

This item was submitted to [Loughborough's Research Repository](#) by the author.
Items in Figshare are protected by copyright, with all rights reserved, unless otherwise indicated.

Advocating systems approaches outside of engineering: reporting on research with the UK insurance sector towards the adoption of trustworthy AI-enabled systems

PLEASE CITE THE PUBLISHED VERSION

<https://asec2020.org.uk/Pages/Standard/Home>

PUBLISHER

International Council on Systems Engineering

VERSION

VoR (Version of Record)

LICENCE

CC BY-NC-ND 4.0

REPOSITORY RECORD

Timms, Paul, and Melanie King. 2020. "Advocating Systems Approaches Outside of Engineering: Reporting on Research with the UK Insurance Sector Towards the Adoption of Trustworthy Ai-enabled Systems". Loughborough University. <https://hdl.handle.net/2134/13341173.v1>.

Advocating systems approaches outside of engineering: reporting on research with the UK insurance sector towards the adoption of trustworthy AI-enabled systems

Paul David Timms, Loughborough University, research@paultimms.co.uk

Dr Melanie King, Loughborough University, m.r.n.king@lboro.ac.uk

Categorisation

- Accessibility: BEGINNER
- Application: GOOD PRACTICE
- Topics: Enterprise Systems Engineering, Project Management, Capability

Abstract

Part of INCOSE's SE vision 2025 is to expand the application of Systems Engineering approaches across industries. One opportunity is the development and deployment of AI-enabled services by enterprises worldwide, as societal expectations for acceptable AI use present significant challenges for policy makers, regulators and system designers. In this paper, we report on an ongoing research project with the UK insurance sector, investigating the application of systems approaches in the adoption of trustworthy AI-enabled systems. We aim to showcase the relevance of a systems approach when addressing impending consumer protections for AI use, referenced as principles for ethical, responsible, or trustworthy use of AI and data technologies, amongst others, dependent on publication and perspective adopted. We explain how the UK insurance industry, and underpinning platform technologies, can be considered a complex system of systems, and how Systems Thinking worldviews can bring coherence. This research builds upon two substantial bodies of work that have synthesised policy and advisory literature (combining governmental, inter-governmental, private sector and civil society stakeholders) on the expectations for acceptable AI and data use across the world. We describe how Systems Engineering practices can be applied to integrate trustworthy design principles into a complex socio-technical environment, and discuss why capability engineering, at the insurance sector level, can help insurance enterprises and industry regulators address ethical / responsible / trustworthy-by-design criteria. We comment on the challenges and limitations we have encountered during this process and discuss the next steps of this research.

Introduction

The increasing capability of Artificial Intelligence (AI), and use of AI-enabled systems and services by enterprises around the world, presents a significant challenge for policy makers and regulators. Within the insurance sector, 14 new 'InsurTech' insurance capabilities are introduced [Stoekli et al., 2018]. Four of these; (1) the exploitation of data for risk assessment and underwriting, (2) the

exploitation of data for claims handling, (3) complimenting insurance services with prevention and recovery services and (4) offering risk-adjusted pricing; pose direct risk to human welfare and societal prosperity. These consumer protection risks, that; (1) AI creates winners and losers amongst consumers, (2) material damage can be caused by the theft of sensitive data, (3) use of AI can pass the ‘creepy’ threshold and (4) consumers may become vulnerable to institutions which become too powerful [Patel & Lincoln, 2019]; must be adequately accounted for in AI-related regulation.

In the UK (and across Europe), recent moves to bolster consumer protection were embodied within the General Data Protection Regulations (GDPR), enacted through the Data Protection Act (2018). While GDPR strengthens or introduces many protections for ‘data subjects’ (e.g. consumers), there is broad consensus that many issues remain unresolved [AccessNow, 2018] and “legal uncertainty” still exists [Insurance Europe, 2019]. Across the globe, private companies, research institutions, public sector organisations and government bodies are proposing further requirements for the acceptable use of AI technologies. While differences are evident between countries and cultures, two significant bodies of work [Fjeld et al., 2020; Jobin et al., 2019] highlight the convergence towards a common list of principles, for *ethical, responsible* or *trustworthy* use of AI and data technologies (hereafter referred to as ‘trustworthy principles’), that will form the next wave of AI technology regulation worldwide.

