ARK-Virus: An ARK Platform Extension for Mindful Risk Governance of Personal Protective Equipment Use in Healthcare

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ABSTRACT

In this demonstration we present the Access Risk Knowledge (ARK) Platform - a socio-technical risk governance system. Through the ARK Virus Project, the ARK Platform has been extended for risk management of personal protective equipment (PPE) in healthcare settings during the COVID-19 pandemic. ARK demonstrates the benefits of a Semantic Web approach for supporting both the integration and classification of qualitative and quantitative PPE risk data, across multiple healthcare organisations, in order to generate a unique unified evidence base of risk. This evidence base could be used to inform decision making processes regarding PPE use.

CCS CONCEPTS

• **Applied computing** → **Health care information systems**; • **Information systems** → *Semantic web description languages.*

KEYWORDS

ARK Platform, Risk Management, PPE, Semantic Web, Linked Data.

ACM Reference Format:
Lucy McKenna, Junli Liang, Natalia Duda, Nick McDonald, and Rob Brennan. 2021. ARK-Virus: An ARK Platform Extension for Mindful Risk Governance of Personal Protective Equipment Use in Healthcare. In *Companion Proceedings of the Web Conference 2021 (WWW '21 Companion), April 19–23, 2021, Ljubljana, Slovenia.* ACM, New York, NY, USA, 3 pages. https://doi.org/10.1145/3442442.3458609

1 INTRODUCTION

This paper describes the Access Risk Knowledge (ARK) platform for socio-technical risk governance and structured evidence collection [3]. ARK's risk governance system is based on the Cube - an established methodology used for analysing socio-technical systems and for managing associated risks [2, 6]. The Cube provides a framework for initiating and analysing organisational change through interlinked, dimension-specific questionnaires. These questionnaires are used to identify, assess, and classify risks, as well as to plan, execute, and evaluate risk mitigation actions.

The ARK-Virus Project, see Section 2, extends the ARK Platform, see Section 3, for use in the healthcare domain - specifically for risk management of personal protective equipment (PPE) use for the purpose of COVID-19 infection prevention and control (IPC).

2 ARK-VIRUS PROJECT

PPE is a critical component of IPC [5, 8] as such, up to date, situation-aware risk management is essential in ensuring that key mechanisms of PPE practice are understood, appropriate actions are carried out and outcomes are monitored [9].

The risk management infrastructure of the Health Service Executive[1] (HSE) in Ireland is currently limited to traditional risk registers, focused on manual reporting, that are siloed in individual organisations. This means that while local innovation around PPE use is possible, this data is rarely shared with other organisations.

The ARK-Virus Project aims to provide a collaborative space for PPE risk management. The ARK Platform uses Semantic Web technologies to model, integrate, and classify PPE risk data, from both qualitative and quantitative sources, into a unified knowledge graph of PPE for COVID-19 IPC. This graph will facilitate the interlinking of risk data with other available datasets on PPE practices, risks and evidence. The ARK Platform will also support the CUBE mindful governance methodology for the analysis, identification and management of PPE risks by healthcare safety experts.

The ARK-Virus project is a collaboration between an academic team and a community of practice in COVID-19 PPE deployment including St James's Hospital[2], Dublin Fire Brigade[3], Tulsa Child and Family Agency[4], Beacon Renal[5] dialysis services and Stewarts Care[6] services for people with intellectual disabilities. By putting ARK in place over many PPE deployment projects, it will be possible

WWW '21 Companion, April 19–23, 2021, Ljubljana, Slovenia

ACM ISBN 978-1-4503-8313-4/21/04.
https://doi.org/10.1145/3442442.3458609

[1] https://www.hse.ie/eng/
[2] http://www.stjames.ie/
[3] https://www.dublincity.ie/residential/dublin-fire-brigade
[4] https://www.tusla.ie/
[5] https://beaconrenal.ie/
[6] https://www.stewartscare.ie/

to conduct semi-automated multi-project analysis and distillation of best practice data into a shareable, privacy-aware, Linked Data knowledge base. Development of this integrated evidence base is critical in optimising the effectiveness of PPE and in understanding the factors influencing compliance with evidence-based IPC measures.

