Contributii ale tehnologiilor digitale la dezvoltarea durabila a mediului construit

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Workshop: "Orașe inteligente - o abordare holistică de sustenabilitate, securitate și reziliență pentru cetățeni și comunități", parte a conferinței "Smart Diaspora: Diaspora în Învățământul Superior, Știință, Inovare și Antreprenoriat 2023"

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Overview

- Theme: Eco-cities & Eco-living
  - Role of digital technologies
- EU-funded project Echo2eco: *A novel sound absorption technology to enable energy efficient construction techniques and promote the health and wellbeing of occupants*
  - Energy-efficient quiet buildings
- Innovate UK-funded project BIMformed: Adaptive Learning for Zero Defects in Building Construction
  - Use of AI to predict and prevent errors in construction

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Sustainable development in the built environment and the role of digital technologies to support it

- **Energy-efficient, environmentally friendly buildings**
  - Use construction materials to store/release energy, e.g. Passivhaus
  - Not compromising pleasant living – e.g. in terms of noise
  - ***Need for acoustic absorbers that allow exposed concrete walls***
  - Cost-efficient?
- **Digital technologies: Simulation and optimization of methods, tools and materials in constructions**
  - **Case study 1: Echo2eco**

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Sustainable development in the built environment and the role of digital technologies to support it (cont.)

- **Build sustainably**
  - Constructions that last
  - Reduce errors
  - Reduce waste in construction
- Digital technologies: *Prediction and prevention of errors* to reduce waste
  - Role for AI
  - Challenges: availability of data; conflict between commercial interest of constructors and need for transparency and data sharing
  - **Case study 2: BIMformed**

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Case study 1: Echo2eco

- *A novel sound absorption technology to enable energy efficient construction techniques and promote the health and wellbeing of occupants*
- European project funded under the Research for SMEs programme
- Aim: *to develop and optimize a new type of microslit acoustic absorber panel, which can be used in energy efficient buildings*
  - Reduce noise in schools, offices, hospitals, etc.
  - Allow exposed thermal mass for 'greener' buildings

Partners

SMEs:

Nowofol (Ger) - plastics

MLT (Ger) - lasers

DeAmp (Nor) - acoustics

Acoustic GRG Products Ltd (UK) - acoustics

SCA (UK) - architects

RTDs:

