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Fake News: a conceptual model for risk management

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This article proposes a model based on a systematic literature review (SLR) that investigates the intersection of Fake News, Risk, and Risk Management. Employing Design Science Research as the primary methodology, it introduces a conceptual model to mitigate Fake News-related risks in specific communities. The model uses ArchiMate to depict a community as an organisational entity, exemplifying its practicality through a Fake News instance from the Central European Digital Media Observatory. The research undergoes rigorous evaluation using the Bunge-Wand-Weber Model, ensuring its consistency and value to the scientific community. This evaluation formalises the proposed conceptual model, offering a structured framework systematically mapping Fake News concepts to mitigate associated risks and disinformation. This study contributes to the Fake News management discourse, providing a practical risk management tool to counter the phenomenon.

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Introduction

The swift rise of digitalisation has offered a transformative view to organisations and new technological advancements. It has also transformed our relationship with information and how we use and perceive technology to communicate. It is essential to remember that digitalisation has brought new and different digital risks to our communities and organisations. A common digital threat associated with digitisation is disinformation, which is the spread of false or misleading information online through the use of Fake News (FN). FN can be a medium for the dissemination of disinformation. It is crucial to understand that disinformation threatens the integrity of information, manipulating public opinion and the decision-making process Christodoulou & Iordanou (2021). Moreover, its false and misleading nature presents a genuine threat to societies, with its impact going beyond the spreading of disinformation, potentially eroding public trust, influencing critical decision-making, and affecting individual and organisational reputation Huber et al. (2021).

As an example of the harm and distress caused due to FN, we have the bombardment of disinformation produced with ideological interference in world political events over the past decade, with examples of its effects in critical political events such as Brexit in the UK, the 2016 US election of Donald J. Trump, years where FN hit its peak Yerlikaya & Aslan (2020). This example highlights how disinformation can rapidly spread, which means it can reach a larger audience, making it increasingly challenging to control and mitigate its impact.

A comprehensive systematic literature review (SLR) on fake news, digital risk, and risk management enabled us to map out the fake news concepts mentioned in the literature and their connections to digital risk. We were able to define fake news, identify its main concepts, and establish the relationships between them. In summary, the SLR seeks to demonstrate that FN is indeed an instantiation of digital risk and paved the way for studying its concepts and developing conceptual modelling here presented.

Given the vast terminology used to define FN, it was essential to present a conceptual model that used the concepts of FN in its multitude of different definitions to provide a metamodel that seeks to understand and decompose the concepts in a rich and diversified manner that reflects the diversity of definitions found in the literature. This article, therefore, aims to build a comprehensive conceptual model derived from the literature that provides clarity to stakeholders, mainly the law enforcement agencies that seek to mitigate the impact of FN in a community.

This research follows the methodology and guidelines of Design Science Research for Information Systems Hevner et al. (2010), where the conceptual model is the central artefact, and the community is modelled as an organisation using ArchiMate modelling language for enterprise architecture. Furthermore, this research seeks to demonstrate through an instance of FN present in the Central European Digital Media Observatory.(CEDMO) archive to fully understand the model applicability and resilience in a given community.

Research Background

This section comprises three integral parts: Risk, Fake News and the interplay between Digital Risk and Fake News.

Risk. The concept of risk has been thoroughly investigated, and the term has different definitions. Renn, O argues that the terms encapsulate different definitions that are not commonly accepted Renn (1998). The International Risk Governance Council (IRGC) defines risk as an uncertain consequence of an event or activity concerning something that humans value Renn (2009). This definition conflates with the Rosa (1998), Rosa (2003), where the authors state that risk is a situation or event where something of human value (including humans) is at stake, thus having an uncertain outcome. The ontological work Aven et al. (2011) also agrees that the two previous references express the same idea.

For this work, the authors adopted the definition provided by industry-standard 31 000 for risk management, which is more attainable, stating that risk is defined as the effect of uncertainty on objectives and goals.These uncertainties can arise from various sources, such as ambiguity in decision-making, economic conditions, technological advancements, and legal and regulatory changes. It is important to note that risk has three crucial components - the likelihood of a given event to occur, its consequences or impacts that derive from an event, and, lastly, the uncertainty encompassing these two factors Dali & Lajtha (2012).

Understanding these components is essential for making informed decisions in the context of risk management. The likelihood of an event signifies the probability of its occurrence, ranging from highly unlikely to almost certain. Consequences, on the other hand, can be of positive or negative outcomes that follow the materialisation of an event. These outcomes have an impact to an organisation and can span a spectrum, enveloping gains, and losses. An effective risk management strategy considers the potential financial implication and evaluates broader repercussions on reputation, operational efficiency, and strategic alignment.

It is worth mentioning that the concept of uncertainty interlinks the likelihood and consequences of an event, highlighting the dynamic and ever-evolving nature of risks. This uncertainty stems from the complexity of interrelated factors, the intricacies of cause-and-effect relationships, and the unpredictability of external influences. It is, therefore, evident that organisations must recognise that risk are not isolated incidents but rather interconnected elements that can trigger a chain of reactions. Consequently, embracing risk management as an ongoing strategy instead of one-time task allows organisations to adapt and respond to the evolving landscape of uncertainties continuously. It is possible to conclude that risk management has become pivotal aspect of modern organisations Dali & Lajtha (2012).

Furthermore, in the current degree of digitalisation, the ever presence of cyber risk poses a significant challenge to individuals, organisations, and critical infrastructures. The consequences of risk related incidents, has the potential to arouse cyber incidents with extensive and long-lasting impacts on critical infrastructure, emphasising the significance of proactive risk management measures Strupczewski (2021). The emergence of contemporary technological strides in digitalisation has ushered in novel prospects for business augmentation, process refinement, and heightened efficiencies. Concurrently, this paradigm shift has engendered a heightened susceptibility to the pernicious encroachments of cyber threats precipitated by the intricate interlinking of our intricate system architectures.

