




## Marijana Ćurak

 <https://orcid.org/0000-0003-3427-7051>

Department of Finance  
Faculty of Economics, Business  
and Tourism  
University of Split, Split, Croatia  
[marijana.curak@efst.hr](mailto:marijana.curak@efst.hr)

## Mirela Duvnjak

 <https://orcid.org/0000-0002-8315-0156>

Croatia Insurance Company Plc.  
Zagreb, Croatia  
[duvnjak.mirela@gmail.com](mailto:duvnjak.mirela@gmail.com)

## Maja Pervan

 <https://orcid.org/0000-0001-6895-5258>

Department of Economics  
Faculty of Economics, Business  
and Tourism  
University of Split, Split, Croatia  
[maja.pervan@efst.hr](mailto:maja.pervan@efst.hr)

# The relationship between the digital maturity and efficiency of Croatian non-life insurers: Exploratory research

Accepted by Editor Ewa Ziemba | Received: October 26, 2023 | Revised: January 13, 2024,  
February 17, 2024 | Accepted: March 16, 2024 | Published: April 5, 2024.

© 2024 Author(s). This article is licensed under the Creative Commons Attribution-NonCommercial 4.0 license  
(<https://creativecommons.org/licenses/by-nc/4.0/>)

## Abstract

**Aim/purpose** – In line with the general trend of digitalization and changing customers' needs and preferences, insurance companies have increasingly applied digital technology to their business. This digital transformation should enhance insurance companies' efficiency and provide further advantages. Therefore, this study's main aim is to analyze the current relationship between the digital maturity of Croatian non-life insurers and their efficiency.

**Design/methodology/approach** – The empirical analysis is based on the data collected via an online survey on a sample of Croatian non-life insurers and from the insurance companies' financial statements. The data was analyzed using the Digital Maturity Model 5.0 by Forrester Research, Inc., Data Envelopment Analysis, and correlation analysis.

---

Cite as: Ćurak, M., Duvnjak, M., & Pervan, M. (2024). The relationship between the digital maturity and efficiency of Croatian non-life insurers: Exploratory research. *Journal of Economics & Management*, 46, 55-78. <https://doi.org/10.22367/jem.2024.46.03>

**Findings** – The surveyed Croatian non-life insurance companies have achieved the second level of a four-level digital maturity scale, on average. Although the digital transformation of insurance companies is a promising efficiency driver, the current level of digital maturity of Croatian non-life insurance companies is not positively related to their efficiency.

**Research implications/limitations** – The research has implications for insurance companies regarding their path of digital transformation, as well as for the regulators establishing an adequate regulatory framework to encourage the digital development of insurance companies. The objective limits of the research refer to the means of measuring digital maturity and the sample size. The research is limited to the Croatian insurance market.

**Originality/value/contribution** – Analysis of the efficiency of insurance companies from the information technology perspective is rare in the academic literature, and this issue has not been investigated using a sample of Croatian insurers. The research contributes to advancing knowledge on the relationship between digital maturity and insurance companies' efficiency.<sup>1</sup>

**Keywords:** digital transformation and maturity, efficiency, Croatian non-life insurance companies.

**JEL Classification:** G22, C67, D22.

## 1. Introduction

Driven by overall technological development, by changing customers' expectations of the ways of accessing insurance services, and to achieve higher efficiency and profitability, insurance companies have increasingly implemented digital technology in their business. The necessity for digital transformation accelerated during the COVID-19 pandemic and lockdown as a response to changing market demands (Lanfranchi & Grassi, 2022). Some insurance companies develop digital innovation in-house, while others apply technological solutions built by external IT companies, and that way take advantage of their consulting services as well. Insurers also invest in IT start-ups or cooperate with them. The integration of digital technology in the insurance business ranges from creating and distributing insurance products, risk assessment, and price calculation to claim adjustment activities, insurance fraud prevention and detection, as well as financial transactions.

---

<sup>1</sup> Part of this manuscript is based on the postgraduate specialist study thesis written by one of the authors. The research was presented at the International Conference on Economics, Finance and Business, International Institute of Social and Economic Sciences (IIES), and Faculty of Economics – Prague University of Economics and Business, Prague, 2023.