Anglia Ruskin University (UK) – acoustics, civil engineering

Norner (Nor) - plastics

National University of Ireland, Galway (Ire) - lasers

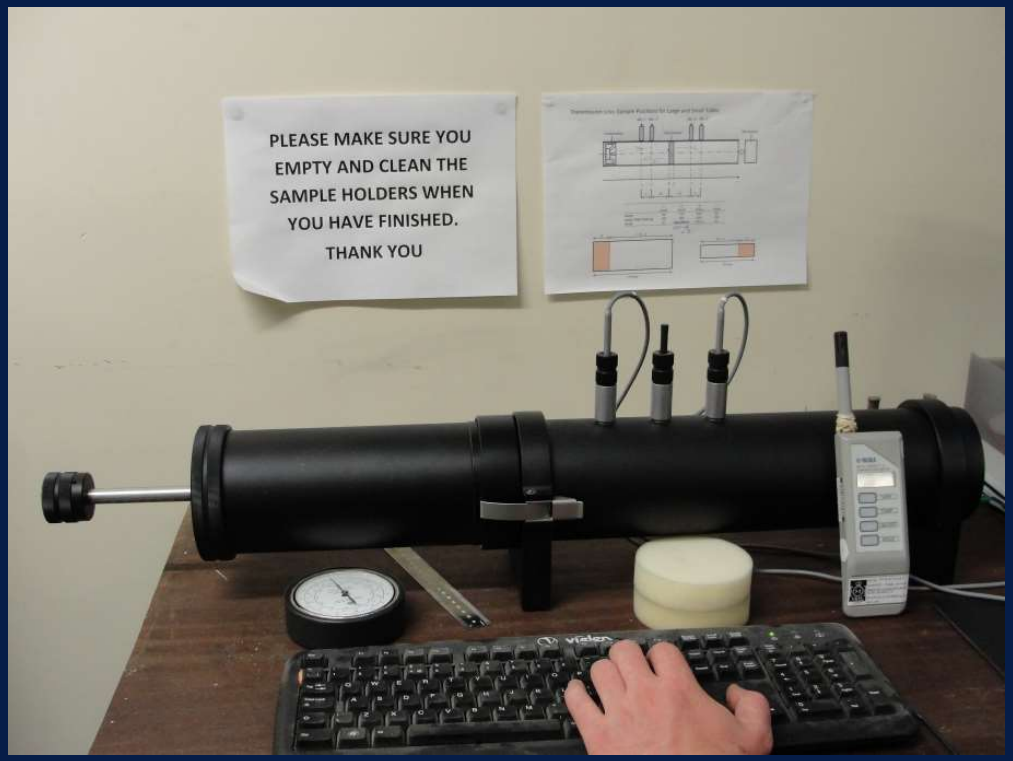
Tasks and deliverables

- Design, modelling and optimization of acoustic design of absorber film, slit width, width, air gap, quantity of slits and distribution across film.
- Development of optimal polymer formulation to achieve the desired mechanical and service life performance with degradation.
- Development of laser technology and laser slitting system: laser-material interactions in relation to the project requirements.
- Validation of market, end-user and legal requirements (e.g. construction, noise and fire regulations).
- Integration, testing and technology validation

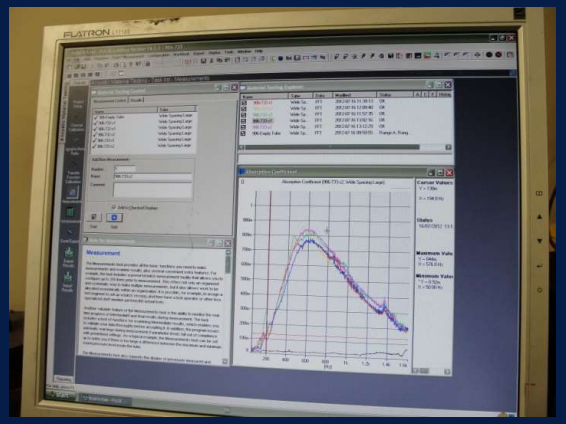
Micro-slit panels as sound absorbers

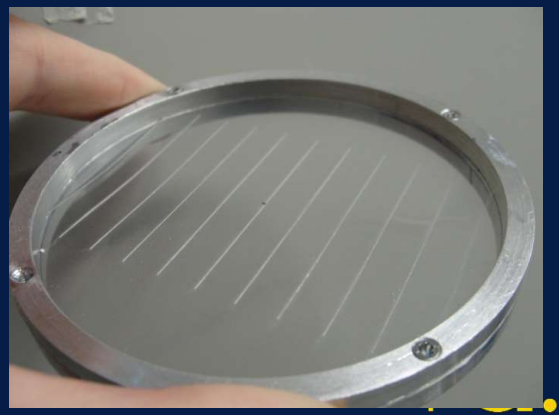
- Distributed Helmholtz resonators:
  - Cavity + small opening through which the sound energy enters the cavity
  - Mechanical analogy: *mass-spring system* (air in slits is a mass and the volume of air in cavity is the spring stiffness).
  - For sufficiently large panels, each opening can be associated with a cavity volume determined by the spacing between perforations.
  - They are ***absorbers*** and ***scatterers*** at the same time, characterized by an 'acoustic impedance' with:
    - *A 'resistive' component (absorption)*
    - *An 'inductive' component (scattering)*