Emphasising this dynamic juncture, it becomes paramount to underscore the imperative of formulating an all-encompassing scheme that addresses preserving delicate information and fortifying digital ecosystems' robustness. Considering the rapidly evolving cyber terrain, the delineation of a holistic approach assumes a pivotal role in mitigating risks and nurturing the resilience indispensable to the sustenance of digital domains Donaldson et al. (2015). Furthermore, it is imperative not to disregard the interconnected risk of disseminating false information, commonly called fake news. This phenomenon capitalises

on technological advancements and interlinked systems to propagate deceptive narratives, misleading individuals. In light of the escalating sophistication and persistence of cyberattacks, comprehending the diverse dimensions of digital risk emerges as an indispensable consideration Singer & Friedman (2014).

Fake News. The literature contains different terms that help solidify the definition of FN, which is the broader terminology of this work. Its spread intentionally or unintentionally has severe consequences, especially if widely believed and followed by individuals, and can potentially erode public trust in institutions or media. Effective dissemination is often granted through effecting spreading online with particular emphasis on social media. Generally speaking, state and private actors responsible for spreading disinformation have developed techniques to propagate falsehoods; such techniques may include using automatic bots that indulge in creating effective dissemination networks and infiltrating real social media accounts Aswad (2020).

When considering the scope of FN, it is fundamental to remember that it does not limit its action solely to social networks; on the contrary, it refers to false or counterfeit material reported in a newspaper, newscast or periodical. It is, therefore, possible to conclude that the spreading of false information takes different forms and uses different means of propagation Ferreira et al. (2020).

Another aspect to consider when talking about FN is the intention behind the actor responsible for the spreading of disinformation. Should the intention be to deliberately misinform the receptor then it can be classified as disinformation. On the other hand, if the intention to disinformed is null, and should it be the result of a mistake or error then it is defined as misinformation. Misinformation may also refer to information that is incomplete Huber et al. (2021). The intention is amplified by private interests seeking political or financial rewards, that micro-target vulnerable individuals as seeds to further spread misinformation Bastick (2021).

There are various definitions of disinformation, including the one provided by the European Commission in its 2018 Code of Practice on Disinformation. According to this definition, disinformation is any false or misleading information created, presented, and spread to make money or deceive the public. This type of information can harm individuals and society as a whole and may pose a threat to democratic political processes and public goods, such as the protection of citizens' health, the environment, and security within the European Union, Comission (2018).

According to the United Nations Counter Disinformation Report, there is no clear definition of disinformation. The report states that this phenomenon reflects the new and rapidly evolving communications landscape and technologies that enable the dissemination of unprecedented content at exceptional speeds. This undermines the public trust in institutions and contributes to a polarised society, creating grounds for populism and authoritarianism, General Assembly (2022).

To fully grasp the phenomenon of FN, it is vital to comprehend its two most associated terminology of information: misinformation and disinformation. It is also essential to comprehend that FN is the broader concept encompassing both realities that can be considered news that provides financial gain or discredit someone. Secondly, they may be referred to as news with a factual context but are presented distorted; and lastly, news that people do not like is classified as FN. These three dimensions are essential, valid, and acceptable definitions Huber et al. (2021).

Digital Risk and Fake News. Technology is undoubtedly a double-edged sword, both an enabler and a potential catalyst for digit al risks. In an age where information spreads unprecedentedly, the rampant propagation of fake news and disinformation has become a significant concern. This trend calls for a paradigm shift in how organisations and communities approach risk management and resilience.

As enterprises adapt their strategies to navigate the complexities of the digital landscape, they must recognise the intricate connection between technology and disinformation. Developing robust risk management practices and protocols is no longer sufficient in cybersecurity and data breaches. Instead, organisations must broaden their perspective and include combating the menace of FN as an integral part of their risk mitigation efforts Kaidalova et al. (2018). This strategy includes introduction of new technology to detect patterns, FN in its different shapes and forms disinformation Truică & Apostol (2023). It may be hard to regulate and control the spread of fake news due to the decentralised nature of the internet, were information crosses borders and spreads quickly. FN, misinformation, and disinformation, of digital disinformation has caused a new wave of concern across communities, having severe consequences that range from political dispute, generating discursive struggles, mostly from hyper partisan outlets Soares & Recuero (2021).

Organisations must proactively implement comprehensive strategies to fortify their defences against the pervasive threat of FN. The first crucial step is identifying the sources and channels through which FN spreads. Employing advanced algorithms and machine learning techniques can aid in tracking the origins of false information and its dissemination patterns, enabling organisations to respond swiftly and effectively with the removal of accounts that actively spread disinformation is a step forward towards a more resilient online environment. It is important to remember that due to the decentralised nature of the internet this might be a very challenging task Ali et al. (2022).

The fusion of technology and the associated disinformation caused by FN requires a paradigm shift in risk management. As organisations grapple with complex challenges posed by disinformation it becomes imperative to develop strategies for the swift detection of disinformation and structure an appropriate response for a constructive mitigation of risk despite the hurdles presented by the decentralised nature of the internet, thus paving the way for a more discerning and secure digital future.

Literature Review
This section intends to present the identified concepts and illustrate them, present its definition and consequent reference in the extracted literature (see Table 1).

Research Design
This section will first introduce Enterprise Architecture and ArchiMate modelling language. Secondly, it will demonstrate how the identified concepts of FN identified in a previously developed SLR are represented in ArchiMate, illustrating its layer and consequent ArchiMate Concept. Lastly, this section will introduce the proposed conceptual model of FN.

Enterprise Architecture. Known as a strategic discipline focusing on designing and managing an organisation's overall structure, processes, systems, and technology and making them align with a given organisation's business goals and objectives - Enterprise Architecture, henceforth EA, aims at providing a holistic view for an organisation. A structured view lets stakeholders understand how different components and resources interact and support the organisation mission Lankhorst & Lankhorst (2009).

EA encompasses different important domains, this includes the business, data, application, and technology architectures.

Table 1 SLR Identified Concepts.