3 ARK PLATFORM

The ARK Platform leverages Semantic Web technologies and W3C standards to integrate qualitative clinical risk management data with quantitative operational data and analytics. At the technical centre of the ARK Platform is a unified model of risk, expressed using an OWL knowledge graph and SKOS taxonomies, that bridges qualitative and quantitative data. This makes large-scale evidence collection and risk analysis more tractable by transforming human-oriented quantitative risk information into structured data using the ARK Cube Ontology[7] and the ARK Platform Vocabulary[8], and by enabling text fields to be annotated with concepts from the ARK Risk[9] and the ARK Health[10] taxonomies. Domain experts can interact with the platform via a web application.

3.1 CUBE Ontology & Platform Vocabulary

The ARK Cube ontology and the ARK Platform vocabulary enable data capture and analysis through the Cube methodology. The ontologies were developed by mixed teams of organisational psychologists and knowledge engineers. The ontologies were implemented using the Web Ontology Language[11] (OWL) specification in Protégé[12]. The Cube ontology is used in the overall architecture of the ARK Platform by serving as a repository of the Cube questionnaire and by modelling questionnaire responses. The Platform vocabulary allows for the modelling of platform users, access controls and user permissions. It also provides a data classification system, based on the HSE Information Classification and Handling Policy[1], that allows data to be categorised according to the sensitivity of its contents. The ontologies contain machine and human-readable metadata, are free of inconsistencies, and are extensible and customisable for different CUBE questionnaires. They have also been validated using the Ontology Pitfall Scanner[13].

3.2 ARK Taxonomies

Both the ARK Risk and the ARK Health taxonomies were defined using the Simple Knowledge Organisation System (SKOS) [7], a W3C recommendation for expressing knowledge organisation systems. The 136 concepts in the ARK Risk taxonomy were defined by domain experts. Whereas the 222 ARK Health concepts were taken from HSE Integrated Risk Management Policies[14] and the HSE Incident Management Framework[4]. R2RML[15] was used to uplift the taxonomies from CSV format to RDF, generating 836 triples and 1445 triples respectively. The taxonomies can be used to annotate data entered on the platform with the view that these annotations could be used to facilitate information searches and evidence linking.

3.3 ARK Application

The ARK Application[16] (see Figure 1) is built on open source Jena[17] knowledge base technology and uses a Node.js[18] web front end to enable users to interact with the system. The platform consists of four main components - a Risk Register, Project Analysis, CUBE Analysis and a CUBE Summary. The Risk Register (see Figure 2) allows users to create a risk using the HSE Risk Assessment format. The Project Analysis (see Figure 3) component allows users to create and analyse projects, and sub-projects, based on identified risks. These risks can be newly created or imported from a HSE Risk Assessment. The CUBE Analysis (see Figure 4) component guides users through completing the CUBE questionnaire. Both the second and third components allow users to interlink answers with supporting evidence and to classify answers with risk related concepts using the ARK Terminologies. Finally, the CUBE Summary (see Figure 5) component provides a summary and visualisation of the Project Analysis and the CUBE Analysis.