Impedance Tube Testing

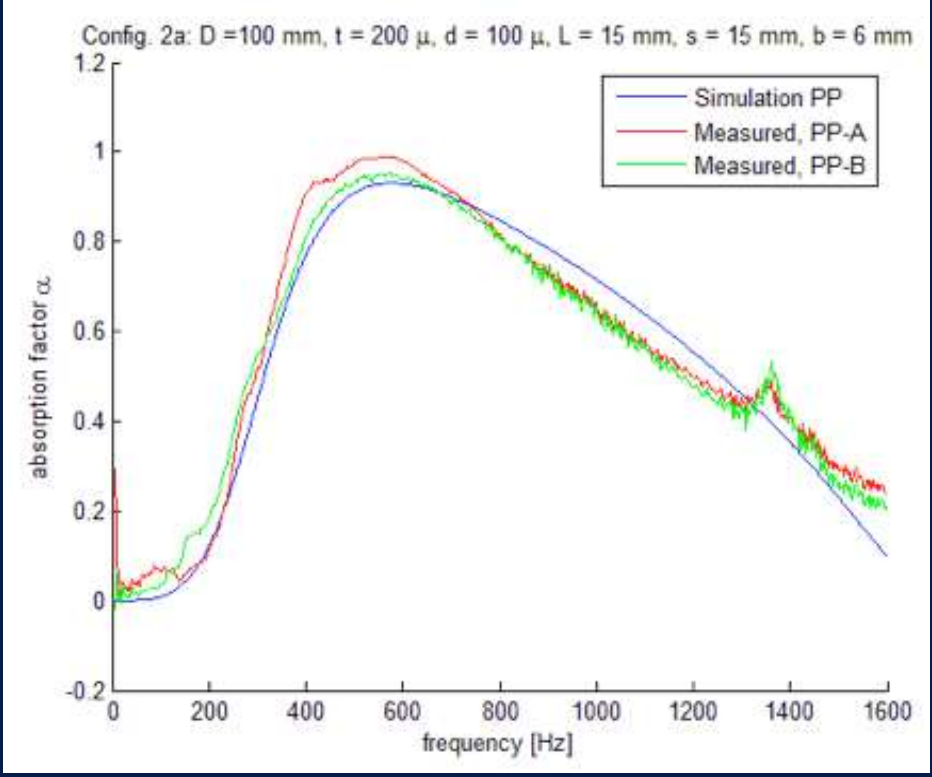


Conducted at University of Salford Commercial Acoustic Test Labs





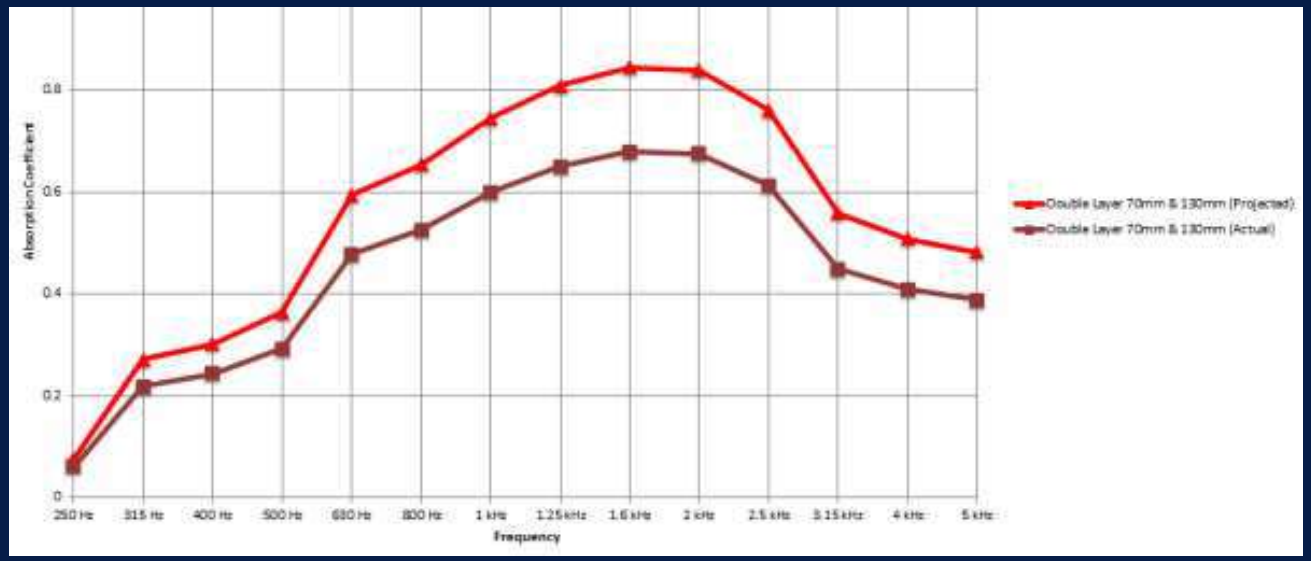
Simulation and impedance tube measurements