SLR Concept	Definition	Reference
Fake News	False misleading information that is spread rapidly either intentionally or unintentionally that may have drastic consequences to the society, especially if widely believe it may have the potential to polarise the different political spectrums. The SLR identified different terms present in the literature that may refer to FN, these include false information, misinformation. disinformation untrustworthy, fabricated, misleading, partisan information, digital threat, inaccurate and viral information.	Alonso García et al. (2020); Aswad (2020); Chiang et al. (2022); De Magistris et al. (2022); Ferreira et al. (2020); Flostrand et al. (2020); Habgood-Coote (2019); Huber et al. (2021); Jain et al. (2022); Kousika et al. (2021); Lazar & Paun (2020); Mehta et al. (2021); Naeem et al. (2021); Paka et al. (2021); Petratos (2021); Pv & Bhanu (2020); Roozenbeek & Van Der Linden (2019); Scardigno & Mininni (2020); Van Bavel et al. (2022); Yerlikaya & Aslan (2020); Zhang et al. (2019)
Misinformation	A type of FN.It refers to false or inaccurate information spread unwittingly and unintentionally through various means, such as social media, news outlets, or word of mouth.	Bastick (2021); Islam et al. (2020); Mehta et al. (2021); Naeem et al. (2021); Paka et al. (2021); Schroeder et al. (2019); Van Bavel et al. (2022)
Disinformation	A type of FN. Information that is intentionally spread to deceive or manipulate people. It may be a form of propaganda designed to influence public opinion, sow confusion, or undermine trust in institutions, individuals, or ideas.	Bastick (2021); Espaliú-Berdud (2022); Ferreira et al. (2020); Huber et al. (2021); Van Bavel et al. (2022); Yang & Tian (2021)
Impact	These are the effects or consequences of false or mis- leading information on individuals or society. The impact of FN can vary depending on the nature of the content and the audience it reaches. The impact of FN can be significant and far-reaching, and it is vital to critically evaluate the information presented to prevent the spread of misinformation and its harmful effects.	Bastick (2021); Benoliel & Becher (2022); Berthon et al. (2018); Caramancion (2021); De Regt et al. (2020); Espaliú-Berdud (2022); Ferreira et al. (2020); Flostrand et al. (2020); Habgood-Coote (2019); Huber et al. (2021); Kousika et al. (2021); Mehta et al. (2021); Petratos (2021); Scardigno & Mininni (2020)
Context	Identifies the circumstances, events, or background information surrounding a particular story, report, and News. Understanding the context of a news item is important because it can help the reader or viewer to assess its credibility, reliability, and accuracy. Iden- tifying the context of a particular FND makes it possible to understand its significance and overall implications for the community.	Baccarella et al. (2018); Cifuentes-Faura (2020); Habgood-Coote (2019); Huber et al. (2021); Lawson & Kakkar (2022); Marres (2018); Mehta et al. (2021); Naeem et al. (2021); Rooke (2021); Scardigno & Mininni (2020); Yerlikaya & Aslan (2020)
Agent	It refers to the actor, individual, and organisations that deliberately create or spread FN to further their interests or agendas. These agents may use techniques to make their FN seem more credible, such as using misleading headlines or images, selectively present- ing information, or fabricating sources. Furthermore, the agent is responsible for initiating the propagation of fake news stories and is usually the main character behind the source. E.g., celebrities, trolls (individuals who intentionally post inflammatory or offensive con- tent), Propagandists, Clickbaiters, Foreign Actors, and Scammers.i	Aswad (2020); Bastick (2021); Boyd (2022); Ferreira et al. (2020); Huber et al. (2021); Islam et al. (2020); Lazar & Paun (2020); Marres (2018); Petratos (2021); Yerlikaya & Aslan (2020)
Verifiability	The ability to check or confirm the accuracy and reliability of a piece of information. Verifiability is an essential criterion for evaluating News because it helps to determine whether the information presented is accurate, false, or misleading.	Bastick (2021); Boyd (2022); Islam et al. (2020); Koohikamali & Sidorova (2017); Kousika et al. (2021); Mehta et al. (2021); Roozenbeek & Van Der Linden (2019); Schroeder et al. (2019); Vasconcellos-Silva & Castiel (2020); Viviani & Pasi (2017); Yang & Tian (2021)
Medium	It refers to the platform, channel, or outlet that regularly produces or disseminates false or mislead- ing information under the guise of legitimate news reporting. E.g.-Social Media Platforms, Websites, Blogs, Email Newsletter Tabloids and similar print- ing material, Television and News Programs, Radio Programs and Podcasts.	Bastick (2021); Flostrand et al. (2020); Huber et al. (2021); Koohikamali & Sidorova (2017); Mehta et al. (2021); Van Bavel et al. (2022); Yerlikaya & Aslan (2020)
Event	The type of occurrence of incident related to FND, which can be of different types, often manipulated and misrepresented of the reality, thus creating false or misleading stories–E.g., misinformation, disinfor- mation, clickbait, spam, untrustworthy propaganda and so forth.	Huber et al. (2021); Islam et al. (2020); Petratos (2021); Van Bavel et al. (2022); Zhang et al. (2019)
Source	The source of FND refers to the origin of the News. They originate from various sources, including individuals, organisations, and foreign governments. Some sources intentionally spread false information to mislead the public or further their agendas. Other sources may inadvertently share false information without realising its inaccuracies.	Caramancion (2021); Huber et al. (2021); Lazar & Paun (2020); Mehta et al. (2021); Viviani & Pasi (2017)
Content	Identifies the circumstances, events, or background information surrounding a particular story, report, and News. Understanding the context of a news item is important because it can help the reader or viewer to assess its credibility, reliability, and accuracy. Iden- tifying the context of a particular FND makes it possible to understand its significance and overall implications for the community.	Huber et al. (2021); Macagno (2022); Rooke (2021); Yerlikaya & Aslan (2020)
Intention	It refers to the purpose or motive behind creating and disseminating false or misleading information. The intent of fake news creators can vary and may include financial gain, political propaganda, ideological or religious beliefs, and social or personal gain.	Habgood-Coote (2019); Huber et al. (2021); Macagno (2022); Yerlikaya & Aslan (2020)

Furthermore, it also ensures that these domains are coherently integrated in a way that leads to organisational improvement, with special emphasis in the efficiency, agility, and decision-making process es within an organisation. A common adopted framework is TOGAF (The Open Group Architecture Frame-work) that provides a structured approach to develop and maintain and architecture Lankhorst & Lankhorst (2009).

