Architectures of Contemporary Information Systems and Legal/Regulatory Environment

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Abstract: The information interchange, between humans and computers, and the data processing in the context of Information Systems and Enterprises became a complex structure with a rapidly developing technology stack. This paper proposes an integrated approach that combines recent technological approaches in architecture for Information Systems and Enterprises concerning the recent development of the technology landscape. There are established scientific and research disciplines in domains such as Enterprise Architecture, Analysis, and Design of Information Systems, Business Process Management and Modeling, Data Management and Administration, and Human-Computer Interaction. The rapid development of Artificial Intelligence (Machine Learning, Data Science) and its applications in enterprise environments necessitates defining a research framework that can support the alignment of these components for research and practical applications. Since Information Systems are of socio-technological phenomenon, and quick development of technologies meddles with the privacy, and personal data of individuals. This fact implies that the legal, regulatory, and ethical set of rules should be considered and built-in through architectural building blocks into Enterprise Architecture. Therefore, the existing and emerging regulatory frameworks are considered to make it possible and realize compliance through artifacts that care about conformance to rules. The legal environment and the ethics that are deduced from the legal rules touch the local and public administrations that operate the cities through advanced IT systems.

1 INTRODUCTION

We are in a rapidly changing IT (Information Technology), Business, Legal, and Financial technologies environment where new approaches emerge and will be incorporated into enterprises. Public administration is not except since IT technology penetrates the public through mass media. The administrative processes should embed the recent technologies that are connected to information management, and document handling, moreover, the governments should take into account the international and national legal rules, e.g., GDPR and AI Act in the European Union (Sovrano et al., 2022; Voigt and von dem Bussche, 2017; Nikolinakos, 2023; Neuwirth, 2022). In change management, we deal with the changes in the company's environment, in the ecosystem, within the company (Business Processes, Workflow, and data collections), and the technologies. Nowadays, there is a lot of turbulence in all aspects of a company's business and IT life. There are sets of disruptive technologies that come into play that influence the Enterprise Architecture (EA): (a) generative Artificial Intelligence (AI), (b) LLM (Large Language Models), (c) generally, AI, Machine, Learning (ML), Data Science (DS), (d) blockchain and General Ledger, (e) IoT (Internet of Things) with low-power radio frequency communication (RF), (f) Cloud computing in tandem with broadband communication, (g) ubiquitous computing, (h) Decentralized Finance, (i) Quantum Computing, and (j) Digital Twins (Expert, 2024; Gartner, 2024). The concept of EA is important for companies to wrestle with the recent technology stacks. The question is how the EA can help companies, especially the resource-scarred MSMEs (Micro, Small, and Medium Sized companies). Some cir-