Room testing

Achievements

- Acoustic absorber:
  - Theoretical model → design
  - optimised for acoustic performance and for manufacturing process,
  - Tested: standing wave tube (ISO 10534), reverberant room (EN ISO 354)
  - Mounting system



Properties (1)

- Physically more robust in handling and during installation and use than market alternatives.
  - Proven by a range of mechanical tests
- Aesthetically pleasing for commercial, institutional or industrial applications
- Fire resistant and not contributing to toxicity in use or when combusted
  - Achieved excellent fire rating in standardized tests
- Recyclable
- Cleanable

Properties (2)

- Provide acoustic absorption of Class B or C
- Likely to reduce energy use and carbon footprint by inclusion in buildings
  - Designed to optimise the use of thermal mass.
  - Experiments and thermal simulations showed that the absorber does not influence thermal behaviour of the thermal mass.
- Low Cost in comparison to alternative acoustic absorption products
- Versatile in its range of applications
- US Patent granted 2019; EU patent pending

US010190312B2

(12) **United States Patent**
Flotre et al.

(10) **Patent No.: US 10,190,312 B2**
(45) **Date of Patent: Jan. 29, 2019**

(54) **SOUND ABSORBING MATERIAL, A METHOD FOR PRODUCTION OF THE SAME AND DEVICE FOR CUTTING APERTURES IN THE SOUND ABSORBING MATERIAL**

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(*) Notice: Subject to any disclaimer, the term of this

(51) **Int. Cl.**

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G10K 11/162	(2006.01)
G10K 11/168	(2006.01)
E04B 9/00	(2006.01)
E04B 1/82	(2006.01)

(52) **U.S. Cl.**
CPC ***E04B 1/8409*** (2013.01); ***G10K 11/162*** (2013.01); ***G10K 11/168*** (2013.01);
(Continued)

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CPC E04B 1/8409; E04B 9/001; E04B 2001/8414; E04B 2001/8438;
(Continued)

(56) **References Cited**

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(Continued)

Case Study 2: BIM|formed™

- BIMformed: ***Adaptive Learning for Zero Defects in Buildings Construction***
- **Innovate UK** Project 21506, Transforming Construction Challenge (Increase productivity, performance and quality in UK Construction
- Partners:
  - TR Control Solutions Ltd (industry lead)
  - Anglia Ruskin University
  - Subcontractors: New Leaf Ltd, AEC3 Ltd

We work with Innovate UK

Get It Right Initiative
www.getitright.uk.com

BIMformed – Adaptive learning for zero defects in building construction

BIMformed™
Understanding to prevent defects

- The total cost of avoidable errors in construction: £10-£25Bn p.a. (10-25% of project cost)
- Issues related to management and planning communication (e.g. inadequate supervision, operatives not asking questions)

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BIMformed™
Understanding to prevent defects

BIMformed - aim

- Aim: predict and prevent errors in the construction industry by means of a machine learning platform.
- Availability of data in the construction industry is a major barrier.
- Most operatives do not get their instruction via digital devices
- Records of errors are not kept in digital form linked to the construction specification (e.g. linked to the BIM model).
- Whilst site supervisors and engineers may use digital devices to aid their checking of the work done, the operatives generally receive their instructions verbally, aided by access to relevant drawings.