Many organisations behave as enterprises, as enterprises can be considered a type of organisation Bogea Gomes et al. (2023). FN poses a significant threat to enterprises, undermining their reputation and credibility in the eyes of consumers. Businesses must navigate this landscape carefully, implementing robust fact-checking measures and transparent communication strategies to mitigate potential damage to their brand Petratos (2021).

ArchiMate. ArchiMate is a widely used EA modelling language and notation standard developed by The Open Group, currently in its 3.0 specification. It is a systematic and consistent way to describe, analyse and visualise the different aspects of an enterprise Org (2019).
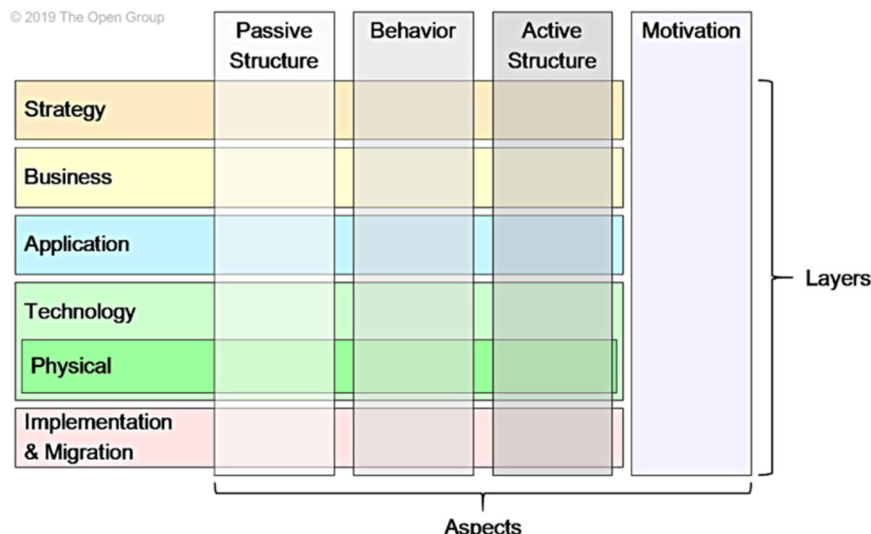
Fig. 1 The ArchiMate Full Framework used to develop the proposed conceptual model. Source: Org (2019).

To fully recognise ArchiMate central value to enterprise modelling it is necessary to acknowledge its Full Framework, which includes the identification of different layers and aspects presented in the Fig. 1 below. It is important to refer that out of the layers that are illustrated below, only the motivational, the strategy and business layers were used to develop the proposed conceptual model.

The common identified strength of ArchiMate modelling language, lies on the ability to represent complex relationships between various architectural elements, e.g., business processes, applications, data, and technological infrastructure Org (2019).

Mapping Fake News Concepts onto ArchiMate. The following section depicts a table with the concepts identified in the literature, the same concept representation in ArchiMate here with some being decomposed for the illustration of different perspectives surrounding the same concept. The last column of Table 2 presents a definition of each ArchiMate Concept in accordance with the Open Group Standard specification 3.0 Org, O(2019). Also, Table 3, presented below, illustrates the different ArchiMate relationships used in the conceptual model, which uses the same specification.

The ArchiMate modelling language was used to create the model, depicting the mitigation of the impact of FN in a community. The conceptual model aimed to model a community as an organisation, and thus, using ArchiMate was deemed appropriate to represent the concepts derived from the literature, their relationships, and notations. The colour scheme was used to differentiate between the ArchiMate language layers. In the text below, **bold** terms represent concepts and their relationships. *Italicised* terms represent ArchiMate elements.

Fake News, mapped here in the strategy layer as a *Course of Action*, represents the inner purpose of a malicious actor to spread disinformation, thus having a clear goal or plan for damaging the reputation of a third party, organisation or individual. A strategic plan is taken into action, prevailing a scenario of misinformation, where the main goal is to disseminate fabricated and misleading information.

Note that for each instance of FN, an associated **Impact** is illustrated in the motivation layer. On the other hand, an impact leads to an *Outcome* or end-result. The impact affects the perception of the truth, distortion of reality through disinformation campaigns, erosion of public trust, social division, economic effects, health risks, political manipulation, crisis response, disruption, media credibility damage and other potential regulatory factors Petratos (2021).

Another critical aspect of paramount representation in the conceptual model is **Context**, which is also present in the motivation layer. For each instance of FN, there is one or more associated contexts, characterised in ArchiMate as *Meaning* - referring to the significance or purpose associated with different elements of FN. Moreover, behind a context of disinformation, it personifies an **Intention** (also in the motivation layer) that illustrates the motive of the perpetrator or actor, represented in the ArchiMate concept of *Driver* - a condition that motivates the agent of disinformation to spread false information Huber et al. (2021).

The **Agent** is a decomposed concept, a decision made by the researchers in order to provide a clear understanding of the two different meanings of the concept - **Fake News Agent** refers to an actor or organisation responsible for plotting and deploying a disinformation campaign and spreading FN - present in the Motivation layer as a *Stakeholder*; and the **Affected Agent** - illustrated in the business layer as a *Business Role* intent to epitomise the individual or organisation that is directly or indirectly affected by the impact of FN Huber et al. (2021); Yerlikaya & Aslan (2020).

