES-4 (Right).

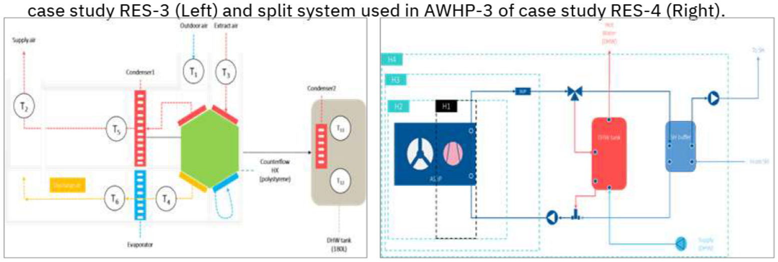


Figure 2: Illustrative schematic of EAHP systems (EAHP-1 & 2) studied in RES-1 and RES-2 (Left) System boundaries defined by SEPEMO project and RHPP project for calculation of seasonal or system performance factor (Right).

Results/Achievements to date

Air To Water Heat Pumps

AWHP-1 & AWHP-3 performance significantly worse in space heating mode than rated performance while AWHP-2 met expectations. Domestic hot water performance results were, on average, in line with expectations.

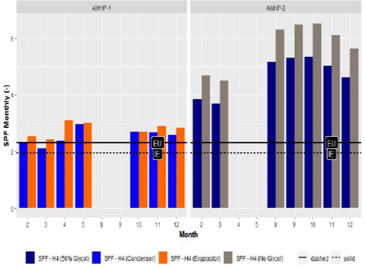


Figure 3: Monthly SPF at H4 boundary for two residential AWHPs in SH mode (Dashed and solid lines indicate the renewable status threshold indicated by EU directives).

Table 3: Hourly averaged performance of all residential AWHPs in SH and DHW respectively compared with values entered into DEAP.

HP	EN 14825 (SH)	EN 15316 (SH)	SPF_{H4ave} (SH)	EN 15316 (DHW)	SPF_{H4ave} (DHW)
AWHP-1	5.1	5.3	2.7	NA	NA
AWHP-2	4.4	5.6	4.9+ to 6.0^	2.2	2.5+ to 3.1^
AWHP-3	3.2	3.5*	2.7~	2.0	2.3~

* Value taken for similar building in the same housing development |

+ 50% glycol assumption | ^ 0% Glycol assumption | ~ data for heat pump was limited

Exhaust Air Heat Pumps

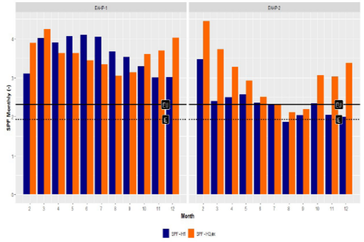


Figure 4: Monthly SPF at H4 boundary for two residential AWHPs in SH mode (Dashed and solid lines indicate the renewable status threshold indicated by EU directives).

Table 4: Hourly averaged performance of all residential AWHPs in SH and DHW respectively compared with values entered into DEAP.

Source	Equiv. Boundary	EAHP-1			EAHP-2		
		Min	Max	Mean	Min	Max	Mean
SPF – H_1	-	0.0	6.0	3.6	0.0	6.0	2.3
SPF – H_3	-	0.1	3.6	2.2	0.1	3.4	1.5
SPF – $H_{3,ex}$	-	1.4	5.2	3.7	1.4	5.2	2.9
Manufacturer (DHW)[1]	H_4	-	-	2.2	-	-	2.2
PHPP (DHW+SH)	$H_{3,ex}$	-	-	2.0	-	-	2.4
DEAP (DHW)	H_4	-	-	2.1	-	-	2.1
Manufacturer (SH)[2]	-	1.7	5.7	4.0	2.1	5.9	4.1

[1] Value was calculated using the relationship between fan speed and airflow rate defined in Appendix A

[2] Calculated using a linear fit of COP and inlet air temperature, based manufacturer data for flowrate of 220m^3/h

Mechanical Ventilation Heat Recovery

Overall, the MVHR-3 unit consumed over 25% less energy at similar settings to those proposed by manufacturers. The bulk Specific Fan Power was consistently lower than expected and there was a 1% to 3% improvement in HRE compared with manufacturers values.

Working across disciplines - Interdisciplinary Considerations

Collaboration with SEAI, industry and private housing sector. Evaluation of industry standards adopted throughout Europe with Irish national building energy performance standards and local installer practice.

Project Team and Key Collaborators

SEAI, MTU, Wayne Morehead Architects, University of Ulster.

Authors: Adam O' Donovan, Paul D. O' Sullivan

MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

Development of a simulation platform to assess integration of renewable energy technologies on dairy farms

What's the problem we are addressing? Why is it important?

- Ireland aims for net-zero emissions by 2050
- Agriculture contributed over **38%** of GHG emissions in 2022
- Balancing emissions reduction with agricultural sustainability is crucial
- TAMS grants promote energy-efficient and renewable technologies
- Assessing technology impact on GHG emissions while ensuring dairy farm profitability is vital
- The main energy consumers on dairy farms are milk cooling, water heating and the milking machine (Figure 1).

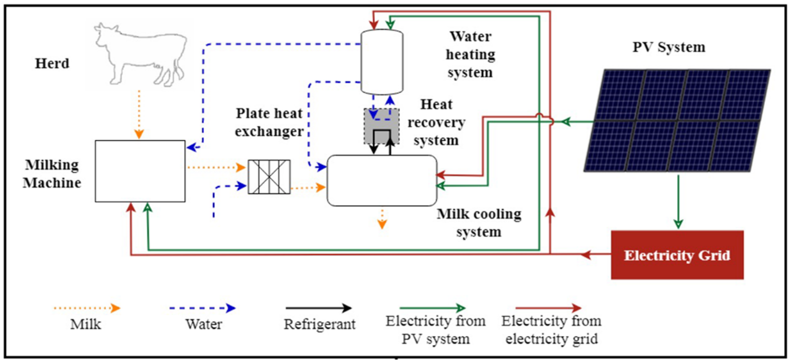


Figure 1: Schematic of main energy consuming infrastructure on dairy farms with integrated solar PV.

How our research generates IMPACT

- Free, user-friendly app accessible on the MTU website
- Empowers farmers to investigate technologies and demand-side management
- Enables researchers to explore diverse farm scenarios
- Assists policy makers in identifying high-impact technologies for national subsidies

Results / Achievements to date

- Highly accurate, validated mathematical model for simulating energy usage on dairy farms (MAPE = 7.10%, R^2 = 0.72, MPE = -0.86%, RPE = 7.56%)
- A suite of optimisation tools for improving decision making regarding the integration of renewable energy technologies
- An open-source simulation platform which is currently being employed by researchers, policy makers and commercial dairy farmers
- Several publications in high-ranking international journals (scan QR code for link)

What is our approach to solving the problem?

- Energy consuming equipment were monitored on 26 Irish dairy farms (table 1)
- Development of a grey box mechanistic model for farm energy analysis using data gained through farm monitoring
- Online app for farmers created which calculates farm electricity use and renewable generation in 15-minute intervals
- Provides ROI and GHG reduction estimates
- Equips users with data for informed energy utilisation and on-farm investment decisions in the dairy sector

Table 1: Average energy efficiency, cost and percentage night rate electricity associated with total energy consumption and each of the main energy consumers for 16 herringbone farms monitored as part of this study.

Energy Consuming system	Energy Efficiency (Avg. Wh kg_{Milk}^{-1})	Energy Cost (Avg. € T_{Milk}^{-1})	Nigh Rate (Avg. %)
Total	29.42	€4.24	44%
Milk Cooling	9.16	€1.32	46%
Milking Machine	5.05	€0.72	47%
Water Heating	9.56	€1.28	46%

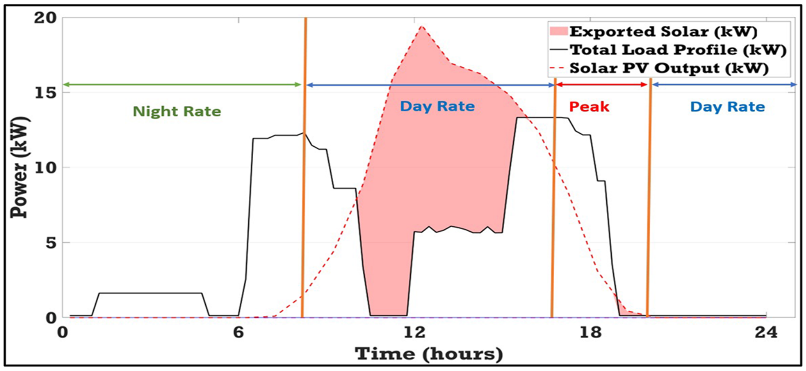


Figure 2: Electricity load profile of a dairy farm simulated by the app. Time-of-use electricity pricing is in place (cheapest electricity during the "Night Rate" period, most expensive electricity in the "Peak Rate" period). PV generated electricity is included in the load profile. This allows the user to see how much of the PV generated electricity is consumed by the farm. The user could consider altering their routines to take advantage of cheaper "Night Rate" electricity or consume more PV generated electricity.