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BIMformed achievements

BIMformed™
Understanding to prevent defects

- The project therefore developed:

1. A framework for data capture from a number of sources, as follows:
    - Web app to record/store operative profile (e.g. age, experience, qualifications)
    - Construction task data captured from a variety of sources (e.g. BIM models, specification documents – i.e. design information)
    - Automatic generation of questions and answers about specific construction task (using a mixture of NLP and parsing of BIM source code file)
    - Administer questionnaire via the web app (using a fast convergence algorithm) to assess quickly operative's understanding of task and provide information on areas of weakness to the machine learning model
    - Information whether error occurred or not for each task in the experiment – captured in the web app post-execution.
2. A machine learning model able to predict likelihood of errors: SVM that takes as input the operative profile, task information and questionnaire results.

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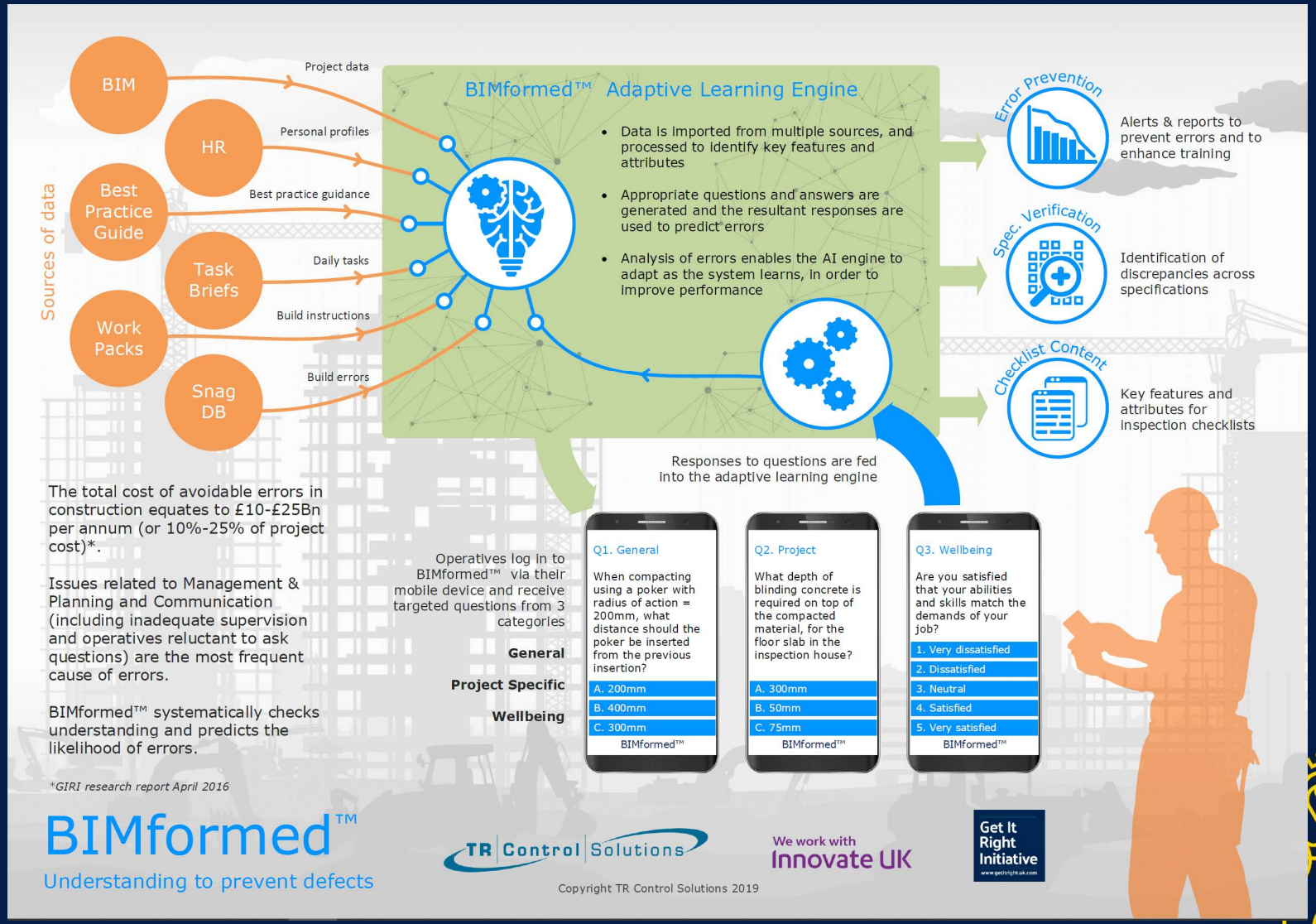