These principles are not, however, operationalised for specific industries. As acknowledged in INCOSE’s SE Vision 2025 [INCOSE Technical Product, 2014], when solutions are sought to meet fundamental human needs, they tend towards the large and complex. Systems Engineering can support the management of this complexity, through its principles and terms that enable communication and improve the ability to integrate complex systems that span traditional domain boundaries [Sillitto, 2012]. Therefore, we propose a systems approach to understand the ‘problem’ of trustworthy principles and develop compliant ‘solutions’ for insurance services built upon new, AI-enabled insurance capabilities.

Approach

Our approach is built upon four fundamental building blocks [King, 2019]: (1) through application of *Systems Thinking* methods, commonly agreed definitions of insurance functionality can be found which integrate the worldviews of regulators, insurance enterprises, consumers and other stakeholders, (2) a *Systems Engineering* process can rationalise and harmonise disparate principles for trustworthy AI adoption into a coherent systems requirements set, (3) the operational and managerial independence of both the insurance industry and AI service delivery means that this is a *System of Systems* (SoS) issue in both problem and solution domains, and (4) *capability engineering* techniques provide the translation language by which we can integrate problem and solution domain SoS together.

Findings

Building Block 1: A Systems Thinking Approach

It is a well-established principle of Systems Thinking that different communities adopt different worldviews (e.g. business vs. technical, customer vs. insurer), and that when they come together come together, they may find that their assumptions underpinning their worldview aren’t shared by other

communities [Sillitto, 2012]. This is no different insurance, where two well established but juxtaposed worldviews are apparent, and present in dictionary definitions [OUP, 2019]:

- the **concept of insurance**: “A thing providing protection against a possible eventuality”.
- the **contract of insurance**: “An arrangement by which a company or the state undertakes to provide a guarantee of compensation for specified loss, damage, illness or death in return for payment of a specified premium”.

We can rationalise these related worldviews through the lens of Hitchin’s 5-layered systems model [Hitchins, 2005]. The *concept of insurance* infers the top-level operational requirement for a level 5 societal system: the logical worldview of insurance customers, of society, policy makers and legislators. By contrast, the *contract of insurance* definition aligns with Hitchin’s level 3 business systems: the logical worldview of insurance enterprises (insurers, reinsurers, brokers, etc.), data services enterprises and technology infrastructure providers. Customer protection regulation (and regulators) sit in a level 4 industry system, which integrates the level 5 & 3 worldviews.

Building Block 2: A Systems Engineering Process

Defining insurance as a set of systems layers provides a framework (Figure 1) to rationalise the incoherence in the trustworthy principles of AI use (Fjeld, et. al. identify 47 principles / 8 groups. By contrast, Jobin et. al. identify 52 principles /11 groups). While both papers address the same common themes, the language and terminology selected to group and categorise principles is notable by its differences. Some variance appears to be caused through grouping of interrelated principles (*e.g. Accuracy vs. predictability, inclusiveness vs. multi-stakeholder collaboration*); these represent differences in the level of system to which these properties can be delivered. Other variances appear to stem from differences in approach: some are written in the form of abstract rights or responsibilities (*e.g. accuracy, right to erasure*), while others are written in the form of prescriptive methods (*e.g. notification when interacting with an AI*). These can be sorted through the principle of functional and