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cles of scholars, researchers, and professionals started considering EA as an obsolete approach to solving problems of companies in the light of current, fashionable tendencies such as e.g. DevOps (development and operations), CD/CI (Continues Development/Continuous Integration) and Agile Development (Murat Erder, 2021; Chintale, 2023; Hering, 2018; Brandon Atkinson, 2018). Nonetheless, the EA as an approach to provide an overarching company perspective seems to be a necessary tool to tackle the recent turbulent and dynamic IT and business environment when new technologies are developed. In light of the rapid pace at which new technologies and their potential applications are emerging, it can be quite challenging to accurately predict the grand challenges that may arise in the future. The professionals and researchers in EA should remain up-to-date with the latest advancements in IT, Data Science, Machine Learning, and generally AI (Artificial Intelligence) so that we can be better equipped to address any challenges that may come our way. There is a symbiotic relationship between Enterprise Information Systems and Enterprise Architecture. Enterprise information systems are important architecture building blocks of an enterprise's architecture. Implementing or modifying such a system involves changes to its architecture. Similarly, any alteration to an enterprise's architecture will impact its information systems. Next-generation enterprise information systems should be viewed in the context of these new realities to avoid any negative impact on their information systems. Some frameworks make it possible to analyze the specific company and its EA, namely the Zachman *ontology*. The business and system engineering approach supports disciplined planning and design that are apt to practical applications, namely TOGAF and ArchiMate (Zachman, 1987; Josey, 2016; Josey, 2017; Meertens et al., 2012). We apply the Zachman ontology to provide a theoretical tool to organize the issues that emerge as the consequence of the rapid technology development the provide a possible mapping to maintain the challenges of both technology and business development. The TOGAF and ArchiMate give a toolset to perform a planning and design exercise by tracking the templates of architectural solutions in the architecture continuum. The TOGAF supports filling in the company-specific template of architecture building blocks with the most recent solutions and options with the integration. We adhere to the neutral terminology of the international standard ISO/IEC/IEEE 42010 against other open or proprietary approaches to EA.(ISO, 2011). Some publications combined the formal, mathematics-based approach and architectures to grasp the significant properties of EISs (Enterprise Information Systems) considering the theoretical foundations of EA (Molnár and Benczúr, 2022; Molnár and Őri, 2018; Őri and Molnár, 2018) There was an investigation of a specific field of Cognitive Information Systems that uses several domains of Artificial Intelligence to approximate the cognitive capabilities of human actors regarding EA (Mattyasovszky-Philipp and Molnár, 2023). The goal is to cope with the emerging phenomena through EA approaches to create a blueprint for enterprises to handle the challenges and incorporate innovation into the business model. We also discuss models and theories that we believe could be useful in addressing the identified challenges of applying technology for innovation. Innovation is a hot topic either from a scientific or professional viewpoint in connection to Information Systems in companies. The issue for the firms is how to yield new services through exploiting IT/IS services (Maglio et al., 2019). To illustrate the value of these models and theories, we discuss recent advances in the field of Enterprise Information Systems (EIS) and EA, which guide to help companies address the emerging issues of responding to rivalry, competition, innovation, and advances in technology. We give an outlook on the related regulations and legal environments that raise the issues of compliance and conformance, and the application of a branch of the related technologies called RegTech.

2 ENTERPRISE INFORMATION SYSTEMS

Enterprise Information Systems (EIS) refers to all the systems, including people, technology, and data, that are used to support the integrated functions of an enterprise. For this reason, EIS is a high-complexity system whose core properties can be grasped in the notion of a socio-technological system. The field of EIS now covers different aspects, such as design, implementation, deployment, rollover, maintenance, and adaptation. Enterprise Architecture is often used to provide a context for enterprise information systems. From this perspective, EA can influence and prescribe the stages of the requirements analysis, requirement specification, design, and implementation of an enterprise EIS (Ashworth, 1988). EIS and EA are closely intertwined, and emerging technologies require that integration issues with established solutions and new technologies be kept under control. The proposed EA solutions can provide a blueprint for the ongoing maintenance and evolution of EIS to adapt to the changing business and technology landscape and adopt new approaches. The

Zachman framework is one of the approaches used in enterprise architecture that provides a comprehensive overview of information systems. Unlike TOGAF and Archimate, which use an engineering approach, the Zachman framework takes a theoretical foundation(ZachmanInternational, 2024). It can be considered as a meta-schema or ontology of the collections of ISs in an enterprise. This theoretical approach can describe a compound structure and can be used for semantic mapping and matching during integration exercises(Ma et al., 2022). According to Lapalme (Lapalme, 2012), the Zachman framework can be regarded as a theory that provides a comprehensive overview of information systems.