Working across disciplines - Interdisciplinary Considerations

- Collaborated with researchers in Teagasc & Bord Bia
- Nexus between energy efficiency and labour efficiency established
- CO2 offset calculator developed in tandem with renewable energy models

Project Team and Key Collaborators

- Fergal Buckley (MTU)
- Ryan Prendergast (MTU)
- Dr. John Upton (Teagasc)
- Dr. Michael D. Murphy (MTU)
- Dr. Eleanor Murphy (Bord Bia)
- Dr. Laurence Shalloo (Teagasc)
- SEAI RD&D fund
- Teagasc Walsh Scholarship

Teagasc
Agriculture and Food Development Authority
BORD BIA
IRISH FOOD BOARD
seai
SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Authors: F. Buckley, J. Upton, R. Prendergast, M.D. Murphy

Funding: Teagasc Walsh Scholarship. SEAI RD&D Fund

SERVICES AND BUSINESS PROCESSES

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Munster Technological University

CIRCULAR ECONOMY FOR REGENERATIVE TOURISM (CERT)

Developing a tourism model that regenerates local communities, local places and economies, the natural environment and provides a meaningful experience for the visitor.

Authors: CERT Project Team

What's the problem we are addressing? Why is it important?

Sustainable development is a challenge faced by the international tourism community particularly as many countries depend on tourism for economic sustainability.

Context:

Worldwide tourism activity is growing

+

Increasing environmental pressure

Problem:

Negative impacts of tourism:

- Social (Overcrowding, growing inequality)

- Environmental (emissions, habitat destruction)

Solution:

A regenerative approach

“better places to live better places to visit”

Regenerative Tourism is the idea that tourism can go beyond sustainability and regenerate local communities & natural environments. How can we develop a tourism model that actually regenerates local communities, local places and economies, the natural environment and provides a meaningful experience for the visitor?

Project Team and Key Collaborators

CERT Project Team		
Ms. Mary Rose Stafford	Dr. Aisling Ward	Dr. Noel Murray
Dr. Sophie Price	Ms. Fiona Scott-Hayward	Mr. Feargus Dunne
	Ms. Shirley Millar	

Collaboration with other research departments within MTU, tourism federations and networks, national and international educational institutions, tourism consultants and businesses.

The impact on tourism businesses, local communities and community groups, will contribute to meeting one of the objectives of “Creating our Future” by engaging with and activating communities on green initiatives & education.

Results & Achievements to date

The CERT programme has been successful in generating funding through several research projects including:

- “Exploring a regenerative approach to community tourism development in Scotland and Ireland” – Royal Irish Academy Scotland-Ireland Bilateral Programme 2022-2023
- “Circular Economy 4 Regenerative Tourism (CE4RT)” – SMP-COSME-2021 TOURSME 2022-2025 *(Lead Partner)*
- “Digital Innovation for Blue Economy and Social Tourism (DIBEST)” – Interreg Atlantic Area 2023-2026

Other results from CERT to date include:

- Submission of funding application to the EPA *(outcome pending)*
- Participation in conferences and presentations to a wide range of audiences
- Industry focused webinars as part of MTU Enterprise and Innovation month
- Development of MA Regenerative Tourism (due to commence Jan 2024)
- Establishment & development of extensive tourism networks

What is our approach to solving the problem?

The aim of the CIRCULAR ECONOMY FOR RENEGENERATIVE TOURISM (CERT) programme is to research and develop a sustainable, circular and regenerative tourism model. This approach includes:

- Generating funding through EU and national channels
- Allocation of research resources
- Research into current status, best practice and future needs
- Developing training material and programmes in circular and regenerative tourism for students and businesses
- Developing practical deliverable solutions for tourism businesses and local communities
- Research, networking and collaboration to develop targeted policy around regenerative tourism

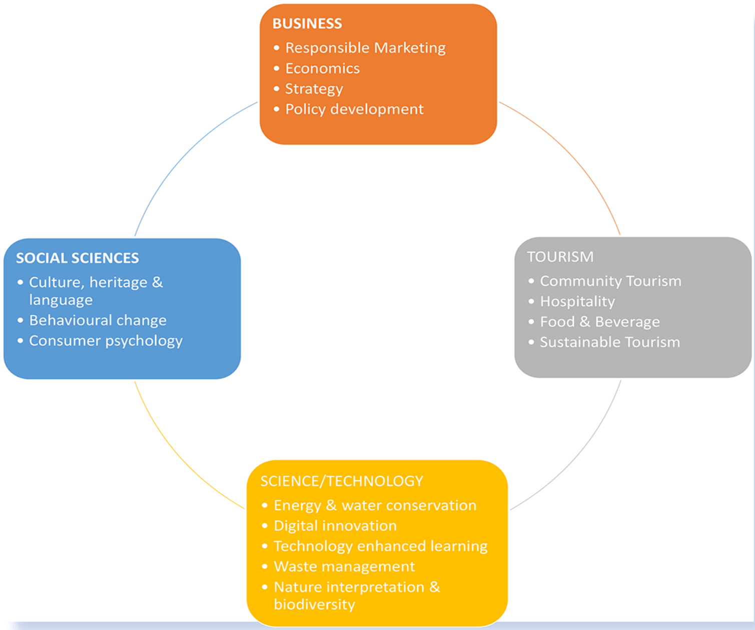
How our research generates IMPACT

Regenerative Tourism through the CERT programme can contribute to the global challenges of tourism development and have a positive societal and environmental impact by:

- Generating profitable businesses
- Tackling climate action
- Benefitting host communities
- Championing local places – nature, culture and heritage
- Empowering visitors to be responsible

Working across disciplines - Interdisciplinary Considerations

The CERT project is by nature multi-disciplinary, replying on input from citizens, communities, businesses and experts in each of the discipline areas to create the practical and robust solutions required to develop a resilient tourism model for the future.



BUSINESS
- Responsible Marketing
- Economics
- Strategy
- Policy development

SOCIAL SCIENCES
- Culture, heritage & language
- Behavioural change
- Consumer psychology

TOURISM
- Community Tourism
- Hospitality
- Food & Beverage
- Sustainable Tourism

SCIENCE/TECHNOLOGY
- Energy & water conservation
- Digital innovation
- Technology enhanced learning
- Waste management
- Nature interpretation & biodiversity

Acadamh Ríoga na hÉireann
Royal Irish Academy
CE4RT
EISMEA
Circular Economy for Regenerative Tourism
Interreg Atlantic Area
European Regional Development Fund
EUROPEAN UNION

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Entrepreneurship Research with Impact at the *Hincks Centre for Entrepreneurship Excellence, MTU.*

Authors: Hincks Research Team

What's the problem we are addressing? Why is it important?

The driver of a thriving economy, entrepreneurship is the key to innovation and job creation. Rising uncertainty and changes in society have increased the interest and importance of research in the broad topic of entrepreneurship.

Through evidence-based research, entrepreneurship is stronger and more impactful.

The Hincks Centre for Entrepreneurship Excellence at MTU supports entrepreneurship in all its forms through research, education and training. The growing Hincks' team of researchers and lecturers explore questions such as:

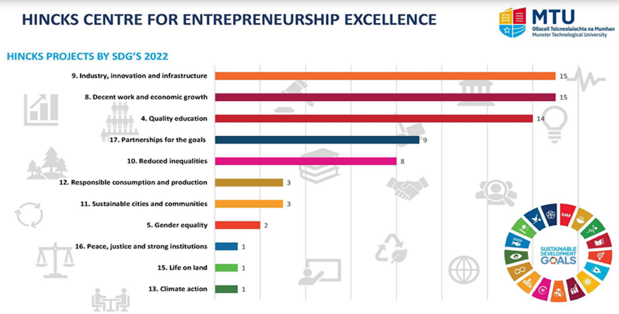
- What is the role of entrepreneurship in a dramatically changing world?
- Who are the most successful entrepreneurs?
- Why do some businesses thrive, and others fail?
- What is the theory-evidence approach to enterprise start-up in the circular economy?
- Are educators ready to embrace sustainable entrepreneurship education?

How our research generates IMPACT

Some examples of how Hincks' activities impact students, research, MTU, the region, society and the economy:

- ✓ Inclusion of the silver economy in the 'South-West regional enterprise plan to 2024'.
- ✓ The publication of 56 peer reviewed journal articles/books/ chapters.
- ✓ The design and delivery of 18 external entrepreneurship training programmes.
- ✓ Established CPEER, MTU's learning community for entrepreneurship educators and researchers.
- ✓ The supervision of 12 PhD and Masters.
- ✓ With competitive funding from Ireland's HEA the Hincks delivers MTU's annual Enterprise Camp for second-level students (approx. 350 participants to date).
- ✓ The Hincks team established and continues to support *EnactusMTU*, an international student led social enterprise society.