The concept of **Source** is also present at the business layers as a *Business Role*, referring to the origin of FN. A decision was made to represent the source as a *Business Role*, rather than a *Business Actor*, as the source is a role that can be played by different individuals, not necessarily the same actor. Also related to the concept of **Source** is the **Content** originating from the different newscasts and outlets and social media present in the business layer as a *Business Service*, serving the **Source** with false information that feeds the spreading Lazar & Paun (2020); Yerlikaya & Aslan (2020).

A concept that stands out due to its importance is **Verifiability**, essentially referring to the investigation taken by Law Enforcement Agencies (LEA), fact-checkers, and journalists alike regarding the veracity of the news. This concept is represented in the business layer as a *Business Process*, as it is intended to represent a much-needed sequence of actions required to verify the information Huber et al. (2021).

Also, on the business layer is the concept of **Medium**, illustrating the means by which disinformation is spread, this could be done through many different forms (e.g., social media,

Table 2 ArchiMate and FN onto concepts mapping.

SLR Concept	SLR Concept in ArchiMate	ArchiMate Concept	ArchiMate Layer	ArchiMate Concept Definition
Impact	Impact	Outcome	Motivation	"An outcome represents an end result that has been achieved."
Context	Context	Meaning	Motivation	"Meaning represents the knowledge or expertise present in, or the interpretation given to, a core element in aparticular context."
Intention	Intention	Driver	Motivation	"A driver represents an external or internal condition that motivates an organisation to define its goals andimplement the changes necessary to achieve them."
Agent	Fake News Agent	Stakeholder	Motivation	"A stakeholder is the role of an individual, team, or organisation (or classes thereof) that represents their interests in the outcome of the architecture."
	Affected Agent	Business Role	Business	"A business role is the responsibility for performing specific behaviour, to which an actor can be assigned, or the part an actor plays in a particular action or event."
Source Intention	Source Intention	Driver	Motivation	"A driver represents an external or internal condition that motivates an organisation to define its goals and implement the changes necessary to achieve them."
Fake News	Fake News	Course Of Action	Strategy	"A course of action is an approach or plan for configuring some capabilities and resources of the enterprise, undertaken to achieve a goal."
Content	Content	Business Service	Business	"A business service represents an explicitly defined exposed business behaviour."
Verifiability	Verifiability	Business Process	Business	"A business process represents a sequence of business behaviours that achieves a specific outcome such as a defined set of products or business services."
Medium	Medium	Business Interface	Business	"A business interface is a point of access where a business service is made available to the environment."
Event	Type of Event	Business Function	Business	"A business function is a collection of business behaviour based on a chosen set of criteria (typically required business resources and/or competencies), closely aligned to an organisation, but not necessarily explicitly governed by the organisation."
	Fake News Event	Business Event		"A business event is a business behaviour element that denotes an organizational state change. It may originate from and be resolved inside or outside the organisation."

news outlets, television, etc.). This concept is represented as a *Business Interface*, as it is a point of confluence and access triggering the source, associated with FN event, and broadly introducing the content of disinformation to the public.

Lastly, we have another decomposed concept in the business layer - **Event**. The concept was decomposed into two concepts - **Fake News Event**, illustrating the instantiation of FN represented in ArchiMate as Business Event denoting a state of change and a behavioural aspect that characterises FN, meaning an event that has a beginning and an end; and **Type of Event** referring to the category of FN represented as a Business Function an activity with a sole function of categorising FN.

Fake News Conceptual Model. Figure 2 below illustrates the proposed conceptual model, for details regarding its ArchiMate notation, definitions, and modelling justification decision please refer to the previous subsections.

Demonstration
This section presents a demonstration of the proposed model into a real instantiation of FN. Furthermore, it also presents the mapping instantiated concepts, and an instantiated conceptual model in ArchiMate.

Fake News Through and Instantiation. In order to find a credible instance of FN, the authors resorted to the Central European Digital Media Observatory (CEDMO) archive. CEDMO is a European independent and non-partisan multi-disciplinary hub that identifies and researches FN activities across the continent. It works closely with fact-checkers from different member states having regional hubs in different regions that work closely to decrease the impact of disinformation, strengthen transparency, understand enhanced media, and rebuild trust in media Observatory (2023).

The chosen instance of FN is titled "BREAKING: COVID-19 Vaccine Can Cause Blindness". This was broadly propagated in social media with particular emphasis on spreading through X (formerly known as Twitter). The full post, dated the 5th of May 2023, suggested that scientific research demonstrated that COVID-19 vaccination was responsible for blindness. The post gain traction when an alternative health blogger Erin Elizabeth retweeted becoming one of the top spreaders of the anti-vaccine content online. The post was later considered by independent fact checkers as being of misleading nature as no evidence suggesting an association between the covid-19 vaccination blindness Goldhamer (2023).

Essentially, the post focused on the study findings to argue that vaccinations caused retinal vascular disease (RVO), thus demonstrating that vaccinated patients had significantly increased risk of RVO, nevertheless, and according to CEDMO consortium factcheckers, the post failed to mention there is not a strong correlation and clear link between vaccination and the referred eye problem. Thus, conclusions suggest that the evidence is not very strong, and moreover the RVO is also not a very common disease, making the post-affirmation unfunded and misleading Goldhamer (2023).

Table 3 ArchiMate Relationships used in the conceptual model (Source: Org (2019)).		
Relationship	**Description**	**Notation**
Association	"It models an unspecified relationship, or one that is not represented by another ArchiMate relationship."	
Assignment	"Expresses the allocation of responsibility, performance of behaviour, or execution."	
Flow	"Represents transfer from one element to another."	
Realisation	"Indicates that an entity plays a critical role in the creation, achievement, sustenance, or operation of a more abstract entity."	
Serving	"Models that an element provides its functionality to anotherelement."	
Specialisation	"Indicates that an element is a particular kind of another element."	

On making a swift reflection on the consequences and impact of this post, it is indeed possible to understand its significant effect on the online community. Like any other piece of misinformation, the problem is not solely on the actual post but on its societal consequences, and this is more true should we consider the high rate of sharing and retweeting contributing to an exacerbated effect of disinformation on a mass scale.