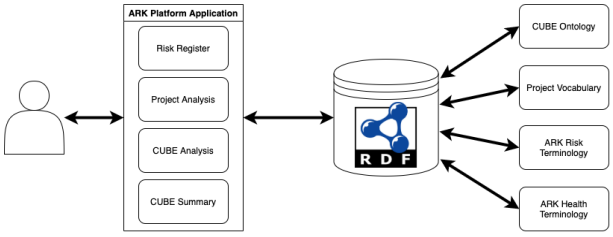

Figure 1: ARK Platform Application

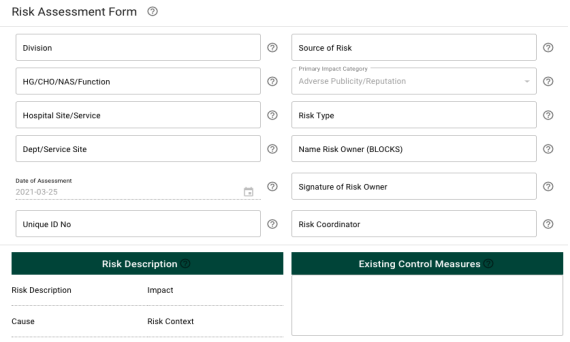

Figure 2: Risk Assessment Form

[7] Available at https://openark.adaptcentre.ie/Ontologies/ARKCube
[8] Available at https://openark.adaptcentre.ie/Ontologies/ARKPlatform
[9] Available at https://openark.adaptcentre.ie/Ontologies/ARKTerminology
[10] Available at https://openark.adaptcentre.ie/Ontologies/ARKHealthTerminology
[11] https://www.w3.org/TR/owl2-primer/
[12] https://protege.stanford.edu/
[13] http://oops.linkeddata.es/
[14] www.hse.ie/eng/about/qavd/riskmanagement/risk-management-documentation/
[15] W3C Recommendation for defining customised mappings to convert non-RDF resources to RDF - https://www.w3.org/TR/r2rml/

[16] Demo available at https://openark.adaptcentre.ie/
[17] https://jena.apache.org/documentation/fuseki2/
[18] https://nodejs.org/en/

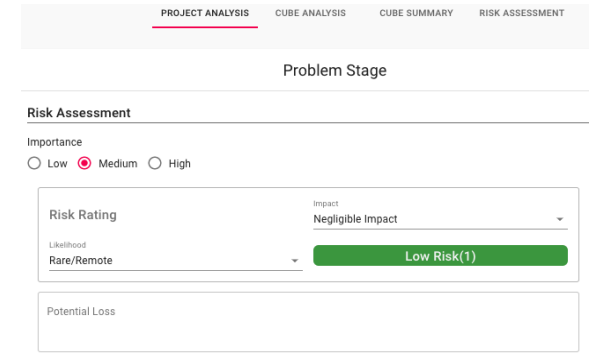

Figure 3: Project Analysis

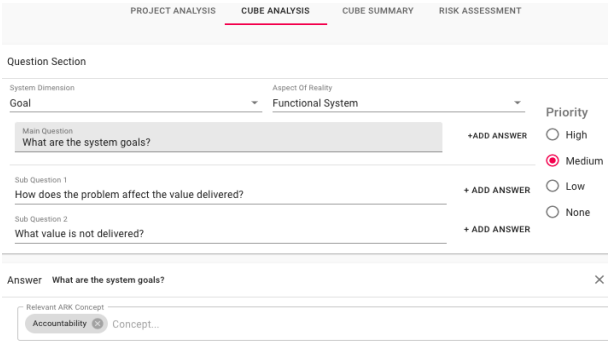

Figure 4: CUBE Analysis

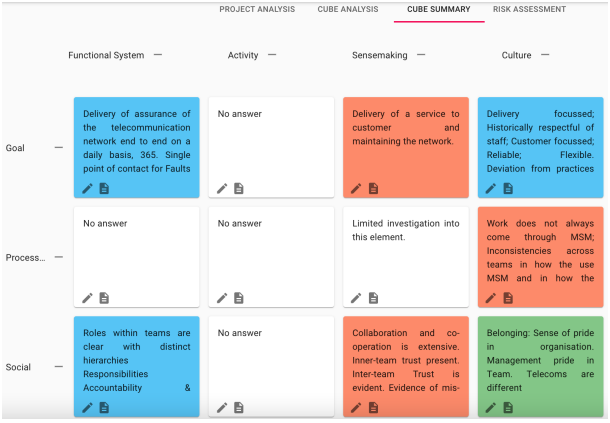

Figure 5: CUBE Summary

4 ARK PLATFORM DEMONSTRATION

A highly interactive demonstration of the ARK-Platform will be provided. The audience will be able to view the CUBE ontology, Project vocabulary, safety management taxonomy and health risk taxonomy via WIDOCO[19] HTML documentations. The audience will also be able to use the ARK application and explore the platform's functionalities using sample PPE risk management data.

[19]https://github.com/dgarijo/Widoco

ACKNOWLEDGMENTS

This research was conducted with the financial support of SFI under Grant Agreement No. 20/COV/8463 at the ADAPT SFI Research Centre at Dublin City University and Trinity College Dublin. The ADAPT SFI Centre for Digital Content Technology is funded by Science Foundation Ireland through the SFI Research Centres Programme and is co-funded under the European Regional Development Fund (ERDF) through Grant #13/RC/2106_P2.

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