The Hincks Centre has long been aware of and aligns its work with the **United Nations Sustainable Development Goals** (SDGs). The Centre's live projects aligned with the SDGs as shown below (some projects impact on multiple Goals).



What is our approach to solving the problem?

The growing team of full-time researchers, support staff and part-time lecturers from across MTU engage in **evidence-based translational research**. Working on diverse projects from cinema and agriculture to the circular economy, minorities and education impacts on the stock of knowledge and a contemporary understanding of entrepreneurship.

Nurturing a culture of curiosity, collaboration and innovation the Hincks Team are open to exploring new project ideas and collaborating with new people/groups/departments.

Project Team and Key Collaborators

Hincks' dynamic team collaborate with many departments, research groups/centres and individuals across MTU in Cork and Kerry. They work with public and private enterprise support groups, development companies/associations and entrepreneurs across the region and nationally.

Marking Hincks 10th anniversary this year, an impact report found the Centre has 175 international connections across 33 countries and research publications with scholars from New Zealand, Vietnam and across Europe.

Hincks Centre's 175 connections across 33 countries

Working across disciplines - Interdisciplinary Considerations

A self-funded research group, the Hincks Centre for Entrepreneurship Excellence has secured funding for 27 international projects from 11 different funding calls including Horizon (2020 & Europe), Interreg (NPA & Europe) and Erasmus+.

The Hincks Centre twice led the MTU team in the DELTA award for Entrepreneurship Teaching and Learning and are proud recipients of several 'Best Paper' awards.

Results / Achievements to date

Entrepreneurship is acting upon opportunities and ideas and transforming them into value for others. This value can be financial, cultural, economic or social.

Hincks' projects include partners from engineering, the arts, culture, science, business and humanities. If you would like to collaborate with us as a student, faculty, researcher or group/centre/ department, please contact one of the team through our website:

https://hincks.mtu.ie/

Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

A Growing Senior Economy: Opportunities for Enterprise, Innovation and Society
Authors: Hincks Research Team

What's the problem we are addressing? Why is it important?

The world's population is growing older. The median age in the European Union is 44.4 years, an increase from 41.9 years, ten years ago. This means people are **living longer and healthier lives**, leading to what is known as the Senior or Silver Economy.

The Senior Economy is the **economic opportunities** arising from expenditure related to population ageing and their specific needs. A European Commission study (2018) estimated the European Silver Economy is worth €3.7 trillion, contributes 32% of Gross Domestic Product and supports 38% employment.

Some of the questions we are curious about:

- What are the opportunities for SMEs in the silver economy?
- How can businesses support older people to age-in-place?
- How aware are entrepreneurship educators and business advisors of the potential value of the silver economy?
- Is there a role for policy in supporting a senior economy in Europe?

How our research generates IMPACT

The Hincks Centre for Entrepreneurship Excellence at MTU is researching the Silver Economy as partners on two European projects: **Interreg Europe** - *SilverSMEs* (2018-2023) & **Horizon Europe** - *Senior EcoNect* (2022-2025). These have led to **significant impact** far beyond the project deliverables.

Examples of Research Output

- Regional & European Composite SWOT Report, Mapping Europe's Senior Ecosystem and Market study.
- **Special Issue** in *Small Enterprise Research* on the Silver Economy
- Peer reviewed **Journal Articles** and Conference papers
- Keynote addresses and invited presentations
- **PhD and Masters** research on the topic
- Case study and video on the impact of the SilverSMEs project.
- 72 Good Practices on the European Commission website, of which the Hincks Centre **successfully submitted 7.**

Policy Impact
The inclusion of the silver economy in Action 1.7 in South-West Regional Enterprise Plan 2024.

Additional Dissemination

- Newspaper Articles
- RTE Brainstorm Article
- Interview on German TV
- Blog for European Agency

Networks & Collaborations

- Older People's Council,
- Age-Friendly CCC
- Ecosystem Mapping Europe
- Age-Friendly Uni @ MTU

What is our approach to solving the problem?

A holistic approach to understanding and raising awareness of this new area affords opportunities for the economy, communities and older people. This can be achieved through collaboration and the development of a strong ecosystem of various stakeholders including SMEs, researchers from multiple disciplines, users, policymakers, enterprise support/advisors and HEIs.

Project Team and Key Collaborators

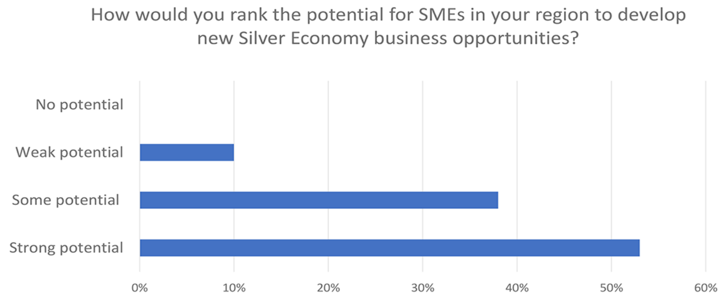
The Senior Economy is a new area of research and an emerging market for businesses. MTU expresses great interest in this topic and has **a large working group**, which includes **Helen McGuirk, Aisling ConwayLenihan, Wei Xiong, Catrina Heffernan, Rebecca Robinson, Sarah Davis, Niamh Lenihan.**

If you are interested in collaborating or have an idea for a project on this topic, you can **contact the Hincks Centre** through the website https://hincks.mtu.ie/ or contact one of us directly.

Working across disciplines - Interdisciplinary Considerations

There are pressing demographic reasons, due to ageing, to develop more sustainable means of supporting older people. This presents new opportunities for SMEs to engage in the production of innovative products or the provision of tailored services.

Opportunities derived from key needs of 3 groups of older people, are those who are **Active (Healthy-Wealthy)**, those who are **Fragile-Vulnerable** and those who are **Dependent**. These diverse groups of older people highlight the importance of interdisciplinary projects and research.



The potential for SMEs to develop new silver economy business opportunities. (McGuirk, ConwayLenihan and Lenihan 2021).

Results / Achievements to date

The topic of the Senior/Silver Economy is an excellent example of **good practice** in nurturing expertise in an emerging topic like population ageing. These include: **A PhD** at the Hincks Centre on senior entrepreneurs, **two large European funded projects** for the Hincks Centre, several **academic publications**, impact on **regional enterprise policy** and the opportunity for several lecturers to **collaborate** with the Hincks Centre and/or **buy-out time** from their teaching to contribute to the stock of knowledge on an ageing population.

Senior Eco-Nect
Funded by the European Union
SILVER SMEs Interreg Europe
European Union European Regional Development Fund

MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

Understanding the biomass availability, flows and value chains of diverse rural regions in Europe.

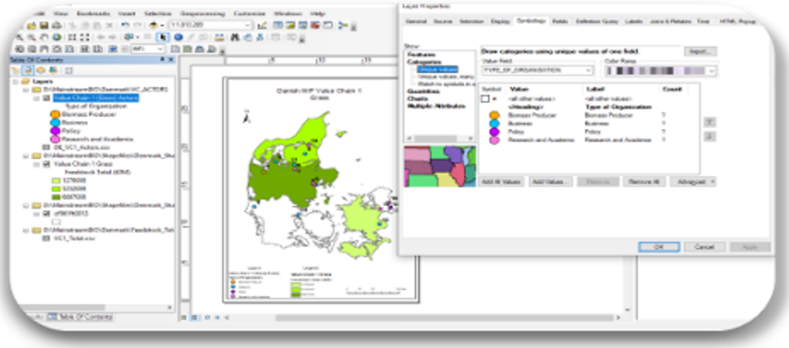
Authors: James Gaffey [1], Alice Hand [1], Carmen Giron Dominguez [1], Robert Ludgate [1], Helena McMahon [1], Rommie Van Der Weide [2], Kimberly Wevers [2], Peter Borisov [3], Vladislav Popov [3], Johanna Kallman [4], Liselotte Puggaard [5], Inigo Rodilla [6], Ana Casillas [6], Beatriz Del Toro [6], Irene Paredes [6], Piotr Jurga [7], Magdalena Borzecka [7], Anastasios Galatsopoulos [8], Leonidas Parodos [9], Evangelia Tsagaraki [9]

What's the problem we are addressing ? Why is it important?

The potential of bio-based products and solutions in developing a sustainable economy has been recognized in the EU Bioeconomy strategy. Though, despite considerable investments in research, innovation, and business support, many EU regions have yet to realize this potential.

The availability of data regarding agriculture arisings and biomass at regional level, where value chains are most likely to be implemented, is sparse. Providing this regional level information, allows actors to better assess the potential of bioeconomy activities for that region.

The project aims to provide a method for analysing the potential for new bio-based value chain development in diverse regions of Europe through a useful framework for mobilising local value chain stakeholders, and understanding the potential and limitations associated with regional available biomass



How our research generates IMPACT

Within the preliminary results to date, 27 biomass chains across the 7 regions have been identified and mapped, giving an in-depth understanding of regional breakdown of biomass and unique insight into key value chain actors.