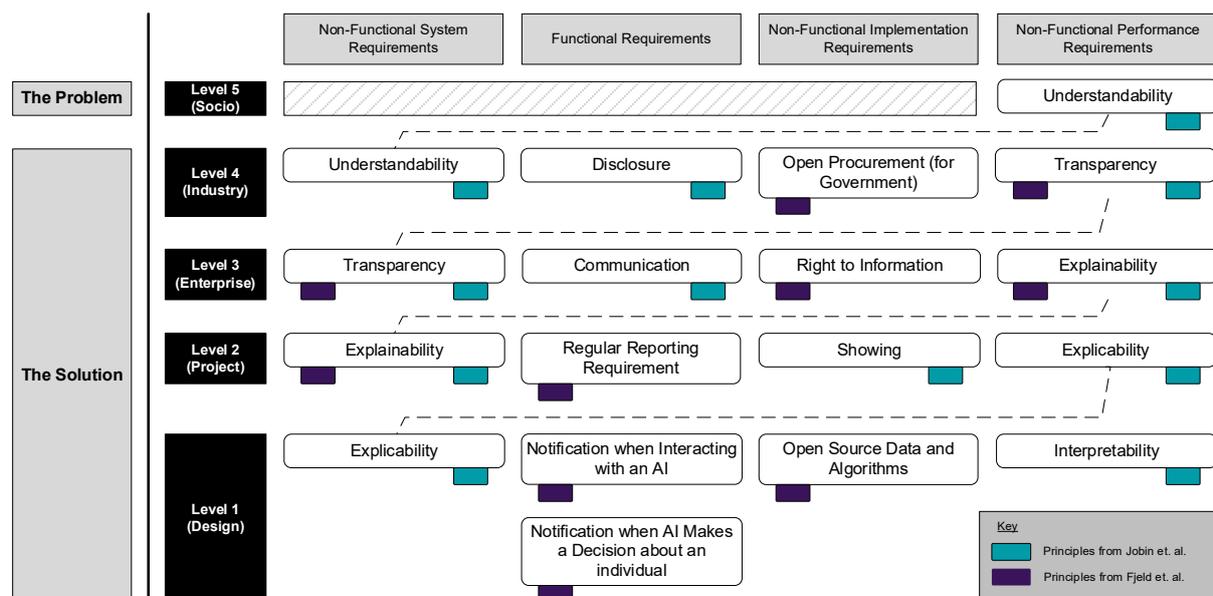


Figure 1 – A framework and example requirements stack for trustworthy requirements. Specifically, this stack combines principles (from Fjeld, et. al. [2020] and Jobin et. al. [2019]) that increase user trust through increased understanding within society. This is why the framework starts with a non-functional performance requirement (level 5). Following the principles of HRM, this becomes a non-functional system requirement (level 4). The above example is intended to demonstrate how the singular issue of ‘understandability’ may be perceived from different levels of abstraction, rather than present a comprehensive and robustly proven systems requirements set.

non-functional requirements, long established in requirements engineering theory [Dick et al., 2017] and embodied within the Holistic Requirements Model (HRM) [Burge, 2006]. Needs and solutions are also conflated (*e.g. the need for understandability vs. the provision of an explanation, the need for non-maleficence vs. doing no harm*). A clear delineation of problem and solution-space will aid this analysis.

Through the translation of trustworthy principles into a ‘stack’ (of functional and non-functional requirements across five levels of system type), we will finish with a framework that associates AI principles with the worldview in which they are considered most applicable (building block 1) and forms the basis of a *Trustworthy Principles System Requirements Specification (TP-SRS)* for AI-enabled insurance services. Using this framework, fundamental needs of society (level 5 non-functional performance requirements) can be coherently translated and understood within the context of collaborative insurance industry activities (level 4), the delivery of service ecosystems (level 3), the project management of system design and operation (level 2) and the design of the AI-enabled service itself (level 1).