2.1 Issues of Enterprise Information Systems and Architecture

The Zachman ontology is a useful tool for understanding the intricate structure of a set of information systems, as well as the associated business processes and workflows. The Zachman Enterprise Architecture provides a toolkit that can be utilized to identify a suitable location for new technology building blocks and to integrate or extend these new components with the existing IT/IS services. As previously mentioned, the main objective of the Zachman Enterprise Architecture (EA) is to provide a comprehensive understanding of an enterprise. This makes the Zachman EA an explanatory theory for Information Systems (IS). By presenting a new perspective on how EA can be perceived, the Zachman EA goes beyond being just a methodology. Rather, it serves as a theory that provides a comprehensive oversight to depict an enterprise. Zachman's Enterprise Architecture (EA) can be perceived as a theory of Information Systems (IS) that helps researchers and practitioners understand the role and objectives of EA. This comprehension is crucial for adapting EA to new business and information technologies, which can help overcome challenges. Developing and maintaining EA and ISs can trigger strategic and tactical planning of EA renewal, followed by the design and implementation of ISs that are touched. Zachman EA can be viewed as a meta-ontology for business and a meta-schema for IS, which can serve as a research methodology and metatheory for IS research. In summary, Enterprise Architecture (EA) is a powerful approach for developing, maintaining, and documenting information systems. It offers a variety of tools and models and has proven effective in many projects. Despite the hype around digital transformation and the many technologies that it encompasses, we believe that EA will remain relevant in aligning, adapting, and extending the business services supported by information systems. While the application of EA can be complex and intertwined with IT, it is essential for enterprise change management and providing a clear picture for stakeholders. The need for change is driven by competition, rivalry, and technological development. Disciplined and agile methods in business and IT projects have changed the way organizational changes, systems, and software are planned and developed. Digital transformation introduces new issues, such as the need for improved customer relationship management and strengthening the network in ecosystems. Organizations require a theoretical approach, such as an ontology or meta-schema, and a lightweight, customized method that is aligned with customer needs and iterative, allowing for continuous improvement. Therefore, an EA methodology based on the Zachman ontology that focuses on business services and can be easily understood by each stakeholder is necessary. We summarize the major properties of Zachman ontologies to make our application understandable Table 1.

The basic idea is to use the English interrogatives to explore the "world" thereby the obtained answers make it possible for a system analyst or architect to depict the various facets of "entities in the enterprise" either tangible or intangible (Gewertz, 2016). Kipling's classical poem gives a clue to the application, then the Zachman ontology yields a guidance.(Kipling, 1998). The *what* embraces the data entities and all possible storage formats, database management systems, data warehouses, data lakes, and the data that are stored in them. The *how* incorporates the intangible business processes and workflows the *where* can be interpreted as the distribution of the communication network, and computing service centers in geography and cyberspace. The *who* can be translated into responsibilities with a strong connection with security, data protection, and access rights. The *when* can be perceived as timing and scheduling, the *why* the mission of the company mapped onto objectives and then regulation, and internal standards. The rows in the table (see Table 1) describe the various views of the enterprise from the different viewpoints of interested parties. The row of the *executive* perspectives is about the strategy, mission, and high-level business concepts and processes. The viewpoint of the *business manager* embodies the business model that can be described as pieces of models that are produced by business analysts. The *business architecture* row represents the models that use the language of IT with a strong business focus to be understandable to the users and stakeholders within the company. Either the system analyst or recently, the business architect who maps and refines the business level model

Table 1: A mapping semantically between Zachman architecture and the recent technology components. (ZachmanInternational, 2024).

Aspects / Perspectives	what	how	where	who	when	why	model view
Executive	Fact, business data / for usage by recent AI/ML/D.Sc.	Business Service utilizing AI/ML/D.Sc	Chain of Business Processes utilizing AI/ML/D.Sc	Business function	Chain of Business Process utilizing AI/ML/D.Sc	Business goal	Scope, Context
Business Manager/ Business Analyst	Underlying Conceptual data model / Data Lake structured and unstructured data	Service with added value originated by the cognitive resonance	Service composition with business analytics	Actor, Role	Business Process Model	Business Objective	Business Notions
Business Architect/ System Analyst	Class hierarchy, Logical Data Model structured, semi-structured, and unstructured data	Service Component utilizing AI/ML/D.Sc	Hierarchy of Service Component utilizing AI/ML/D.Sc	User role, service component	BPEL, BPMN, Orchestration	Business Rule	Descriptive Models of the System
System & Software Engineer	Object hierarchy, Data model	Service Component utilizing AI/ML/D.Sc at program code level	Hierarchy of Service Component utilizing AI/ML/D.Sc at program code level	Component, Object for observation of security	Choreography	Rule Design	Specification of Models in the relevant technologies.
Implementor/realization of Business Objects	Data in DBMS	Service Components	Hierarchy of Service Components	Component, Object for observation of security	Choreography, Security architecture	Rule specification	Configuration model of the applied toolset
The Enterprise	Data	Function	Network	Organization	Schedule	Operationalized rules	Components of Operation (Realization)