Mapping the Instantiation onto the SLR Concepts. Table 4 presented below serves as a visual representation of the relationships between the identified instantiated concepts of FN and the SLR Concepts in ArchiMate.

Table 4 presents the instantiated concepts of FN derived from the chosen event of FN previously presented in the above subsection. A single event of FN produces several instances that are of possible consideration for our model. It is essential to understand that this work solely seeks to model one instance. When reading the entire article presented in the CEDMO fact-checking repository, we quickly realised that different instances are suitable for modelling. The provided content was initially spread through X, re-shared by other users in the same social network and reproduced in other social media such as Facebook and Instagram. Later, it was also reproduced in the blog of an alternative health blogger - Erin Elizabeth and others Goldhamer (2023).

A decision was made amongst the authors to solely demonstrate in the bellow instantiated conceptual model the first instance, meaning the moment that the disinformation was first shared by Mario Nawfal on the social network X. Having this into consideration, the above table derived the instantiated concepts of FN presented on the left column on Table 4. Please note that the instantiated concepts illustrated on the left column map with the concepts of the right column.

Instantiated Conceptual Model. This subsection explains the flow of disinformation. This characterisation is based on the intrinsic intention to fuel conspiracy theories Goldhamer (2023). The below paragraphs show the concepts in **bold** and the relationship between concepts are *italicised*. It also presents on Fig. 3 the instantiated conceptual model.

The first instance of the spreading of disinformation to the general public regarding Covid- 19 vaccination, and its possible connection with blindness occurs in X, having been triggered by an individual, thus represented in the model as **Individual: Source** it *Assigns* a stakeholder known as Mario Nawfal an entrepreneur and alternative health advocate represented as a stakeholder as he directly benefits from the impact of this instantiation in society. The concept is illustrated as **Mario Nawfal Alternative Health Advocate: Fake News Agent**. The **Impact**_Brings Risk_ to a community, illustrated as role **Community: Affected Agent** representing the different affected communities. The intention questions the judgments of the scientific community, introducing doubts regarding the safety of COVID-

19 vaccines and generating alarm. Cifuentes-Faura (2020); Vasconcellos-Silva & Castiel (2020).

A **Fake News** impact *Characterised* by its context, represented as **Covid-19: Context** and it is *Instantiated* by an event characterised and defined by the CEDMO and AFP factchecker as Covid-19 Vaccines Blindness: Fake News Event. The instantiation is then *Spread* through a the social network X a chosen **Medium** for propagation of FN, represented in the model by its instantiation **X:Medium**. The **Medium** is associated to a specific **Content** - Mario Nawfal Post, represented in the model as **Mario Nawfal Post: Content** that is then classified and defined as disinformation, illustrated as **Disinformation: Type Event**. Lastly, the source of FN *Is Linked* with the **Intention** to mislead the general public, represented as **Mislead General Public:Intention**.

Evaluation

This section elucidates the researchers' systematic approach to evaluating the conceptual and instantiation models introduced in the previous section. The study embraced the Bunge-Wand-Weber Model (BWW model) for evaluation–a comprehensive framework for appraising a First Normal Form (1NF) conceptual model and its instantiation within a database system - an ontological approach for evaluation proposed by Fettke & Loos (2003). This approach offers a structured and rigorous methodology for assessing the quality and efficacy of a database schema in faithfully representing real-world information, ensuring a methodical and well-rounded evaluation process. We aim to adapt this methodology, initially designed for database assessment, to evaluate our models, leveraging its proven effectiveness for our research purposes.

The first step towards the application of this framework was the delineation of the following research questions (RQ):

RQ1 - Is there any instantiated concept that is not mapped onto a SLR concept in ArchiMate?

RQ2 - Is there any instantiated concept maps more than one SLR concept in ArchiMate?

RQ3 - Does each SLR concept in ArchiMate map onto each instantiated concept?

RQ4 - Does each SLR concept in ArchiMate maps onto one or more than instantiated concept?

The below Fig. 4 illustrates the four ontology deficiencies identified by the suggest ontological approach Fettke & Loos (2003) the interpretating whether the instantiated concepts are mapped onto the constructed conceptual model.

The proposed RQs reflect and illustrate the ontological deficiencies identified by Fettke, P., Loos, P.(2023) Fettke & Loos (2003). To further assess and evaluate our model, the authors seek to answer the RQs by applying the BWW model framework designed to address three key aspects:

1. An intricate examination of the conceptual mapping found in Table 4 of this paper.
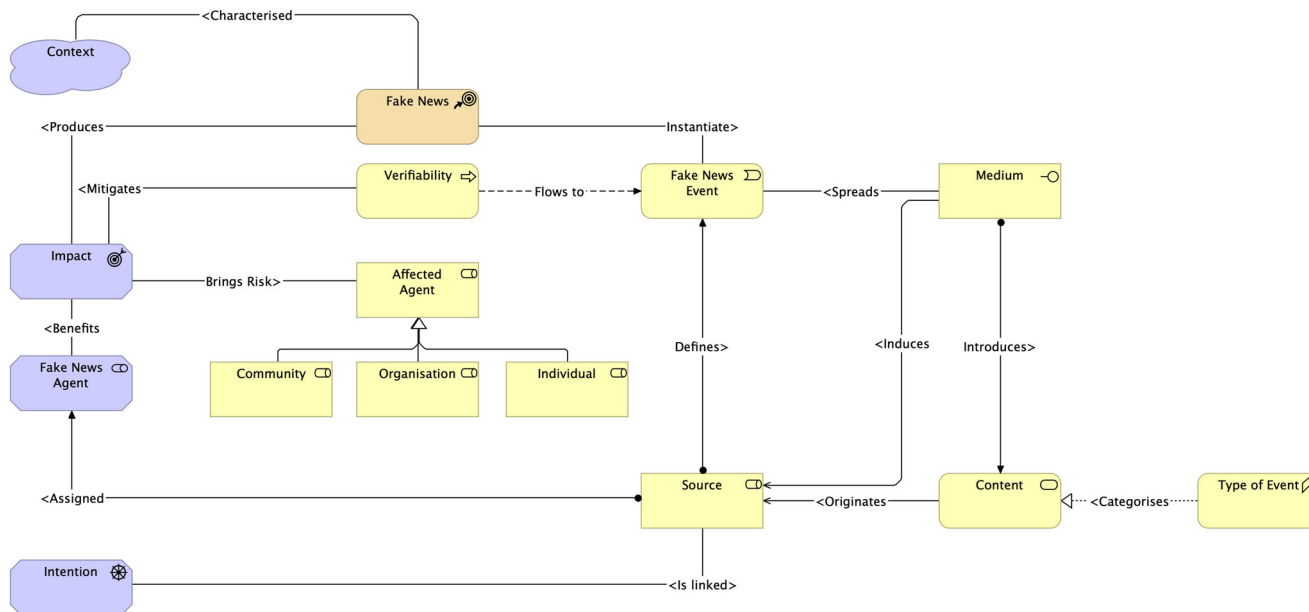
Fig. 2 Fake News conceptual model in ArchiMate. Fake News conceptual model following the ArchiMate specification notation as Org (2019).