Building Block 3: A System of Systems Perspective

A completed TP-SRS must be considerate that both the contract of insurance, and the mechanism by which AI value is derived, are *System of Systems (SoS)* issues with operational and managerial independence in both problem and solution domains (a well-established requirements management idea [Dick et al., 2017]):

Problem domain: the insurance industry is a complex system comprising of many distinct roles. Insurance prices are determined by underwriters (who estimate customer’s potential claims (losses) and decide whether to sell policies to them and at what price), based on market conditions and the premium rates established by actuaries (who collect claim (loss) statistics and use this to calculate premium rates for different classes of policyholders). Loss adjusters (claims adjusters) decide the value of claims when these are made by customers, and in many insurance markets, an intermediary (usually an insurance agent or broker), between the buyer and the insurer plays the role of “market maker,” helping buyers to identify their coverage and risk management needs and matching buyers with appropriate insurers [Cummins & Doherty, 2006; Owadally et al., 2018]. Other direct and indirect channels such as contact centers, internet, banks, aggregators (i.e. price and product comparison companies) and third-party retailers are also part of the mix [Boobier, 2016].

Solution domain: industries leveraging AI and data services are trending towards platformisation [Evans & Gawer, 2016; Jacobides, 2019] as platforms (“*frameworks that permit collaborators – users, peers, providers – to undertake a range of activities, often creating de facto standards, forming entire ecosystems for value creation and capture*” [Mattila & Seppälä, 2015]) enable data value extraction [Bygstad & Hanseth, 2018] and easing data sharing barriers [Richter & Slowinski, 2019]. The defining feature of platformisation, at any level, is that the insurance service provision becomes a property of multiple, operationally and managerially independent enterprises. This represents an increasingly difficult governance challenge [Sahel, 2016] in the management of customer (insurance) data.

Platformisation is observed across Hitchin’s system levels. Those that span traditional domain boundaries (level 5) include Ping An’s one-stop health ecosystem (where insurance forms part of an integrated service) [Swiss Re, 2019], Amazon’s bundled insurance protection for products it sells

[Kenney & Zysman, 2015], and NEOS's smart home system (which provides active household protection with insurance as a supporting function) [Oxbow Partners, 2019]. Platforms that span the breadth of the insurance domain (level 4) include the Open Insurance Initiative [OpenInsurance.io], which seeks to mimic the open banking concept and Lloyds (of London's) six proposed integrated platform solutions for the marketplace; (1) complex risk platform, (2) risk exchange platform, (3) claims handling platform, (4) capital investment platform, (5) syndicate-in-a-box platform and (6) service hub [Howard, 2019]. Level 3 platforms play a role in the delivery of the contract of insurance we described earlier. While it is inevitable that insurers operate their own internal platforms for many activities, the interest here is on the external service provision offered by InsurTechs. Examples include Concirrus' Quest platform (which provides a behavioural risk -based data analytics service) [Concirrus] and Vitality (which offers incentivised life insurance policies using fitness tracker data acquired from smart watch providers such as Apple, Fitbit) [Vitality]. Level 2 platforms exist within the data value chain [Curry, 2016], for example, Google (TensorFlow), Microsoft (Cognitive Services), Amazon (Lex) and IBM (Watson).

Building Block 4: Capability Engineering at the Sector Level

Trustworthy principles seek to minimise the risk that insurers develop AI-enabled products and services that seek 'too much' value, at the expense of consumer protections and human civil liberties. The value in this context is the capability to derive knowledge (from data and information) and, based on that knowledge, make decisions and perform actions; known as the big data information value chain [Abbasi et al., 2016]. Any completed TP-SRS must therefore associate requirements for trustworthiness with these capabilities, and the capabilities defined by Stoeckli et. al. [2018] (see our introduction). The SoS nature of insurance, in problem and solution space (see building block 3), means that many actors require difference capabilities, and that the capabilities are delivered by multiple organisations. Only with a clear definition of capability, associated with roles and responsibilities, can we ensure a trustworthy SoS with any confidence of success [Jamshidi, 2008].