Besides affecting the business processes of insurance companies, digital innovations have been instrumental in creating fully digitalized suppliers that compete with traditional insurance companies. This refers to InsurTech, or the integration of advanced technology solutions in insurance operations (Kelley & Wang, 2021).

Despite exposing insurance companies to challenges, digital transformation might enhance insurance companies' efficiency. While the efficiency of insurance companies has been studied from various perspectives – distribution channels, mergers and acquisitions, organizational form, capital, management, regulation change, and the comparison of efficiency among countries (more recent review of the studies can be found in Kaffash et al. (2020)), this specific topic has not been properly addressed in the literature.

The analysis of the impact of the level of the implementation of digital transformation on the efficiency of insurance companies is still rare (Lanfranchi & Grassi, 2021). The same is true for research on the effect of digital innovations on the performance of insurance companies in general (Bohnert et al., 2019). The reasons could be related to the fact that the digitalization of the insurance industry has intensified only recently, and it can take years for such complex investments to bear fruit, provided that implementation issues are properly addressed. Moreover, company-level data on insurers' digital transformation and maturity are of limited availability. Notwithstanding these concerns, exploring the topic is of the utmost importance.

According to the information available to the authors, there is no study on the relationship between digital maturity and the efficiency of insurance companies in the Republic of Croatia. To bridge the gap in the literature, the main aim of this research is to analyze the correlation between digital maturity and the efficiency of Croatian insurance companies in the segment of non-life business. The empirical analysis is based on data collected via an online survey from 10 out of 12 Croatian insurers that operated in the non-life insurance market (they represented 90% of the non-life insurance market in 2021 (Croatian Insurance Bureau, 2022)) and from the insurance companies' financial statements for 2021. The data were then analyzed using Digital Maturity Model 5.0 by Forrester Research, Inc., Data Envelopment Analysis (DEA), and correlation analysis.

The analysis showed that, on average, the surveyed Croatian non-life insurance companies have achieved the second level on a four-level digital maturity scale and that insurance companies' digital maturity and efficiency are negatively correlated. As stated above, the relationship between digital transformation and

efficiency is a complex one and our sample limitations did not allow us to address that complexity explicitly. However, we think that an exploratory investigation of the topic is valuable, and we offer some plausible explanations for our main result at the end of the paper.

The paper is structured as follows. Section 2 presents a review of the literature on the opportunities and challenges of the digital transformation of insurance companies. Section 3 presents the methods and procedure of the empirical research. Section 4 depicts the results and discussion. Section 5 concludes the paper.

## **2. Literature review on opportunities and challenges of digital transformation**

As it is generally stated, innovations are an essential driver for increasing the competitiveness and performance of companies. The same is expected for digital innovations. Since the application of digital technologies affects the entire insurance value chain (Eling & Lehmann, 2018; Eling et al., 2022), it has the potential to affect the efficiency of insurance companies as well. The integration of digital technology enables a reduction in human involvement and lowers the costs of insurers' operations (International Association of Insurance Supervisors [IAIS], 2017).

The potential benefits of digital innovations encourage insurance companies to take steps in their digital transformation as an extensive implementation of digital technology and digital resources to promise new revenue generation, create innovative business models, and more broadly, develop novel approaches to conducting business (Spremić, 2000). According to Ivančić et al. (2019), there are seven dimensions of digital transformation, referring to strategy, people, organization, customers, ecosystem, existing technologies, and innovations. Digital transformation not only transforms business processes but also management systems, as well as clients' relationships. There is no unique digital transformation model: digitalization should be carried out based on the specific characteristics of each insurance company (Duvnjak, 2022).

Digital maturity refers to the level of implementation of digital transformation in a particular company. It is a concept that integrates both technological and management perspectives (Chaniyas & Hess, 2016; Teichert, 2019). The first of these refers to the degree of applying information technology in performing tasks and processing information in an organization, while the management per-

spective relates to the degree of digital transformation or status of digital development. Thus, this indicates what an organization has achieved in digital transformation activities and how it systematically prepares to adapt to the digital environment to maintain competitiveness (Chaniias & Hess, 2016; Teichert, 2019).