Some of the main findings within the mapping exercise that will generate key impact include:

- Majority of by-product feedstock may already be serving an important function
- Almost 96% of materials are going towards either soil, feed or energy production.
- Feedstock prices also depend on source, current use & country.
- Support future knowledge transfer & cooperation

What is our approach to solving the problem?

This study looks to provide an understanding of selected existing biomass arisings, flows, value chains, stakeholders, and innovations in diverse regions in Europe. Supporting this with the additional mapping of current value chain stakeholders along with innovative uses or projects, can also help in building bridges towards scaling new value chains around existing biomass opportunities.

Project Team and Key Collaborators

The CircBIO research group at MTU are part of a consortium from across the EU, ACRRES Wageningen University (NL), Agricultural University of Plovdiv (BG), RISE Processum (SE), 5 Food and Bio Cluster Denmark (DK), Innovarum (ES), Institute of Soil Science and Plant Cultivation (PL), White Research (BE), and Q-Plan International (GR). Regional Multi-actor Innovation Platforms (MIPs) have been established to enhance cooperation among key rural players towards co-creating sustainable business model pathways in line with regional potentials and policy initiatives.

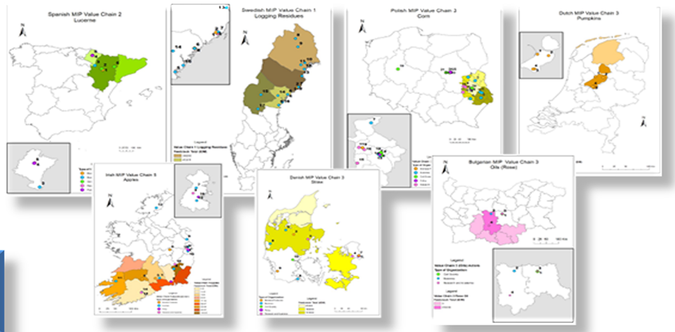
Two themes from the Creating Our Future Report are addressed:

- Supporting Innovation in Farming and Food
- Embedding Climate Action Across Society.

Working across disciplines - Interdisciplinary Considerations

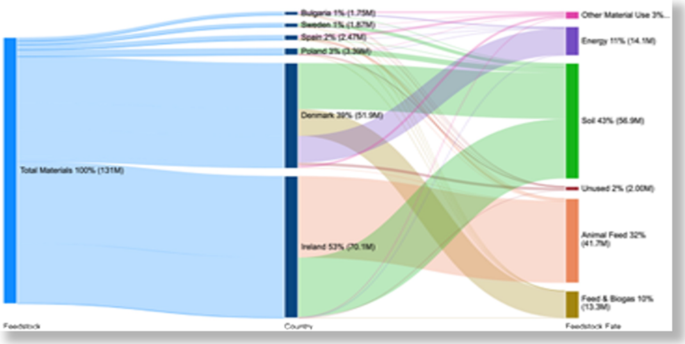
The process to complete the Biomass Arising Maps analysis of biomass arisings and flows and evaluation of 27 feedstock value chains across 7 diverse regions.

Key actors within each of these value chains across the areas of production, business, policy, civil society and research were used for information to input into these maps and well as the resulting biomass flow diagrams. The project will engage with these different actors to build opportunities at a region level.



Results / Achievements to date

While each region has diverse primary production & feedstock opportunities, there are often common areas of interest between Europe's regions. This may offer opportunities for technology transfer, learning & cooperation. In addition, it is also apparent that much of the largely by-product biomass is already going towards applications which may be considered low economic opportunities. However, many of these application, such as soil, feed, energy applications, serve a vital function, and would likely need to be replaced if diverted to new applications. In theory, the replacement materials could end up being less sustainable. Further research is required to better understand how much of the identified biomass can be sustainably diverted for these new bio-based value chain opportunities.



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[1] CircBIO, Munster Technological University, Dromtacker, Tralee, Co. Kerry, Ireland
[2] ACRRES, Wageningen University and Research, Lelystad, The Netherlands
[3] Agricultural University of Plovdiv, Plovdiv, Bulgaria
[4] RISE Processum, Domsiö, Sweden
[5] Food and Bio Cluster Denmark, Aarhus, Denmark
[6] Innovarum, Madrid, Spain
[7] Institute of Soil Science and Plant Cultivation, Puławy, Poland
[8] White Research, Saint-Gilles, Belgium
[9] Q-PLAN, International, Thessaloniki, Greece

MAINSTREAM BIO
MAINSTREAMING SMALL-SCALE BIO-BASED SOLUTIONS ACROSS RURAL EUROPE

Horizon Europe
THE NEXT EU RESEARCH & INNOVATION PROGRAMME (2021 – 2027)
European Commission

MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

How can CPD opportunities provide professionals in the Graphic Design sector with the knowledge and tools to implement Sustainability Thinking in their workplace?

What's the problem I am addressing ? Why is it important?

In recent years the **interest and demand in upskilling opportunities for Sustainable Business Practice has risen** considerably. This is reflected in Skillnet reports, in the offerings by training providers and Higher Education institutions nationally and internationally as well as newly emerging Organisations of Designers that wish to change how they practice their profession.

The main problems for Graphic Designers upskilling in this area...

1 Lack of awareness that Sustainability principles can be applied to communication/graphic/web design and encompass much **further reaching considerations** than just choice of materials in print design, but rather **include principles of systems thinking and a deeper understanding of technological processes than generally required of a designer**, as well as business ethics and an understanding of how to **evaluate the true environmental, societal and economic cost of design products** in order to avoid greenwashing.

2 The concept of **Sustainability Thinking is comparable to Systems Thinking or Design Thinking** in that a **learner of the concept must first grasp the underlying theoretical principles** but will need to learn how to apply them in practice in order to master the skill. It can thus be hypothesised that **reading** glossaries, databases and case studies in form of books or websites **will not be as effective for the learner** as interactive material such as workshops or toolkits that **trigger the right kind of questioning.**

3 Recommendations for applied Sustainable Communication Design can only be made in a general form in any printed or static medium, as **technology advances too quickly**, and with it change best practices for example in image compression technology.

...so how do you teach Sustainability Thinking?

What is my approach to solving the problem?

I want to **test effectiveness of** existing and newly developed **training material** such as books, video material, toolkits, apps, websites, databases, workshops, conferences, training courses etc. in Sustainability Thinking and Behaviour Change in Graphic Designers.

Effectiveness will be measured through testing of the designers **ability to apply sustainability principles** (i.e. finding and evaluating environmental, societal end economic impact of solutions) to sample briefs prior and post engagement with the training material. Alternatively, the ability to evaluate and apply may be tested through self-assessment in form of surveys, thus relating questions to real-life client briefs which may however make objective evaluation of results difficult due to different clients, environments, and resources available to the designer.

Once the effectiveness of different training methods is **evaluated,** the study will result in the **development of corresponding material** which can then also be tested on individual practitioners or within sample design agencies. The ultimate anticipated outcome lies in **being able to make academically informed recommendations for systems change – changing the way we upskill as practitioners in the design sector.**

How my research generates impact

Gaining a better understanding of effective CPD for Graphic Designers in a systemic field such as Sustainability Thinking will lead to conclusions that **could transform Design education** in general.

Training material in Sustainable Graphic Design is very limited, and any resulting material from this study will make a significant contribution to Design educators and training providers worldwide. Within the research community, the study will provide a **bridge between the fields of design education/CPD, environmental psychology in the workplace and Sustainable Graphic Design.**

Achievements to date

I **investigated the industry progress** in *'Sustainable Graphic Design Practice in Ireland'* during my first Masters in 2015, and while much has happened since, Sustainability as a term is overused now more than ever, while too often being detached from its meaning or any means of accountability. In 2018, I graduated with an MSc in Environmental Sciences from Trinity College, having written my thesis in collaboration with German Paper Research Institute PTSpaper. **Studying Environmental Sciences** and the chemical and mechanical processes involved in paper production, treatment and recyclability has given me an understanding of complexity involved with grasping Environmental Sustainability. Since only very few educational resources and materials or courses are available or accessible for Graphic Designers globally to upskill in this area, I dedicated my third Masters project in *Teaching Education and Development* to **developing a Certificate Course** bridging this gap.

I share some of my findings in my research podcast *Conscious Communication Design* and in articles published in Irish Design Magazine 100Archive.

Working across disciplines -Interdisciplinary Considerations

Having worked in the **design-, the IT-, the print- and the paper technology sector**, I understand **no communication or collaboration takes place** between these sectors but is **required to advance sustainable business practice for graphic designers**, as the discipline itself as well as resources involved in the production of any graphic output involves multiple industries.

Great advances are being made in Sustainable Web Design and ICT in the UK and Europe, which builds another intersection to Graphic Design practice, and an opportunity for interdisciplinary learning.