There are many worldviews of capability. In Table 1 of Henshaw et. al. [2011], actors are associated with a particular 'Weltanschauungen' of capability. In this paper, we adopt Weltanschauungen 6 (W6), *Capability Systems Engineering*, to ensure a consistent definition across actors; integrating the buyer (insurance customers), architect (regulator), users (see building block 3; problem domain), capability owners (see building block 3; solution domain) and suppliers (data and technology providers). In this Weltanschauungen, the enterprise goal is to adopt trustworthy principles. The enterprise is the insurance sector (as defined using Hitchin's 5 system layers in building blocks 1 & 2). This enterprise consists of multiple organisations that deliver insurance services (as defined in building block 3) using a range of AI-enabled systems. These AI-enabled systems consist of equipment, processes, people, support services and infrastructure.

Observations and future research

By treating the bodies of research conducted by Fjeld, et. al. [2020] and Jobin et. al. [2019] as representative of all problem domain (stakeholder) requirements for AI use in all industries, we can move directly to a set of system requirements, rationalised by Hitchin's system levels. This possible due to comprehensive nature of these bodies of work, both in terms of the stakeholders represented, and the geographical diversity of publications. The proposed framework is therefore cumulative of all

possible principles; a future comparison of these requirements against UK policy is necessary to indicate variances between the UK and other demographics (and unearth 'best practice' not adopted).

To operationalise trustworthy principles for insurance services requires reverse engineering, to associate generic (solution domain) system requirements with the specific capabilities of AI-enabled insurance services (the problem domain space). Future research should focus on the development of a complete requirements set (TP-SRS), appropriately harmonised with the new capabilities that AI technologies are enabling within insurance. A supporting capability framework is required, which integrates the five actor perspectives of Henshaw et al.'s Weltanschauungen 6. Capabilities describe the value of functions, i.e. *how* functions are delivered [Graves, 2012]. By viewing capabilities as functions at a lower system level, we can harmonise functional and capability perspectives by acknowledging that the actor discussing capability of an (e.g.) level 4 system is describing the need (the function) of a level 5 system, this addressing the apparent incongruence between Henshaw et al.'s Weltanschauungen 6 (Hitchin's level 4 to 1) and our functional model (Hitchin's level 5 to 2).

Finally, various SoS issues must also be addressed. Is AI-enabled service delivery best perceived as a Hitchin's layer 3.5, or a slice through multiple layer 3 systems? How are the many various insurance models (e.g. private home insurance vs. commercial marine insurance) addressed? Will a completed TP-SRS require specification of types of data? How will competing principles (*e.g. privacy versus open source data, security versus transparency*) be resolved when systems are adopted?

References

- Abbasi, A., Sarker, S., Chiang RHL & Lindner CH. (2016). *'Big Data Research in Information Systems: Toward an Inclusive Research Agenda'*. J. Assoc. Inf. Syst.
- AccessNow (2018). *'Mapping Regulatory Proposals for Artificial Intelligence in Europe'*.
- Boobier, T. (2016). *'Analytics for Insurance: The Real Business of Big Data'*. Chichester: Wiley.
- Burge, S. (2006). *'The Systems Engineering Tool Box: Holistic Requirements Model (HRM)'*.
- Bygstad, B. & Hanseth, O. (2018). *'Transforming digital infrastructures through platformization'*. In: 26th Eur. Conf. Inf. Syst. Beyond Digit. - Facet. Socio-Technical Chang. ECIS 2018.
- Concirus. *'About us'*. Available at: <http://www.concirus.com/who-we-are> [Accessed 7 May 2020].
- Cummins, JD. & Doherty, NA. (2006). *'The Economics of Insurance Intermediaries'*. J. Risk Insur. 73: 359–396.
- Curry, E. (2016). *'The Big Data Value Chain: Definitions, Concepts, and Theoretical Approaches'*. In: New Horizons for a Data-Driven Economy: A Roadmap for Usage and Exploitation of Big Data in Europe. Cham: Springer International Publishing.
- Dick, J., Hull, E. & Jackson, K. (2017). *'Requirements Engineering'*. Cham: Springer.
- Evans, PC. & Gawer, A. (2016). *'The Rise of the Platform Enterprise'*.
- Fjeld, J., Achten, N., Hillgoss, H., Nagy, AC. & Srikumar, M. (2020). *'Principled Artificial Intelligence: Mapping Consensus in Ethical and Rights-based Approaches to Principles for AI'*.
- Graves, T. (2012). *'Service, function and capability (again) – Tetradian'*. Available at: <http://weblog.tetradian.com/2012/09/22/service-function-capability-again/> [Accessed 29 Jan 2020].