Artificial Intelligence (AI), Machine Learning (ML), Data Science (D.Sc.)

into models according to the relevant IT descriptive methodologies. The typical examples are models of business processes, workflows, and databases in heterogeneous technical approaches that make it possible to investigate the opportunities for digital transformation. The *system engineering* row deals with "physical" design, the transformation of the logical design into architectural building blocks that are technology-dependent. For instance, the logical data model has been translated into database management-specific languages, e.g. SQL schemas, the process models into program codes, the communication network model into equipment specifications and components of a software-defined network, etc. The *implementor* row treats with the mapping of the physical design onto the components, and tools of the available technology, e.g., building up the database by running the SQL statement specifying the data schema, or compiling the program code into executable code, then test them and adjust them to the specific technology. The *enterprise* row incorporates the operation of the company in a tangible, physical format, the intangible bit streams are in the physical equipment or virtual systems in cloud computing.

3 DIGITAL TRANSFORMATION AND MSMEs

Consumers demand personalized services and products according to the concept of hyper-personalization that appeared in electronic services (Jain et al., 2021). Companies can satisfy this requirement through digitalized services and digital products exploiting IT. There is enforcement to create innovative solutions, and value propositions according to actual business models (Maglio et al., 2019; Osterwalder and Pigneur, 2010). Improvements in IT and communication technologies are making information available throughout the life cycle of products, services, and business processes. Manufacturing systems, service provision, and people are closely interconnected. In addition, the resulting large amounts of data can be used in recent IT, namely Data Science, Machine Learning, and comprehensive Artificial Intelligence (AI) for optimization of the tasks within workflows, moreover forecasting the demands for resources, services, and products. EA has a great opportunity to effectively adopt and integrate digital transformation through a disciplined approach of Zachman ontology and then the TOGAF can be used for the realization of the architecture and augmenting the business services along with the supporting services of ISs. The first two rows of Zachman EA are strongly business-oriented and contain a more formalized mapping of the business

strategy, the alignment of the business with the recent technologies, and innovation perspectives to be implemented through digital transformation. Moreover, the ecosystems, digital products, and electronic services become part of the architecture. We outline an EA approach for supporting digital transformation in MSMEs concerning the recent IT solutions. From a bird-view perspective, we separate two major threads that we can conceptualize as a higher level and a detail level approach. The higher level defines the architecture of the whole MSME. At the detailed level, single functions in ISs are realized, built, and rolled over. Besides the two overarching iterative cycles (see TOGAF and Archimate (Josey, 2016; Josey, 2017)) two pillars help to advance the digital strategy of an enterprise. The business strategy should be formulated as a digital business strategy or should be included explicitly. The digital business strategy embraces the velocity, scale, and scope of the use of recent IT in the companies. The business model contains information like value proposition containing value curves, customer systems, and revenue structure (Cardoso et al., 2015). The next step is to work out a company-specific architecture that considers the general and sector-specific solutions. The goal of this stage is to refine the business model according to the first two rows of the Zachman EA. The proposed architecture contains models of business services in the form of business processes, data collections, the distribution of human and computer nodes, etc. The third row in the Zachman EA incorporates the major IT/S services and data collection that are required for implementation. Thus, the architecture to be implementable can be concluded from the proposed architecture. This phase considers the digital transformation strategy and takes into account the existing architecture.