Project Team and Key Collaborators

I anticipate to continue my research in form of a **PhD in Sustainability** at Darmstadt University of Applied Sciences under supervision of experts in the field of **Environmental Psychology**, the perspective I miss in my own background.

I will work closely with Skillnet, as well as the newly formed Irish branches of **Sustainable Design Organisations** ADGREEN, PURPOSE DISRUPTORS and DESIGN DECLARES.

Please connect on:
www.linkedin.com/in/lisazimmermanndesign/
or email: lisa.zimmermann@mtu.ie
@CCDbyLisa

CREATIVE AND PERFORMING ARTS

MTU Ceol-Scoil Chorcaí Cork School of Music

ADVANCECRT

Access, Culture and Sound, Oh My!

THIS POSTER HAS BEEN DESIGNED TO BE AS ACCESSIBLE AS POSSIBLE. IF YOU WOULD LIKE A PDF COPY THAT IS SCREEN-READER COMPATIBLE, PLEASE CONTACT CAITLIN AT CAITLIN.KELLY@MYCIT.IE

What is the problem and why is it important?

Equal access for disabled people to cultural and leisure activities is a right. Ireland is quite behind in terms of accessible cultural heritage:

- We signed the UNCRPD in 2007
- We ratified the UNCRPD in 2018

Ireland is slow to progress when it comes to disability and disability rights.

Much of Ireland's tangible heritage is completely inaccessible to a variety of disabilities, but the gap is particularly noticeable when it comes to visual impairment. One of the biggest issues with being excluded from Cultural Heritage is that it has a knock-on effect. What does that mean? Well, if you're not able to access your cultural heritage, not only are you excluded from that experience, but you're also excluded from conversations that stem from those experiences, which means you're left out of the community.

What is the approach to solving the problem?

This project looks to investigate the use of augmented sound design as a facilitator for accessible cultural heritage experiences for visually impaired/blind people, but what does that mean exactly?

Cultural heritage and history are the same thing. A lot of the time when people think of cultural heritage, they think of historically relevant sites, and while historically relevant sites can fall under cultural heritage, they aren't inherently part of that category. The heritage site being used for this project is Drombeg Stone Circle in West Cork. It's a site that's both important to the community around it, and also a site that has historical relevance.

ACCESSIBLITY

Augmented Audio in this case refers to sound and soundscapes that layer on top of real-world audio thus "augmenting it". It uses directional sound, which makes the experience more immersive!

This study uses co-design as one of its' methodologies - in other words, the people who will actually be affected/seeking this solution are involved from the start, with myself and my research team providing the expertise on sound design, tech, and access, and my expert users providing **lived experience.** The value of lived experience in accessibility research cannot be understated, and my participants have been so insightful thus far!

Accessibility in this case refers to providing **equal access** to everyone, regardless of their level of ability.

As part of establishing a baseline of access in heritage sites in Ireland, last year a study of 11 sites was carried out. A discussion on these findings and how they have impacted the approach are in the results section.

Meet the Team!

- Caitlin Kelly (PhD researcher, expertise in Accessibility, Music, Music Technology, and Cultural Heritage)
- Cárthach Ó Nuanáin (Supervisor, expertise in Music Technology, Computational Musicology, Interactive Media and New Interfaces)
- Hugh McCarthy (Supervisor, expertise in Inclusion, Music and Music Technology)
- Juan Francisco Martinez (Technical Advisor and Research Fellow, expertise in Cyberphysical Systems, Embedded Systems, Sensor/Transducer Design, IoT)
- Louis Fortineau (Intern and Engineering student, Mobile App Development, Software Development)

How the research generates IMPACT

As mentioned in the problem section, there is a gap when it comes to accessibility, particularly for people who are blind or visually impaired. Currently, many hertiage sites have little to no supports for people with these disabilities, and this project aims to resolve that. In creating a solution that makes sites more accessible. not only are pople more able to engage with tehir heritage, their better able to connect with their communities. This is crucial, as disabled people are already frequently "othered," so every bridge built is incredibly important.

Working across disciplines - Interdisciplinary Considerations

As can be seen in the Meet the Team section, so many different disciplines have been influencing the work. The research itself is also interdisciplinary - everything from heritage to gaming to audio displays are being covered. This facilitates a final result that is as accessible as possible. In other words, different disciplines bring different perspectives and different tools. When working in accessibility in particular, being open to different perspectives and creative solutions to problems is key to innovation in a user-centred way.

Results and Achievements to Date

Access Studies

- 11 sites visited, 10 were OPW Sites
- For outside the sites, a variety of factors were considered, but they were primarily to do with the physical structure of the space
- The surveys for inside the sites were subdivided into four main categories:
  - Architecture,
  - Media,
  - Signage,
  - Tours
- While many sites had disabled parking, the majority had inaccessible main entrances – 8 out of 11 had disabled parking, but only 5 out of 11 had fully accessible main entrances.
- There was very little support for blind/visually impaired individuals, and those accessibility measures frequently cost extra
- Support for Deaf/Hoh* individuals was also uncommon, with only one of the sites visited having consistent ISL tours and a Loop system.
- Multimedia was almost always inaccessible in some way (Lacking subtitles, closed captions, audio description, etc.) – regardless of the date it was created

Participant Interviews

- 4 participants have now been interviewed, each with different presentations of visual impairment/blindness
- Significant interest in CH from all participants
- One participant specifically interested (unprompted) in "3D Sound"
- A preliminary visit to the site is planned, with both the expert users and abled/sighted people, so that there is data to compare from.
- Enthusiasm from participants at better inclusion, but also better awareness, particularly from guides and facilitators

Development

- **Sensors and Beacons:**
  - Bluetooth not feasible for either Drombeg nor Indoor Sites. We've done several tests, due to the characteristics of the circle, the beacons behave very strangely. They're not useable at Drombeg, and would likely perform even more poorly in an indoor environment. GPS seems to work better here, looking at the potential to use UWB beacons for the project.
  - Currently working on different potential sensors and communication between sensors and Unreal Engine 5, as well as using the Google Maps API
  - Data scraping of weather data to affect the sound design, as well as date and other factors
- **Virtual Model:**
  - I have sourced a virtual model of Drombeg online, using that to begin the programming in Unreal Engine 5.
  - The goal with the virtual model is to have the events that are currently triggered by the keyboard or avatar overlap to be triggered by the sensors on the site.
- **Tactile Model:**
  - An additional access tool that Caitlin and Juan came up with was a 3D printed model of Drombeg. This tactile map allows the participants to create a mental map of the site in their heads, and was very well received thus far.

Publications and Presentations

- There is an upcoming conference proceedings paper that will be published with IEEE, it was presented at I3DA 2023
- MTU Writing Competitions '22& '23
- Presented at SAMIS Conference in 2022
- Presented at several MTU research events
- Presented to the Glucksman BEAMUP Expert Group
- Poster at Advance CRT '21 Colloquium

Inclusive Music Ensemble (IME)
Access to Higher Education for People with Disabilities

What's the problem we are addressing ? Why is it important?

Many Learners with disabilities may never have the opportunity to engage in educational and cultural activities of HEIs. Currently there is a heightened level of political focus on inclusion in society for people with disabilities. While Ireland signed the **UN Convention on the Rights of Persons with Disabilities** in 2007, it took until 2018 to ratify it.

- Article 24 highlights the right of persons with disabilities to education and ensuring an inclusive education system at all levels and lifelong learning.

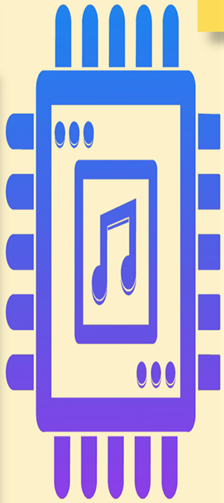
- Article 30 highlights the right of persons with disabilities to take part on an equal basis with others in cultural life and taking appropriate measures to enable persons with disabilities to have the opportunity to develop and utilize their creative, artistic and intellectual potential, not only for their own benefit, but also for the enrichment of society.

How our research generates IMPACT

IME raises awareness of a discipline-specific approach potentially providing pathways to the higher education landscape in other discipline specific
Areas.

- It addresses the marginalisation of learners with a disability and seeks to provide solutions to inclusive, creative music education, realises priorities of inclusive education, matters of equality, working with local community, diversifying our learning population, and delivering on our commitments.

- Whilst many frameworks exist at a national and international level gaps remain in the implementation of HEI programmes that should fulfil our obligations.



What is our approach to solving the problem?

Since 2021 IME seeks to co-design and deliver a model for an inclusive programme of music study at MTU Cork School of Music (CSM) including sub-level 6 QQI offering and qualification in parallel with level 6+ credit, in an inclusive, co-learning, shared classroom situation. Specific Principles of Co-Design for Student Success are examined and implemented

Working across disciplines - Interdisciplinary Considerations

IME is a transdisciplinary initiative and engages with musicians, artists, technologists, teachers, disability experts, and pedagogy researcher throughout Ireland and internationally.