There are different models for assessing the digital maturity of various organizations (for a review, cf. Chaniias & Hess, 2016; Kirmizi & Kocaoglu, 2023; Kruljac & Knežević 2019; Ochoa-Urrego & Pena-Reyes, 2021). Teichert (2019) presents the most common areas used in digital maturity assessment models as follows: digital culture, technology, operations and processes, digital strategy, organization, digital skills, innovation, customer insight and experience, governance, digital ecosystem, leadership, compliance and security, products and services, and the business model. As stated by Berghaus and Back (2016), digital maturity models can have two functionalities: descriptive – maturity models are used to assess the current state of digital transformation, taking into consideration specific criteria, and prescriptive – they allow to define the direction of action, and the abilities needed to achieve the target level of digital maturity. Additionally, the models can have a comparative purpose, enabling internal and external benchmarking (Röglinger & Pöppelbuß, 2011).

Although there are various forms of digitalization, the most important technologies applied to the insurance business are cloud computing, the Internet of Things (including telematics), big data, artificial intelligence, and the blockchain (Sheng et al., 2017). These technologies have the potential to generate improvements that could be realized through the whole process of providing insurance, from sale activities and the development of new insurance products to claims processing.

The interaction between insurance companies and customers and the sale of insurance products could be realized by using websites, mobile devices with apps, social networks, chatbots, social media, and robo-advisers (Eling & Lehmann, 2018). A direct online distribution channel of insurance products provides opportunities for faster selling activities, access to a large number of insurance customers, and more accessible entrance to new markets at lower costs in comparison to traditional sales forces (agents and brokers as well as bancassurance). In performing selling activities, insurance companies usually apply artificial intelligence, big data, machine learning, and the Internet of Things (Lin & Chen, 2020).

Digital technology could modify existing and develop new insurance products. The aim is to create products that are customizable and customer-oriented (Kelley & Wang, 2021). This is especially applicable in health insurance (e.g., pay-as-you-live policies) and motor insurance (e.g., pay-how-you-drive policies). Additionally, as a response to general digitalization and the importance of cyber risk (Allianz Global Corporate & Specialty [AGCS], 2023), insurance companies create new products related to cyber insurance and fully digital products enabled by smart contracts (Eling & Lehmann, 2018).

However, even though insurance companies focus their current digitalization efforts on sales and product development, according to Naujoks et al. (2020), the most significant opportunity for benefits from digital transformation comes from underwriting activities and claim management. Digital innovations provide the automatization of insurers' underwriting activities and, therefore, faster performance. The application of digital technology, especially the Internet of Things, and advanced analytics, enables insurers to take into consideration more risk factors and assess risks more precisely (e.g., determining the level of risk by tracking the driving and health habits of insureds). Thus, besides enabling the gathering of large amounts of data, the data are more detailed and precise compared to data collected by traditional methods (Ostrowska, 2021). In this way, insurance premium reflects risk more accurately (e.g., pay-how-you-drive policies take mileage and driving style into consideration (Ostrowska, 2021)). Additionally, premiums for insureds exposed to lower risk are reduced, decreasing the adverse selection problem. Furthermore, since a reduction in premium is related to data collected from the Internet of Things, this could encourage insureds to take preventive measures and change their health habits and driving style, ultimately reducing losses.

Insurers provide apps for assistance in case of loss and support in claim reporting (Eling & Lehmann, 2018). The application of technologies for gathering data, like Internet of Things sensors, telematics, and drone technology, enables insurers to get digital notification of the loss (McKinsey & Company, 2018) and collect valuable data for loss assessment. Moreover, by tracking insureds' behavior, insurers could alert insureds to some dangers (e.g., car speed, water levels, and temperature in houses), prevent losses, and consequently, reduce the number of claims (Eling & Lahmann, 2018). A more significant amount of data and advanced data analytics enhance fraud detection and reduce moral hazards in insurance (Lin & Chen, 2020), additionally lowering claims. According to McKinsey & Company (2018), the potential efficiency gains in claims opera-

tions are especially high for property and casualty insurers, whose digital innovations can reduce claims expenses by 25-30%. Naujoks et al. (2020) assessed that for a prototypical non-life insurer in Germany, the reduction in claim payments is expected to be up to 19% and loss adjustment expenses up to 62%.