3.1 Enterprise Architecture Support for Digital Transformation

As we stated previously, the recent architecture approaches should take into account the ecosystem. The Zachman as a theory and TOGAF as practical design theory and project guidance can be used in tandem. (Bondar et al., 2017). The company and its surrounding ecosystem can be seen as a co-evolving environment: the company and its network of connections with other stakeholders should be systemically designed to enable digital transformation and sustainability trends. EA provides meaning to and supports the transformation of the business. (Bakarich et al., 2020). The senior management should deal with the first row of the Zachman EA with innovation, digital transformation, and sustainability. The Business Architecture in TOGAF handles the business analysis models and the related artifacts focused on the non-technology aspects, e.g. Business Process description in BPMN (White and Miers, 2008). The second and third rows treat the socio-technological facets of various ISs. The artifacts, incorporating the models in these rows, are IT/IS artifacts, e.g. the description of facts and documents in models of the domain, and the IT and business events are represented in the form of behavior models of IS that is touched, and the behavior model depicts the dynamic side of the system. The third row contains design models, e.g. logical data model, in the form of entity-relationship, or UML class model. The fourth row contains the artifacts of models that can be considered scientific models, models according to Computer Science and IT. For instance, Petri Nets for Business Processes, Finite State Machines for state transitions, or rigorous relation database models according to Codd's relation database theory that is founded in the theory of relations, algorithms, and sets. The disciplined approach of EA can make it possible for the enterprise to be adaptive and to get the silos fallen to achieve business modularity. The technical architecture gives a synergistic set of data collections and processes devoted to information handling to buttress the digital transformation. The enterprise should consider the automation and data science technologies during an EA exercise, automation technologies: (1) Cloud computing, (2) IoT (Internet of Things), (3) Blockchain, and (4) Robotic Process Automation (RPA). The processes contained in the "how" column will be extended by Data Science Technologies to achieve efficiency and effectiveness (Pisoni et al., 2021). However, Data Science Technologies demand data from several sources. A Data lake as a data architecture is an apt solution that can collect the data from various resources and can be made available for the various AI/ML algorithms for further processing(Molnár et al., 2020). The use of data raises several issues, primarily the legal and ethical use of data in the algorithms. (I) data of consumers, (II) data of operations from Customer Relationship Management System and IoT devices, telemetry systems., (III) data from social networks, (IV) data from the Public Administration, and (V) data from the partners in the ecosystems who either cooperate or compete with the enterprise. The paper of Molnar and Pisoni (Pisoni et al., 2021) contains a comprehensive set of optional domains of data analytics in companies and a set of algorithms in Data Science and Machine Learning that can be applied for analysis. The data analytics tasks are strongly coupled to business processes and activ-

ities in workflows. The outlined EA based approach can assist MSMEs in the digital transformation since this EA supports the data preparation, model definition, variable selections and then training and tuning the model. We will discuss in the next section the issues related to Data Architecture that will become manifest through the data processing activities of IS architecture.

4 THE FACETS OF RULES OF LAWS AND REGULATIONS

Having described above some aspects of Enterprise Information Systems and Architecture, we have to stop and have a look at the aspect, that usually comes as a whip-crack at the finish of the development: legal compliance. We like it or not, IT developments, especially those of disruptive technologies and their followers, face a heavily fragmented regulatory environment. Legal specialists (in the field of personal data, AI, data management, etc.) are expensive but still essential for evading fines and other business killer legal procedures.

4.1 The Legislative Landscape

After five years of cohabitation with the **GDPR** (European-Parliament "and" of the Council, 2016) it is useless to explain its goals but the other fruits of the European legislation are worth stopping. First of all the proposal on the regulation of Privacy and Electronic Communications (**ePrivacy Regulation**(European-Parliament "and" of the Council, 2017)) repealing the 20-year-old ePrivacy Directive will complete and clarify the provisions of the GDPR concerning electronic communication by regulating among other things confidentiality, storage, and erasure of electronic communication data or defining the permitted processing of electronic communications data.