Table 4 Map of the instance of FN onto SLR concepts in ArchiMate.	
Instantiated Concepts	**SLR Concept in ArchiMate**
Impact	Impact
Covid-19: Context	Context
Mislead General: Intention	Intention
Mario Nawfal Alternative Health Advocate: Fake News Agent	Fake News Agent
Community: Affected Agent	Affected Agent
Individual: Source	Source
Fake News	Fake News
Mario Nawfal Post: Content	Content
AFP:Verifiability	Verifiability
X:Medium	Medium
Disinformation: Type of Event	Type of Event
Covid-19 Vaccine Blindness: Fake News Event	Fake News Event

2. The identification and rectification of any constructive deficiencies in the proposed model.
3. The applications of the normalisation process onto the instantiated model.

RQ1 - Is there any instantiated concept that is not mapped onto a SLR concept in ArchiMate?

To answer this RQ we firstly looked at both models presented in the Figs. 2 and 3 to assess if each of the concepts of the instantiation mapped onto one and only one SLR concepts in ArchiMate. As we previously demonstrated in the Table 4, each of the instantiation concept maps onto one and only one SLR concept in ArchiMate.

We then decided to re-examine the FN instantiation description, focusing our analysis on CEDMO's fact-check repository Goldhamer (2023). In particular, we delve deeper into "Disinformation" as a Type of Event, engaging in a thorough discussion regarding the classification of this concept, ultimately arriving at a consensus that "disinformation" indeed serves as the appropriate classification for the type of event. Other possible classifications include misleading information, which according to the developed SLR can happen intentionally or unintentionally and can

occur in various forms, as information or communication presented leading people to form an incorrect understanding or conclusion.

The selective nature of the information presented by the fake news agent Mario Nawfal suggest the misusage of scientific information, with author taking advantage of information from a scientific paper to quote facts out of context and presenting it in a way that amplifies fear and uncertainty towards vaccines and general health care practices Goldhamer (2023). One can argue that the intention behind the spreading of fake news can differ from the one presented in the model (e.g., discredit of vaccination campaigns, reputational damage to the national health service, etc.), nevertheless the authors decided that the best way to represent a more generic intention and thus keep misleading the general public as the main intention behind the spreading of disinformation.

RQ2 - Is there any instantiated concept maps more than one SLR concept in ArchiMate?

The represented models do not show associations between one instantiated concept and two or more SLR concepts in ArchiMate. In other words, there is no redundancy of concepts represented in our model, as each concept has a clear definition and differs from other represented concepts. It is essential to differentiate decomposed concepts that only represent one SLR concept. There are undoubtedly two concepts that were decomposed: Agent and Event.

There is indeed a difference between decomposition and redundancy. A decomposition happens because a concept holds more than one meaning in the literature (e.g., the concept of the agent is divided between the affected agent and the agent that spreads FN), whereas redundancy happens when there is a concept that represents the exact meaning of another. Having observed this reality, the authors decided to interpret the definition provided by the SLR ? and decomposed the concept to avoid misrepresenting the different meanings of the different concepts in the literature.

RQ3 - Is there any SLR concept in ArchiMate that does not map onto any instantiated concept?

The suggested problem patent in RQ3 is a problem of excess conceptual representation illustrated in Fig. 4, where the instance would have less concepts than the ones patent in the conceptual
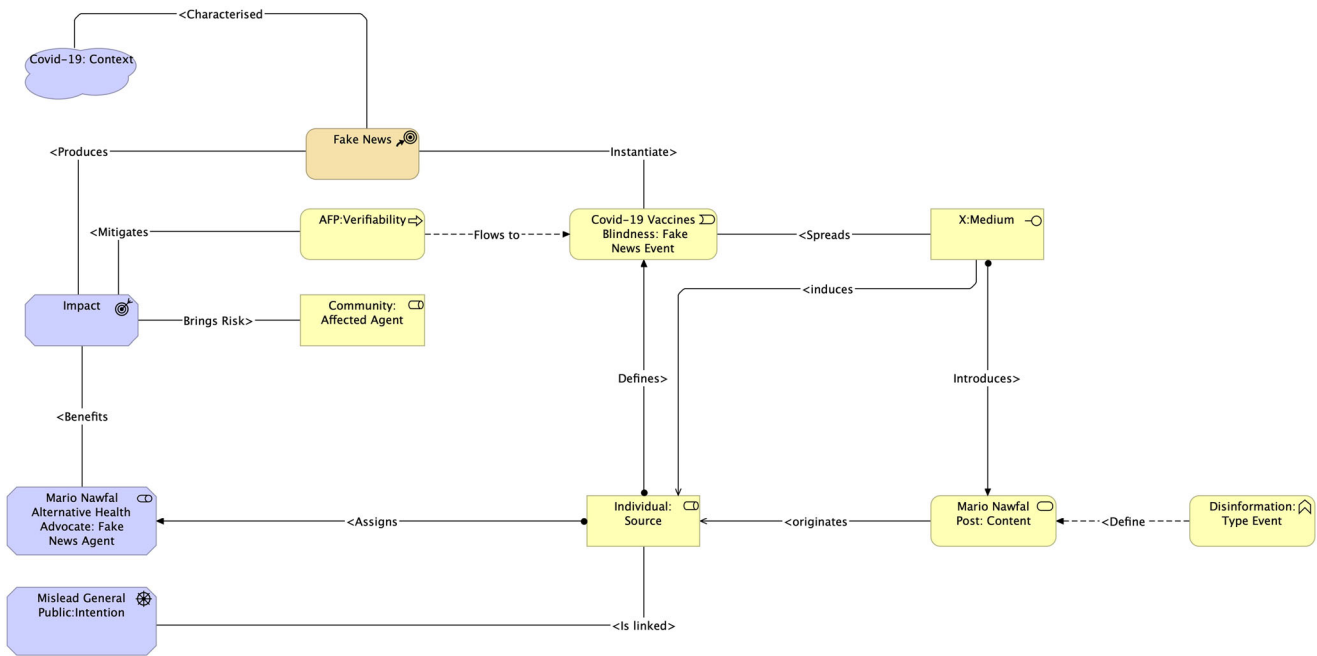
Fig. 3 Instantiated Conceptual Model in ArchiMate. Fake News Instantiated conceptual model following the ArchiMate specification notation as Org (2019).