Four staff from MTU & CETB are involved in delivering the IME programmes:

1) An experienced music technologist to investigate and facilitate engagement for all in the musical experience.
2) An experienced music composer with broad artistic influences to facilitate co-creation of content.
3) An experienced inclusion expert from the disability services sector - preferably with a music background – to facilitate proper understanding of disability issues & advocacy, and observe, advise, and help maintain an inclusive approach in a classroom setting with a diverse range of learners and (dis)abilities.
4) A tutor to deliver the separate session for the level 3 cohort, occasionally level 6

Project Team and Key Collaborators

Inclusive Music Ensemble, MTU, Cork ETB, COPE Foundation, Enable Ireland, Inclusive National Higher Education Forum (INHEF), St John of God Services Kerry.

This initiative address multiple categories indentified in “Creating our Future” report including:

- Enhancing a human centred approach to health and social care
- Reimagining learning and development across the life course
- Promoting equality, diversity, and inclusion in Ireland
- Valuing and connecting community
- Nurturing the humanities, culture, and the arts

Contact: Hugh.McCarthy@mtu.ie.

Results / Achievements to date

- IME offers an inclusive college experience of ensemble music making to a wide spectrum of potential learners, with and without disabilities
- IME leverages digital audio and music interface technology to enhance this learning experience. Our integration of technology will also support in delivering on the development of digital skills for all learners when building bridges to a more inclusive society.
- IME is the first inclusive programme of study in Ireland to offer awards specifically in music-making and performance – above and below level 6. This type of approach is rare and places MTU and CETB firmly in a larger National and European context.
- IME presents a possible model for use in other disciplines and programmes in MTU and further afield.
- IME is engaging in meaningful dissemination to its stakeholders through public performances and its upcoming release of three co-created tracks

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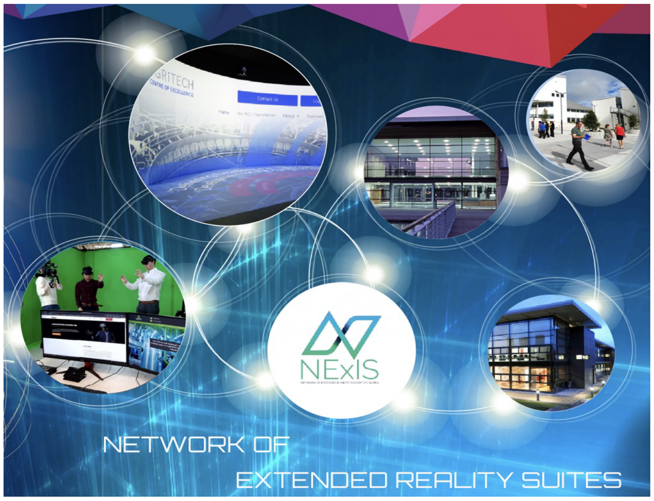
NExIS: Network of Extended Reality Innovation Suites

A strategic collaboration between extended reality research groups at MTU in the fields of AR, VR, MR, Marine Simulation, Video and Audio media production.

Authors: Cárthach Ó Nuanáin, Kevin O'Mahony, Sara Morrissey, Mike Griew

What's the problem we are addressing ? Why is it important?

NExIS was formed to **unify the extended reality research groups** across multiple campuses in MTU. This core strategic collaborative group works to represent MTU across all areas of extended reality (XR) at local, regional, national and European level for knowledge sharing, capacity building, grant-sourcing and social integration projects.



Results/Achievements to date

Réaltacht

- Cross-disciplinary arts engagement project with support from Innovation Month
- Virtual trad session that transports you to the Triskel Christchurch, The Corner House Pub and Siamsa Tíre: The National Folk Theatre of Ireland
- Significant Education and Public Engagement:
    - Over 80 staff and students reported positive feedback during Innovation Month
    - Press Coverage and Interview in the Evening Echo
- Forthcoming Publication:
    - "*Réaltacht*: Creating Immersive and Accessible Experiences of Irish Traditional Music in Virtual Reality" in *4th International Symposium on the Internet of Sounds*, Pisa, 2023 (forthcoming)

XaRt 2023

- Virtual and Physical Exhibition of Virtual artworks to take place in MTU in 2023/2024 with support of Le Chéile
- Three diverse artists chosen to work with NExIS mentorship and technical capacity to produce unique and immersive experiences

Funding applications: EU Interreg, SFI Discover

Researchers engaged to date: 30 inc. 9 new staff

What is our approach to solving the problem?

- Facilitating the introduction of XR technology into the classroom to **enhance teaching and learning** in all campuses and disciplines.
- Affording the research community access to XR technology both as the subject of **research** and as tools for data-gathering.
- Collaborating with industry, the creative arts, supporting enterprise research and providing **technology sandboxes**
- Bringing together results of **capacity building** and **knowledge sharing** by integrating technology through live demonstrations and technology showcase events.

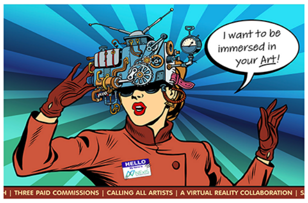
Project Team and Key Collaborators

Prof Joseph Walsh (MTU Kerry)	Principal Investigator
Dr Sara Morrissey (MTU Kerry):	Research Coordinator
Kevin O'Mahony (Nimbus):	Industry Coordinator
Mike Griew (NMCI):	Technical Lead
Dr Cárthach Ó Nuanáin (CSM):	Creative Research Coordinator

Additional Support: Hugh McCarthy, Prof John Barrett, Dr Paul Green, ACE Centre, MTU Students

Working across disciplines - Interdisciplinary Considerations

Interdisciplinarity is at the heart of NExIS. The core research team is composed of marine engineers, user experience designers, research scientists, and experts in audio, video and virtual graphics. Further to this every project that NExIS has worked on has incorporated additional disciplines at the development and delivery phases ensuring principles of co-design are adhered to and working towards the widest engagement and impact. These have included artists, musicians, as well as the university and general public.


I want to be immersed in your Art!
THREE PAID COMMISSIONS | CALLING ALL ARTISTS | A VIRTUAL REALITY COLLABORATION

How our research generates IMPACT

IMPACT 1: cross-disciplinary engagement
IMPACT 2: capacity building work placements which have led to FT positions
IMPACT 3: community engagement at root and branch level

MTU
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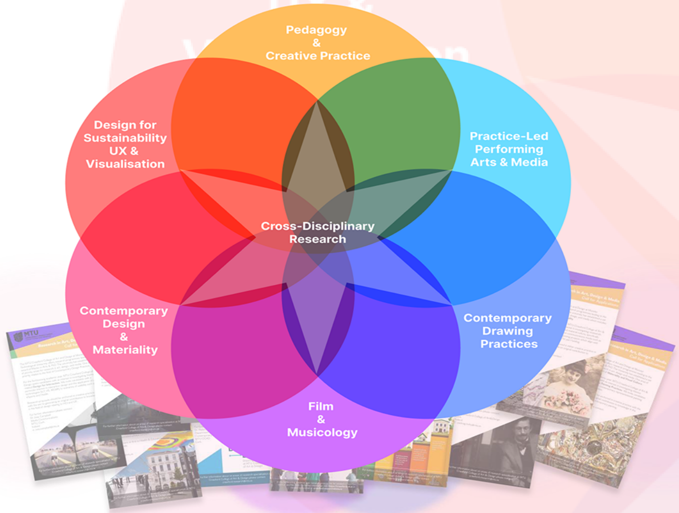
Munster Technological University

Developing MTU research strategy for Creative & Performing Arts & Media to support sustainability and collaboration

What's the problem we are addressing ? Why is it important?

The research is aimed at developing a strategic approach to grow and sustaining creative arts research at third level. Research in the Creative and Performing Arts and Media (CPAM) is often conducted differently to traditional research in STEM areas. The development of a creative practitioner's individual creative vision is a critical feature of third level arts education. Early career research practitioners therefore often embark on projects that are original in their individual form of expression or employ a highly-developed personal creative language. These research activities have the potential to significantly impact audiences that are confronted by creative design work, music composition, performance or exhibition. There is currently a challenge therefore for Technological Universities (TU) seeking to develop sustainable approaches to CPAM research when the knowledge and scholarship produced by individual projects is not clearly aligned with the universities' wider research strategies and strengths. Developing research specialization in the CPAM and better ways to communicate its importance, particularly within the TU sector lends greater potential for collaboration and sustainability.


Pedagogy & Creative Practice
Design for Sustainability UX & Visualisation
Practice-Led Performing Arts & Media
Cross-Disciplinary Research
Contemporary Design & Materiality
Contemporary Drawing Practices
Film & Musicology

How our research generates IMPACT

By establishing priority areas for CPAM research, it is possible to identify more clearly specific project types to support in the future. This boosts the probability of building expertise in the selected research areas. As a result, we can better target research candidates that are directly aligned with the priorities and strengths we intend to build and sustain.