The total cost of avoidable errors in construction equates to £10-£25Bn per annum (or 10%-25% of project cost)*.

Issues related to Management & Planning and Communication (including inadequate supervision and operatives reluctant to ask questions) are the most frequent cause of errors.

BIMformed™ systematically checks understanding and predicts the likelihood of errors.

*GIRI research report April 2016

BIMformed™

Understanding to prevent defects

TR Control Solutions

We work with Innovate UK

Get It Right Initiative

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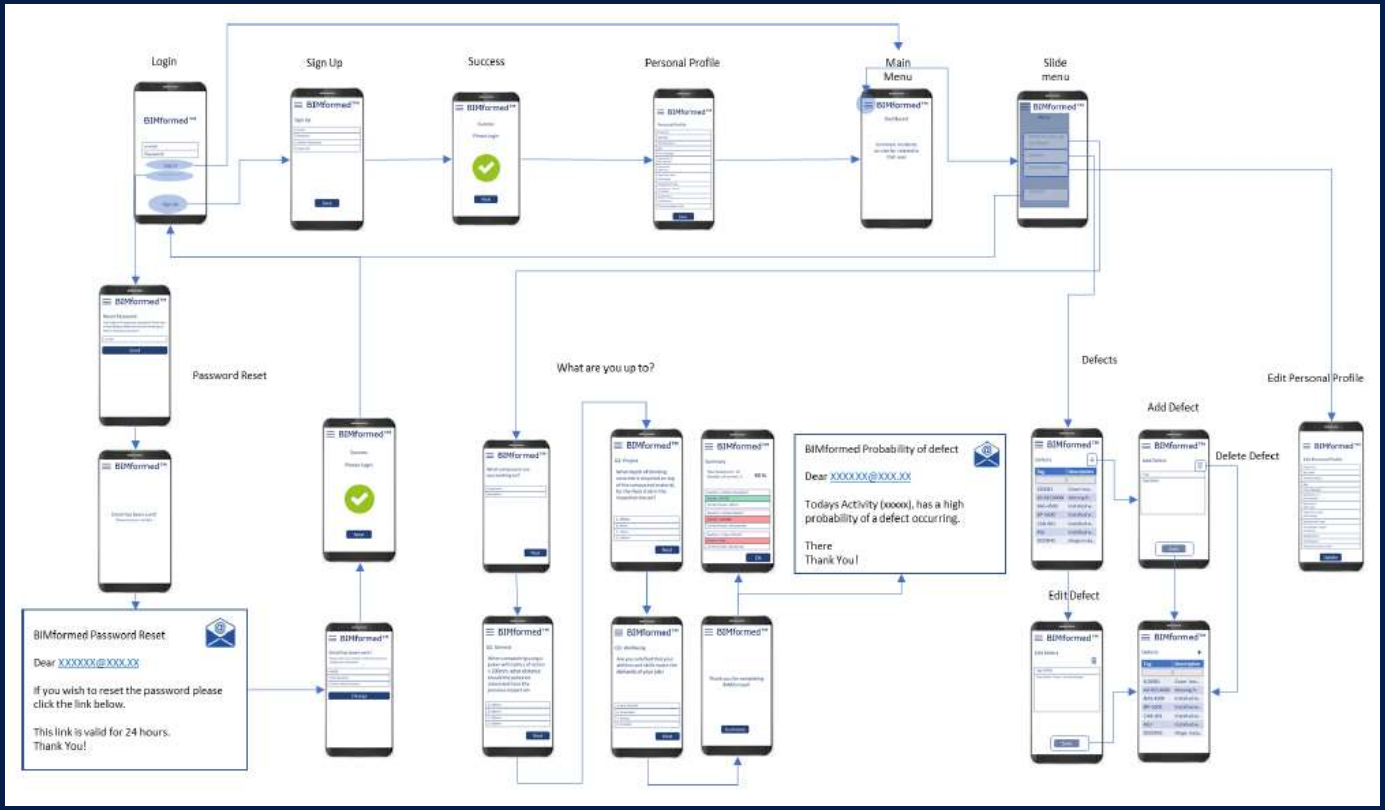
BIMformed™
Understanding to prevent defects