Fig. 4 Ontological Deficiencies Grammar. Source: Fettke and Loos (2003).

model. To avoid this problem the authors supported their conceptual representation into a previously developed SLR. The idea was to have a solid definition of the concepts before defining the conceptual model, thus ensuring that for each concept correspond one instantiated concept.

Furthermore, it is important to understand that the identification of the instantiated concepts derived from pure interpretation of the description of the instantiation in its source patent CEDMO Repository Observatory (2023) and briefly summarise in the demonstration (section 5) of this paper.

In conclusion for each instantiation there is a SLR Concept that corresponds and therefore there is no isolated SLR concept in ArchiMate present in our model.

RQ4 - Is there any SLR concept in ArchiMate that maps onto more than one instantiated concept?

Each instantiated concept maps into only one SLR concept in ArchiMate in a one-to-one relationship. In practice, if we want to reduce redundancy and apply the BWW model according to Fettke & Loos (2003), we will first have to determine which instantiated concepts would require normalisation by creating an interdependent relationship between an instantiated concept and a derived one. In other words, we would have to look at the present model in Fig. 3 and first decide which instantiated concept we would like to normalise. Should we, for example, decide upon the x: medium instantiated concept, we would have to create another Business Interface and provide a composed relationship between concepts.

The suggested alteration would mean that we would have to add a composed relationship to the X: medium instantiated concept with, for example, X Post: medium. Note that the composition relationship would indicate that the post only exists if the X: medium concept exists, or in other words should X: medium cease to exist the X post: medium would also cease to exist.

Should we decide upon this normalisation, this relationship would only be a complement to the original model and would not necessarily add any extra value to the instantiated conceptual model; therefore, in order to ensure robustness, a decision was made to keep the model more straightforward and only represent the X: medium instantiated concept. In conclusion there was the possibility that two instantiated concepts would be associated with one SLR concept in ArchiMate, though to ensure having simpler model and a robust one a decision was made not to make alterations to the model.

Conclusion

This paper proposed a conceptual model to identify and analyse the risk associated with the impact of Fake News and Disinformation, which can cause reputational damage to individuals, organisations, and brands in the community Flostrand et al. (2020). It is, therefore, important to take steps to study the

phenomenon of Fake News and invest in policies, techniques and frameworks that aid in mitigating the associated risk.

The risk of FN is also strongly related to the digital environment of a given community. The conceptual module here presented aims at aiding policymakers, legal enforcement agencies, and business organisations in providing a comprehensive framework that firstly contributes to the verification of the veracity of the information, provides a means to identify the agent (s) of disinformation and relates the context with the different mediums of propagation and spreading of the news.

The work presented here opted to use Design Science Research as a prime method to design a conceptual model, demonstrate through a credible instantiation and evaluate the proposed model using a credible framework. It is important to understand that this research work would only be possible due to the strong foundation of a developed systematic literature review that aimed at defining the terminology between the cross of - Fake News and Risk terminology.

Furthermore, this work demonstrates the conceptual model in ArchiMate utilising the case of "BREAKING: COVID-19 Vaccine Can Cause Blindness." Future work involves refining this conceptual model by employing other case studies to ensure a comprehensive perspective on FN risk management.

The results of this study are a practical conceptual model and a systematic mapping of the concepts of FN and the proposed instantiation. Moreover, the evaluation that followed the proposal indicated a solid and robust model, with the evaluation suggesting that common mistakes such as mapping incompleteness, redundancy, excess and overload are not present in the model. It is vital to notice the relevance of the design decisions contributing to this result.

An evident limitation of this research work is its reliability to the adopted SLR view and strategy and subsequent interpretation, so our results also depend on its accuracy. It would strongly benefit our research if we could have a Multivocal Literature Review that considers the academic literature and the grey literature present in online libraries.

Data availability
All data concerning the Systematic Literature Review may be provided by the authors upon request. The conceptual model was modelled in Archi Software Tool, all files can be made available upon request.

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Author contributions

JVC conducted the research, conceived the ArchiMate model, conducted the demonstration and evaluation, and wrote the draft of the manuscript. SBG validated the ArchiMate Model and its instantiation.MMS coordinated the study, participated in the design of the research protocol, and oriented the evaluation process. All authors read and approved the final manuscript.

Competing interests

The authors report declare no competing interests.

Ethical approval

This article does not contain any studies involving human participants performed by any of the authors.

Informed consent

This article does not contain any studies with human participants performed by any of the authors.

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