Digital technology could support other functions of insurance companies and enhance decision-making. Artificial intelligence and data analytics could be applied to the investment management of insurance companies, providing a base for making better investment decisions (Lin & Chen, 2020). Big data and artificial intelligence could be integrated into the risk management of insurance companies, enabling the automation of risk management decision-making (Eling & Lehmann, 2018), like those related to reinsurance. Efficiency gains from digital transformation could also be expected in support activities of insurance companies (Eling & Lehmann, 2018).

Overall, cost reductions are expected to reach up to 29% in five years (Naujoks et al., 2020). In the same period, revenues could be increased by up to 28%, mainly from an increase in market share due to passing cost savings to the users of their services by reducing insurance premiums (Naujoks et al., 2020). Insurance companies that provide services to individual customers are expected to receive the earliest and most significant impact of digital transformation compared to insurers that serve commercial customers, for which underwriting and claim processing activities are more complex (Naujoks et al., 2020). Furthermore, efficiency gains in the health insurance line are expected to be the highest due to frequent interaction with customers (Eling & Lehmann, 2018).

In addition to the aim of enhancing performance, insurance companies implement digital technology to align with the technological transformation of their stakeholders and to satisfy the expectations and needs of their clients, especially clients of the new generation (Duvnjak, 2022). The process has accelerated during the last few years due to the adoption of digital technologies during the pandemic.

Users of insurance companies' services could benefit from insurers' digitalization in terms of easier access to insurance, more transparent pricing, easier comparison among products offered by different insurers, improved insurance services, and product customization. More choices and lower insurance premiums might also be on offer (European Insurance and Occupational Pensions Authority [EIOPA], 2023; Eling & Lehmann, 2018; Lin & Chen, 2020; Naujoks et al., 2020; Sheng et al., 2017). Due to the faster collection of data, the period between reporting claims and their settlement is shortened (Naujoks et al.,

2020), making paying reimbursements to beneficiaries faster. According to McKinsey and Company (2018), this could increase the satisfaction of property and casualty insurers' customers by 20%.

In addition to its positive effects, the digital transformation of insurance companies comes with challenges, too. The most significant are those related to cyber security, as well as risks associated with privacy and personal data protection, accuracy of data, potential discrimination of clients due to the new technologies, and regulatory and legal risks. Integrating the new technology into the operations of insurance companies could cause more cyber risks. While the new technology provides greater opportunities to the insurance companies for fraud detection, at the same time, the technology offers new means to fraudsters for perpetrating fraud and increases operational risk for insurers. The quality and accuracy of data collected by Internet of Things technologies could be questionable. The online sale of insurance is passive compared to sales through brokers and agents and, therefore, fits only simpler insurance products (motor insurance, travel insurance, health insurance). Additionally, some clients are prone to traditional insurance distribution and claims reporting.

According to Berdak and Williams (2021), some of the biggest challenges in implementing digital transformation are lack of vision and strategy, ineffective digital transformation management, security risks, personal data protection, and user experience design. Moreover, despite obvious advantages, European consumers express their concerns about the digitalization of the insurance business, and these are mainly related to unjustified increases in insurance premiums (the increase not associated with the risk of insured), data privacy, and cyber risk (EIOPA, 2023).

Bohnert et al. (2019) analyzed the impact of digitalization on the value of 41 European publicly traded insurance companies. They confirm a positive effect, with the strongest impact for insurers that have a comprehensive approach to digitalization, encompassing both the digital innovations of internal operations of insurance companies and innovations in interactions between insurers and their customers (external context). Based on data from 35 US non-life insurance companies and both parametric (SFA) and non-parametric analyses of efficiency (DEA), Lanfranchi and Grassi (2021) found that the insurance companies they analyzed were not able to exploit technology for the improvements in their efficiency. Ma and Ren (2023) analyzed the effect of InsurTech innovations on insurance companies, considering the stock market reactions to these investments. They found that the effect depends on the type of technology. A positive



impact is found for the announcement of investment in peer-to-peer insurance, blockchain, and on-demand digital insurance, while investors negatively react to the insurers' InsurTech investment related to digital analytics, distribution, cross-selling, and innovations in cyber security.