BIMformed web app



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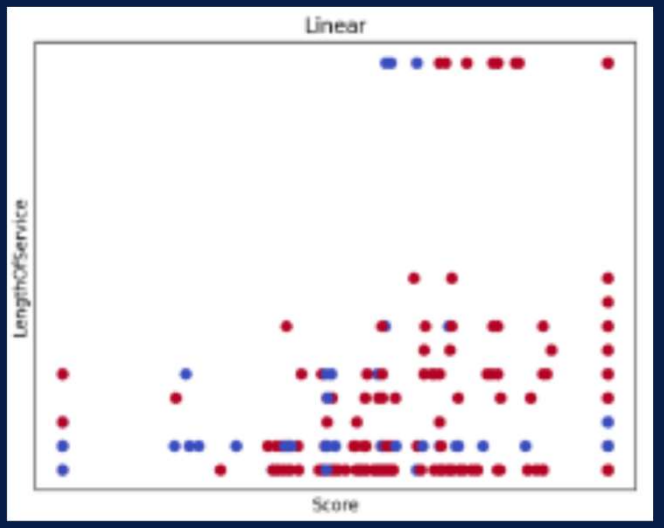
Data collection

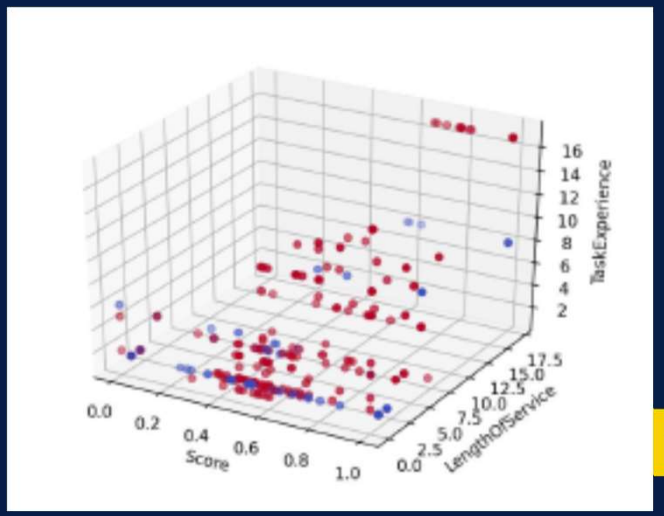
- Data were collected in relation to questions testing operatives knowledge against wiring regulations BS 7671 18th edition, and if any defects had occurred in the last 5 working days.

ML model results

BIMformed™
Understanding to prevent defects

- Fig. 1:Correlation between "Score" and "LengthOfService". (2 Fields)
- Fig. 2: Correlation between "Score","LengthOfService" and "TaskExperience". (3 Fields)
  - the red points demonstrate "DefectOccurred =False"
  - blue points represent data items with "DefectOccurred =True".
- Conclusion
  - With the current ML model (at 75% reliability) we are able to conclude (actual data) that those with the highest score in the questions WITH the longest service and task experience in their profile are less likely to produce defects in their work.





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