In the strategy we have developed as part of this project so far, we have been conscious of our alignment with the UN Sustainability Goals. Sustainability is the single most important issue of our time and considerations for how design and implement ethical practices is as obvious as it is urgent.

Also envisaged are greater impacts within the cultural sector through collaboration between art and performance and computer-based and networked technologies. Existing projects demonstrate possibilities for providing computer supported VR access to cultural experiences for remote or disadvantaged audiences who may be otherwise excluded. Deeper collaborations with technology-oriented disciplines provide an opportunity to dramatically increase impact in the cultural sector with works that employ evolving smart technologies with traditional creative techniques. In this regard, MTU has a particular advantage with its broad disciplinary scope to impact contemporary design, art, and performance as collaborative opportunities are discovered. In the coming academic year new PhD research within CSM and CCAD will soon focus on exploring existing barriers to cross-disciplinary projects within the university.

What is our approach to solving the problem?

Our approach is both thematic and empirical. We have:

- Conducted secondary research surveying past and current research activities within MTU CCAD and MTU CSM from 2000 to the present.
- Identified and classified patterns of research activity that have emerged over time from the available data.
- Engaged with staff and students in the relevant schools to establish a set of priority areas for CPAM research in MTU.
- Presented and tested the relevance of the proposed priority areas with research active staff and students in MTU.
- Surveyed external CPAM research organizations to establish standard practices in communicating and evaluating research within the domain.
- Interviewed a sample of academic staff in research roles in external organizations to clarify attitudes and practices relating to excellence in CPAM research.
- Developed a communication strategy to support the promotion and growth of existing research strengths in CPAM research at MTU.
- Identified through the agreed priority areas preferences for incoming research projects and opportunities for interdisciplinary collaboration.

Working across disciplines - Interdisciplinary Considerations

This project has an explicit interest in developing collaborative partnerships with other disciplines both internally and external to MTU. A key purpose for establishing priority areas is to ensure the research conducted within the CPAM has a strong identity which can be communicated clearly; and specializations that can be improved through collaboration with large cross-disciplinarity projects. It is also recognized that collaborative interdisciplinary activities are key to the sustainability of CPAM research.

Current researchers are already engaged in collaborative interdisciplinary activities. Examples include traditional and computer supported drawing, art and virtual reality, technology-enhanced accessibility to music performance and cultural events, tangible interaction & data visualization, and design for sustainability.

Results / Achievements to date

With the agreement of research active staff in CSM and CCAD we have established the priority areas that will guide our investment in research from now. These priority areas relate to Pedagogy, Design for Sustainability & UX, Film & Musicology, Contemporary Drawing Practice, and Practice-led Performing Arts & Media. These put in place a baseline from which researchers can negotiate interaction with other disciplines and better identify funding supports for future research candidates.

Rather than relying on candidates to approach MTU with potentially interesting research proposals we have now been able to design calls for research projects which actively align with staff research interests and with our overall research strategy in the wider context of MTU.

We also received SATLE funding to help develop reusable learning objects (RLRs) to better support the formulation of suitable research proposals for PhD projects in the CPAM area; this project is currently underway.

Project Team and Key Collaborators

Niall Smith, Head of Research, MTU, Cork; Ciara Glasheen-Artem (CSM Head of School); Rose McGrath(CCAD Head of School); Cárthach Ó Nuanáin (CSM); Ciara O'Leary Fitzpatrick (CSM); Paul Green (CCAD); Avril O'Brien (CCAD); Donal Moloney (CCAD).

Authors: Paul Green, Donal Moloney, Avril O Brien, Cárthach Ó Nuanáin.

Dance-in-Education: An Inclusive Approach

Dr. Sharon Phelan

> *"The dancer with self-conviction has power; many a dance of poor power has been put across just by the superb belief of the performer in the work… If you believe in yourself probably everybody else will too." (Humphrey 1951; 84)*

Hypothesis:

Can teachers fulfil the dance potential of every student, irrespective of their physical and intellectual levels of ability?

What's the Problem we are Addressing? Why is it Important?

Dance is largely exclusive. It is linked to fitness and body image. Talented dancers execute skill and technique, and they strive for perfection. As Emilyn Claid (2006) once stated, westernised dance involves symmetry, lines, beauty, and utter perfection.

However, this restricted view of dance, fails to acknowledge creativity and individual movement style. It also proves problematic for teachers of Dance-in-Education, as it excludes dancers of weaker physical and intellectual ability. Inadvertently, this undermines government policy to promote inclusivity in education.

How this Research Generates Impact?

This research project will advance the knowledge of Inclusive Dance for all teachers, inside and outside the education system. The final goal is to publish a book, titled "Dance-in-Education: An Inclusive Approach". The book will contain the academic knowledge and teaching methods required to teach dance to students of differing physical and intellectual abilities.

As the book focuses on movement themes versus set skills and techniques, it will be inclusive. There students will choreograph their own dance works and express their thoughts using their own movement styles.

A range of choreographic forms are also presented, which students can use to structure their dances. Sample tasks are provided throughout the chapters. They can be used as a resource for teachers as they devise their own dance sessions. In addition, a series of Inclusive Dance Sessions is provided.

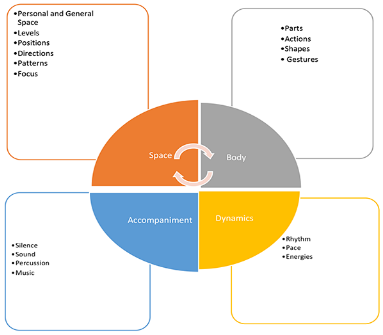
Initially, the book will be presented as a resource for teachers, in primary and second level education. It will be accompanied by in-services and workshops. Then, the book will be presented to teachers of dance in community-based contexts. Again, the teachers will receive in-services and workshops. The book will also provide a resource for students of third level dance, nationally and internationally.

Results/Achievements to Date

- Inclusive Dance modules are present across degrees in Social Care, Physical Education and Adaptive Physical abilities in MTU North Campus, Tralee. They are the first of their kind in Ireland.
- Academic papers on Inclusive Dance have been delivered and published nationally and internationally.
- Links are established with Down Syndrome Kerry and Enable Ireland.
- The first section of the book, and the session plans are completed.
- Recently, a short dance performance, titled " Together" was performed by resident Inclusive Dance group, *Equal Ends*, on International Woman's Day. The five performers were of differing ages and physical ability. Post-Performances feedback was positive in the extreme and it is envisaged that it will develop into a full-length show..
- An Inclusive Dance workshop was presented for people with and without Down Syndrome on Culture Night (22nd October).

What is the Approach to Solving the Problem?

THE INCLUSIVE DANCE MODEL



The research presents an **Inclusive Dance Model.** (Please view above.) It has four movement themes: **Space, Body, Dynamics** and **Accompaniment**. Each movement theme has sub-components.

Space is the first movement theme and there are five components. These include *Personal and General Space, Levels, Positions, Direction, Air and Floor Patterns,* and *Focus*. The **Body** is the next movement theme, and the components are *body parts, body actions, body shapes* and *gesture*. The components in **Dynamics** include rhythm, pace and energies. **Accompaniment** is the final movement theme, and the components are silence, percussion, voice, sound, and music.

The teachers will use the **Inclusive Dance Model** during dance sessions**.** This will widen their students' movement vocabularies and provide them with freedom of choice and freedom of expression. This broad-based approach is inclusive as it ensures that all students can work within their own parameters.

As the students improvise, they will become artists. Their responses will be spontaneous, existing movement patterns will be broken and something instinctive and untaught will transpire. Even if other students have performed the movement phrases before, it will be immaterial. The students will perceive the phrases to be their own work.

Project Team and Chief Collaborators.

The author of the book is Dr. Sharon Phelan. Collaborators to date include cast members in *Equal Ends*, the inclusive performance group at MTU Tralee, multi-media staff, and fellow academics.

Working across Disciplines

Currently, Inclusivity underpins dance modules within Degrees in Early Childhood and Education, Social Care, Physical Education and Adaptive Movement Activity in MTU, Tralee. Dance is an integral part of all these programmes.

The *Equal Ends Dance* Troupe

MTU, North Campus Kerry

HUMANITIES

#ThisIsEndicott

MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

Interdisciplinary Learning on EU Research Project Opportunities for learning

Authors: Dr. Kristin Brogan, Catherine Moylan

What's the problem we are addressing ? Why is it important?

EU Commission funded projects (e.g. Erasmus+) provides a perfect pathway to increase Internationalisation in higher education for both staff and students.

The main objective of Erasmus+ programmes is to encourage and assist lifelong learning and develop staff and students in the area of education, training, youth and sports across Europe and beyond its borders.
There is the anticipation that participation in Erasmus+ programmes will result in social cohesion, increased innovation & being a European citizen.

How do we ensure & promote collaboration & social cohesion within MTU & beyond?

How our research generates IMPACT….