Although there are studies in the field of digital transformation of insurance companies, there is scarce empirical literature on the impact of digital maturity on insurance companies' efficiency. Additionally, while the efficiency of Croatian insurance companies has been studied (Jurčević & Mihelja Žaja, 2013; Medved & Kavčić, 2012; Pervan et al., 2021a, 2021b; Škrinjarić, 2016; Učkar & Petrović, 2022), to the best of our knowledge, there is no research on the relationship between the achieved levels of digital transformation and the efficiency of Croatian insurance companies. Thus, in the following sections of the paper, we empirically analyze this aspect of insurers' activity.

### **3. Research methods and procedures**

The empirical part of the research is divided into three segments. In the first part of the analysis, we evaluate the digital maturity of the insurance companies using a survey and the digital maturity model. In the second stage, an analysis of the insurance companies' efficiency, using data from their financial statements, is performed. Finally, to study the relationship between digital maturity and the efficiency of insurance companies, we apply correlation analysis (since regression analysis, due to sample size, could not be performed).

#### **3.1. Estimation of the digital maturity of insurance companies**

Digital Maturity Model 5.0 by Forrester Research, Inc. (VanBoskirk et al., 2017) is applied to analyze the digital maturity of insurance companies. The model is publicly available, and it contains a description of the methodology that enables conducting research and applies dimensions identified as the most commonly applicable in scientific research in the currently available models (Duvnjak, 2022; Teichert, 2019). The same model of version 4.0 was applied by Gajsek et al. (2019). According to the model, there are four dimensions for assessing digital maturity: culture, organization, technology, and insights. The culture dimension refers to the assessment of how much digital culture is permeated and how much it is supported in a specific company, while the organization

dimension encompasses the alignment of the company in supporting the strategy of digital transformation, governance, as well as execution. Technology is related to the implementation of emerging digital technologies in a company's activities, whereas the insight dimension (VanBoskirk et al., 2017) measures the success of a company in using customer and business data to assess effectiveness and inform strategy.

Each dimension consists of seven statements (the statements on the four dimensions of digital maturity used in the questionnaire are available at the following link: <https://foloop.in/uploads/images/stock/The-Digital-Maturity-Model-5.0-1.pdf>), resulting in 28 statements in total. To scale responses, the 4-point Likert scale is used (0 points – completely disagree, 1 point – somewhat disagree, 2 points – somewhat agree, 3 points – agree entirely). The scores range from zero to 84. Considering the number of points, there are four levels of digital maturity. The first one, Sceptics, has a score ranging from zero to 33, and they ignore digitalization. Companies with scores ranging from 34 to 56 belong to the Adopters segment, which represents those who are stuck in conventional ways of performing activities. Those with digital maturity levels from 57 to 74 are Collaborators who collaborate but are not insight-driven (they are not, for example, data-driven or driven by customers' experiences), while the highest degree of digital maturity, ranging from 75 to 84, indicates differentiators that show ad hoc excellence (VanBoskirk et al., 2017). Besides questions related to the applied model, the insurers were additionally asked about the specifics of their digital transformation.

As for the analysis of the digital maturity of insurance companies that operate in Croatian insurance markets, data are collected through an online survey. The survey software SurveyMonkey was used. The survey was conducted from November 23, 2021 to December 10, 2021. The sample consists of three non-life insurance companies and seven composite insurers, which in total represent 10 out of 12 insurers that operate in the non-life insurance market. The market share of these insurance companies, measured by the share in total non-life insurance premiums, amounted to 90% in 2021 (Hrvatski ured za osiguranje [Croatian Insurance Bureau], 2022), confirming the sample's representativeness. Respondents were C and higher-level executives.