Henshaw, MJ de C., Lister, P., Harding, AD., Kemp, D., Daw, AJ., Farncombe, A. & Touchin, M. (2011). *'Capability Engineering - An Analysis of Perspectives'*. In: INCOSE Int. Symp. 21.

Hitchins, D. (2005). *'World Class Systems Engineering - The 5-layer Model'*. Available at: <http://systems.hitchins.net/systems/world-class-systems-engineer.html> [Accessed 30 Apr 2020].

Howard, LS. (2019). *'Lloyd's Reveals Blueprint to Build 'Most Advanced Insurance Marketplace''*. Insurance Journal.

INCOSE Technical Product. (2014). *'A World in Motion - Systems Engineering Vision 2025'*.

Insurance Europe. (2019). *'Annual Report 2018-2019'*.

Jacobides, MG. (2019). *'In the Ecosystem Economy, What's Your Strategy?'*. Harv. Bus. Rev. Sept.

Jamshidi, M. (2008). *'System of Systems Engineering: Innovations for the 21st Century'*. Hoboken: Wiley.

Jobin, A., Ienca, M. & Vayena, E. (2019). *'The global landscape of AI ethics guidelines'*. In: Nat. Mach. Intell. 1:9.

King, M. (2019). *'A Systems Perspective on Developing Enterprise AI Capability'*. In: TECHNGI Artificial Intelligence and Next Generation Insurance Services Conference.

Mattila J & Seppälä T. (2015). *'Machine in a Cloud – or Cloud in Machines? Emerging New Trends of the Digital Platforms in Industry and Society'*.

OpenInsurance.io. *'Open Insurance - Who are we?'*. Available at: <https://openinsurance.io/about/> [Accessed 19 Apr 2020].

Owadally, I., Zhou, F. & Wright, D. (2018). *'The insurance industry as a complex social system: Competition, cycles and crises'*. Jasss 21.

Oxbow Partners. (2019). *'25 Emerging businesses well placed to have an impact on the insurance industry in 2019'*.

Oxford University Press. (2019). *'Meaning of Insurance'*. Lexico.com.

Patel, K. & Lincoln, M. (2019). *'It's not magic: Weighing the risks of AI in financial services'*. Centre for the Study of Financial Innovation (CSFI).

Richter, H. & Slowinski, PR. (2019). *'The Data Sharing Economy: On the Emergence of New Intermediaries'*. In: IIC Int. Rev. Intellect. Prop. Compet. Law 50.

Sahel, J-J. (2016). *'Multi-stakeholder governance: a necessity and a challenge for global governance in the twenty-first century'*. In: J. Cyber Policy.

Sillitto, H. (2012). *'Integrating Systems Science, Systems Thinking, and Systems Engineering: understanding the differences and exploiting the synergies'*. In: INCOSE Int. Symp. 22.

Stoekli, E., Dremel, C. & Uebernickel, F. (2018). *'Exploring characteristics and transformational capabilities of InsurTech innovations to understand insurance value creation in a digital world'*. In Electron. Mark. 28.

Vitality. *'About Vitality Health and Life Insurance and Investments'*. Available at: <https://www.vitality.co.uk/about/> [Accessed 01 May 2020].