The regulation on the **free flow of non-personal data** aims to ensure the free flow of data other than personal data within the Union by laying down rules relating to data localization requirements, the availability of data to competent authorities, and the porting of data for professional users. By this legislative tool, the goal is to deepen the difference between the practice, and usage of personal and non-personal data while trying to facilitate the free movement of the latter. The **Open Data** (European-Parliament "and" of the Council, 2019) directive is replacing the PSI directive and aims to exploit the potential of public sector information by providing real-time access to dynamic data via adequate technical means and increasing the supply of valuable public data for re-use.

The **Data Governance Act**(European-Parliament "and" of the Council, 2022d) aims to facilitate data sharing across sectors, among businesses, and between businesses and public authorities by establishing a framework for trusted intermediaries that facilitate data sharing while ensuring compliance with data protection regulations. The **Data Act**(European-Parliament "and" of the Council, 2023) is more on business-to-consumer and business-to-business data sharing by defining an obligation to make product data and related service data accessible to the user and by providing the right of the user to share data with third parties.

The **Digital Markets Act (DMA)** (European-Parliament "and" of the Council, 2022b) regulates the large digital platforms, such as search engines, digital markets, web browsers, virtual assistants, cloud services, online advertising services, etc., which are gateways for business users to reach end users. The regulation defines numerous obligations on fair practice of competition, data accessibility, or interoperability. **Digital Services Act (DSA) (European-Parliament "and" of the Council, 2022c)** (European-Parliament "and" of the Council, 2022c) amending and complementing the e-commerce directive together the with DMA aims to create a safer digital space, by providing harmonized rules for the provision of intermediary services in the internal market and a framework of conditional exemptions from liability for intermediary service providers beside specific rules on due diligence obligations for certain categories of intermediary service providers.

In these norms, the legislation is still technologically neutral, not so in the case of the regulation of AI systems. The essence of the **AI Act** (European-Parliament "and" of the Council, 2021) is the fear, the risk management of this disruptive technology. The fact, that even the legal definition of AI has changed each round of the legislative process tells a lot about the soundness of the proposal. Besides, a huge amount of administration, work will be loaded on the developers, providers, or others involved in the marketization of these systems. The directive on **AI Liability** (European-Parliament "and" of the Council, 2022a) aims to define single rules on the disclosure of evidence in the case of high-risk AI systems and on the burden of proof in the case of non-contractual fault-based civil law claims brought before national courts for damages caused by an AI system.