A staff survey was disseminated to staff who had participated in EU Commission projects within the ITT, now Munster Technological University in 2020.
The survey noted that respondents who worked in cross-disciplinary teams acquired financial, communication, administrative skills and management skills that increased their awareness of the differences in relation to needs and expectations when interacting with other disciplines & other European partners.

Results / Achievements to date

EU research projects allow an opportunity to engage with people from different cultures which results in development of a personal perspective on participation and Internationalisation

Staff members learned new skills, embraced new cultures, and used what they learn to help benefit the college and their own department. One quote received which really sums up the overall opinion on EU projects was "working on EU projects had enabled me to broaden my mind, learn new technologies and gain real life experiences that I can bring into the classroom to share with my students"

What is our approach to solving the problem?

We bring together a diverse group of MTU staff from various disciplines & encourage and promote interdisciplinary learning at MTU.
Staff with a background in Applied Languages, Intercultural studies, Tourism, Business, Nursing, Health & Leisure and Hospitality have worked together & collaborated on these projects.
This approach allows inclusivity, promotes diversity and allows staff to develop their skills and expand their networks.

Project Team and Key Collaborators

Over 15 people from different disciplines, on both campuses, work on EU research projects. These staff & students communicate with the other EU project partners to develop a research plan and ensure that all communication is available in a variety of languages across a variety of mediums (social media, website, tv, radio, handbooks & flyers)
Working on these projects is a wonderful opportunity to work with people from different disciplines in our own university but also in universities & higher education institutes across Europe

Working across disciplines - Interdisciplinary Considerations

Working together has the potential of increasing the awareness and appreciation of diversity, with partners sharing individual cultural backgrounds. Staff members report more flexibility in their approach to teaching (for example, using different teaching methodologies as discussed with their international partners or learning there is not just one correct didactic approach when teaching). Working with international partnerships also ensured that they were up to date with the latest technologies & other communication platforms.

European Commission

Erasmus+

WELLBEING AND FOOD

MTU
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Munster Technological University

'Fun Fit' a physical activity & fundamental movement skill intervention to support children with underlying conditions.

Authors: Eoin Kaar, Mai O' Leary, Irene Hogan and Tara Coppinger

What's the problem we are addressing ? Why is it important?

☐ Fewer than 20% of school-aged children with underlying conditions are meeting recommended physical activity (PA) levels[1].

☐ High levels of physical inactivity place children at increased risk of developing preventable obesity-related diseases[2]; whilst engaging in regular PA and limiting screen-based behaviours is associated with fewer health complaints[3].

☐ The combination of physical inactivity and sedentary behaviour limits children's opportunities to develop the basic fundamental movement skills (FMS). The role of FMS as a precursor to lifelong health and wellbeing has gained significant attention in recent years[4,5].

☐ Perceived competence and enjoyment can play significant roles in determining current and future PA participation [6,7,8].

☐ This research will evaluate the effect of a new 8-week community-based PA and FMS intervention on children's PA levels, FMS, enjoyment and self efficacy.

Community-based PA intervention designed collaboratively

Piloting and evaluation of PA intervention

Feasibility of new intervention to encourage continued PA participation

How our research generates IMPACT

Short Term

- Increase PA levels
- Increase PA enjoyment
- Increase social connectedness
- Provide PA opportunity

Medium Term

- Improve FMS skills and confidence
- Decrease Body Mass Index (BMI)
- Increase PA motivation & self efficacy

Long Term

- Encourage and sustain enjoyable PA experiences
- Create a pathway for continued participation in PA
- Improve health indicators & FMS

Results / Achievements to date

☐ Two interventions delivered, intervention 1 (n = 13), intervention 2 (n =12)

☐ Data collected pre and post intervention

☐ Significant improvements found in individual FMS skills, intervention 1: jump (p=.024), roll (p=0.43) skills. Intervention 2: leap (p=0.02), catch (p=0.04), kick (p=0.01) skills.

☐ Significant improvements found in total locomotor (p=0.01), total object-control (p=0.03) and total FMS (p=0.01) in intervention 2.

☐ Significant increases found in enjoyment and self-efficacy markers across both intervention groups.

☐ Significant increases in self-reported mean daily PA levels in intervention 2 (p=0.03).

☐ Only 4% of all participants reached the recommended levels of weekly PA post intervention, and 66% of all participants were classified as either overweight or obese both pre and post intervention.

What is our approach to solving the problem?

☐ **Objective 1:** Design of appropriate physical activity intervention for children with underlying conditions.

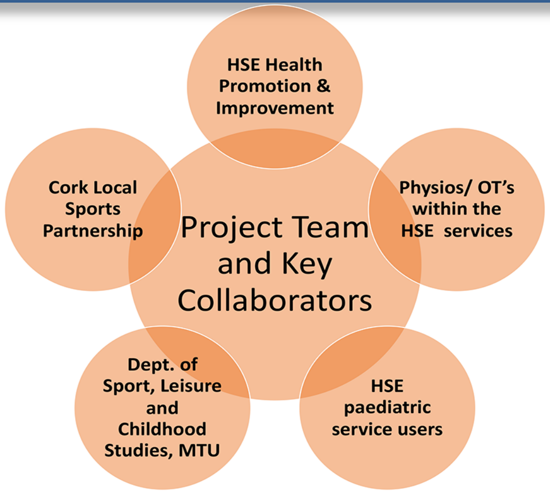
☐ **Objective 2:** Screening and recruitment of children from paediatric services & waiting lists in Cork.

☐ **Objective 3:** Delivery of an 8-week community-based PA intervention.

☐ **Objective 4:** Evaluation of intervention:
- PA levels
- FMS
- Enjoyment
- Self-efficacy

☐ **Objective 5:** Creating a PA pathway for this cohort to support continued participation in PA.

Project Team and Key Collaborators



Project Team and Key Collaborators

HSE Health Promotion & Improvement

Physios/ OT's within the HSE services

HSE paediatric service users

Dept. of Sport, Leisure and Childhood Studies, MTU

Cork Local Sports Partnership

Working across disciplines - Interdisciplinary Considerations

☐ This project incorporates a multidisciplinary, partnership-based approach between Cork Kerry Community Healthcare and Cork Local Sports Partnership to try and address this public health challenge.

☐ The interdisciplinary team includes the Local Sports Partnership, the Health Promotion and Improvement team, Physiotherapists, Occupational Therapists, Exercise Professionals, MTU and other sport and health workers.

☐ The team are responsible for promoting the programme and working with health professional to identify suitable participants for enrolment as the first step to long-term PA participation.

☐ A need was identified for the programme in 3 Community Health Networks (CHN) in Cork to date. The team are working to bring the programme to all 11 CHN's in Cork.

☐ Funding programme delivery is the main consideration and concern for the team for the sustainability of the programme and for future scalability.

References
1. Harrington, D.M.; Murphy, M.; Carlin, A.; Coppinger, T.; Donnelly, A.E.; Dowd, K.; Keating, T.; Murphy, N.; Murtagh, E.; O'Brien, W.; et al. Results From Ireland North and South's 2016 Report Card on Physical Activity for Children and Youth. J. Phys. Act. Health 2016, 13, S183–S188.
2. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT; Lancet Physical Activity Series Working Group. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet. 2012 Jul 21;380(9838):219-29. doi: 10.1016/S0140-6736(12)61031-9.
2. Keane E, Kelly C, Molcho M, Nic Gabhainn S Physical activity, screen time and the risk of subjective health complaints in school-aged children, Preventive Medicine, Volume 96, 2017, Pages 21-27, ISSN 0091-7435,https://doi.org/10.1016/j.ypmed.2016.12.011.3.
3. Stodden, D.F., Goodway, J.D., Langendorfer, S.J., Roberton, M.A., Rudisill, M.E., Garcia, C. and Garcia, L.E. 2008. A Developmental Perspective on the Role of Motor Skill Competence in Physical Activity: An Emergent Relationship. Quest, 60(2), 290–306.
4. Robinson, L., Stodden, D., Barnett, L., Lopes, V., Logan, S., Rodrigues, L. and Hondt, E. 2015. Motor competence and its effect on positive developmental trajectories of health. Sports Medicine, 45(9), 1273-1284.
5. Cairney, J., Kwan, M.Y., Velduizen, S. *et al.* Gender, perceived competence and the enjoyment of physical education in children: a longitudinal examination. *Int J Behav Nutr Phys Act* **9**, 26 (2012). https://doi.org/10.1186/1479-5868-9-26.
6. Carroll, B., & Loumidis, J. (2001). Children's perceived competence and enjoyment in physical education and physical activity outside school. European Physical Education Review, 7(1), 24—43.
7. Papaioannou, A., Bebetsos, E., Theodorakis, Y.,Christodoulidis, T., & Kouli, O. (2006). Causal relationships of sport and exercise involvement with goal orientations, perceived competence and intrinsic motivation in physical education: A longitudinal study. Journal of Sports Sciences,24(4), 367—382 .

Cork Sports Partnership
Comhpháirtíocht Spóirt Chorcaí
SPORT IRELAND

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