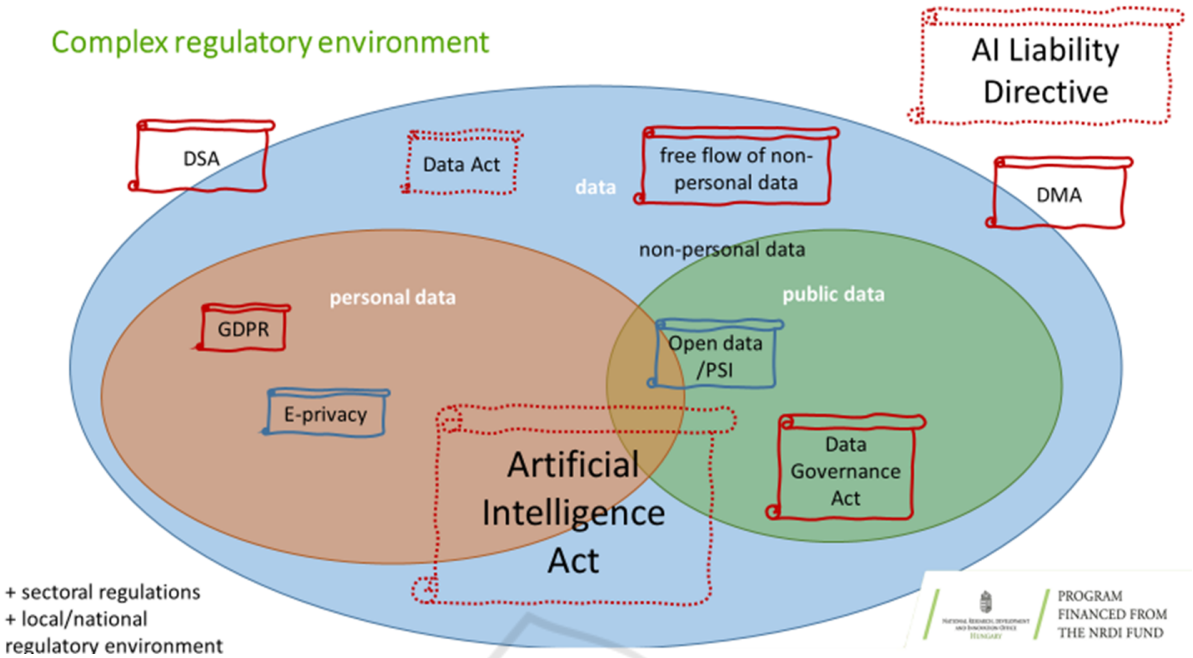

Figure 1: Landscape on new regulatory environment based on the EU data strategy.

4.2 Main Legal Issues of EISs

The above-outlined legal landscape already proved the indispensable involvement of legal knowledge in the development and maintenance of EISs. Still scratching the surface, besides the evident problems arising due to the processing of personal data, many other elements of the systems are exposed to legal compliance issues. Maybe the most important, as well the most difficult will be to define which data are subject to the right of the 'free movement of data', and what datasets the company or authority has to share with the data subject or other interested parties. Moreover, not only the public sector but also the participants of the private sector collecting huge amounts of information (such as data of smart tools, etc.) are subject to sharing this information with various types of entitled persons. A well-thought-out and conscious database design is needed to ensure that business objectives are legally compliant, but also that their technological implementation is legally and economically efficient. Not only the major platforms but many smaller as well will face obligations concerning business activity, which will be reflected in the architecture of their systems. In the future, the problems of AI technologies will be added to these compliance issues: starting from the correct classification of the technology used through the risk evaluation till the concrete administrative obligations of the upcoming rules will put a huge workload on the developers. The use of machine learning algorithms has the potential to perpetuate or amplify biases inherent in the training data. Organizations need to adopt strategies to identify and mitigate biases in data analysis and to apply data science and machine learning algorithms that promote the ethical use of data science and machine learning.

4.3 Data Protection or Data Security

For IT professionals assuring the security of the data is not only essential, but it is a continuously repeating task from the system planning to its maintenance. But data security is only half of the job: 'data protection', as the abbreviation of the 'legal protection of personal data' is a more complex issue. Companies should understand compliance with data protection regulations and utilize proper mechanisms. Since the GDPR it has been a legal obligation to involve compliance professionals in the development and implementation of the 'data protection by design and by default'. The first step is to precisely define the complexity of the data in processes: from a privacy point of view, it is enough to have the chance to identify a natural person from the data processed to get the whole system under the scope of the GDPR. A thorough analysis may lead to the redefinition of the database structure by creating its anonymized and/or pseudonymized parts. As IT technology develops it allows more and better automated individual decision-making which is not *ab ovo* permitted by the law, more, they are not just banned but even the lawful practices must satisfy the

prescribed rights of the data subjects. The use of AI, as a new, disruptive technology automatically leads us to the inevitable task of data protection impact assessment.

5 CONCLUSIONS

Enterprise Architecture is a multi-disciplinary field that is essential in today's complex business environment. On one hand, businesses face constantly changing market conditions and interconnected processes, and on the other hand, they need to adopt new technologies to stay competitive. Recently, computing has evolved to incorporate modern AI algorithms, specifically machine learning and soft computing. Research on Enterprise Architecture should also focus on the needs of MSMEs to identify cost-effective architecture components and solutions that can provide AI-related services to both their staff and partners. This is because larger companies have the financial resources to embed computing solutions into their services. From the legal point of view, we have to underline that the involvement of legal professionals in the developments in its very first phase is crucial – defining data transfer interfaces, grouping data in line with the regulatory needs, implementing the data protection by design and by default, etc. – not only because of the legal risks of the systems on market or in use but also its unforeseeable effect on the growth of the development costs and resource needs in its pre or post-launch phase.

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