### **3.2. Data envelopment analysis and correlation analysis**

Data Envelopment Analysis (DEA) is a nonparametric evaluation method capable of evaluating the efficiency of a Decision Making Unit (DMU) (in this analysis, an insurance company). It transforms multiple inputs and outputs into a single numerical score representing a DMU's efficiency. Two types of DEA models can be distinguished: (1) The CCR model, pioneered by Charnes et al. (1978), and (2) The BCC model, formulated by Banker et al. (1984). While the first model operates under the assumption of constant returns to scale (CRS) and assesses overall technical efficiency (OTE), the second model is built upon the concept of variable returns to scale (VRS) and measures pure technical efficiency (PE).

Based on their orientation, two types of models can be identified: an input-oriented model, which prioritizes minimizing input while maintaining output levels, and an output-oriented model, which aims to maximize output while keeping input constant. In the context of insurance, where there is more influence over inputs than outputs, an input-oriented model is chosen, aligning with previous research in the field, e.g., Cummins and Xie (2013).

The microeconomic theory stresses that to generate outputs and, accordingly, create incomes, firms' production functions commonly include inputs such as capital, labor, and land. Hence, three inputs (capital, number of employees, and technical provisions) and two outputs (net premiums and investments) for each non-life insurer are used in DEA analysis.

Considering the inputs, according to Eling and Luhn (2010), most of the existing studies of insurance companies' efficiency use at least capital and labor as inputs. The capital is divided into equity and debt capital. We use equity as an input as it is important for insurance companies to fulfill regulatory requirements and guarantee the accomplishment of their obligations to policyholders (Huang & Eling, 2013). Debt capital is raised by issuing insurance policies. As a measure of debt capital, we use net technical provisions. To measure labor input, due to data availability, the number of employees is applied.

According to Cummins and Weis (2013), the value-added or production approach is the most appropriate for measuring insurers' output. Thus, we apply this approach in our research. The approach states that insurers provide three main functions. The first one refers to risk-pooling and risk-bearing. It contributes to value-added as insurers manage the risk pool, collect insurance premiums from policyholders, and redistribute them to those insureds who have suffered

a loss. The second function is the intermediation function. It refers to issuing insurance policies and investing funds in various instruments in financial markets until insurance companies have to pay claims. The last function refers to “real” financial services relating to insured losses, adding value by creating coverage programs, prevention activities services, and other real financial services to their customers. Output proxies of the risk-pooling and risk-bearing services of insurance companies that are usually used in the efficiency analysis are insurance premiums and present value of losses (Eling & Luhnen, 2010). Taking into consideration data availability, we use net insurance premiums. As the output proxy of the intermediation function, we apply investments. Since premiums and investments are correlated to the “real” financial services provided by insurance companies, the output of this function is not separately considered in studies of insurance companies’ efficiency (Huang & Eling, 2013). Selected variables are also in line with prior efficiency-focused studies (e.g., Hatami-Marbini & Saati, 2020; Kaffash et al., 2020; Li et. al., 2021; Pervan et al., 2021b).

The number of inputs and outputs is consistent with Glany and Roll (1989), according to which the minimal number of decision-making units, in this case, insurance companies, should be at least twice the number of inputs and outputs. All data for input and output variables were obtained from insurance companies’ financial statements for 2021.

As an application of multiple regression analysis is not possible on such a small number of observations, we applied correlation analysis on the results obtained by digital maturity and efficiency models, as this method is usually used for measuring the association between two variables. Since the Digital Maturity Level is based on a Likert scale (categorical data), the Spearman coefficient of correlation is applied, and this part of the analysis is performed with SPSS Statistics 23.

#### **4. Research findings and discussion**

In estimating the digital maturity of non-life insurance companies, to check the reliability or consistency across a set of questions for each participant, Cronbach’s Alpha is calculated for each of the four dimensions of digital maturity. The results of the reliability analysis, Cronbach’s Alpha, for each dimension (consisting of seven statements) are presented in Table 1.

**Table 1.** Cronbach’s Alpha

Dimension	Cronbach’s Alpha
Culture	0.80
Technology	0.66
Organization	0.76
Insights	0.86

Source: Authors’ calculations based on survey data.

The value of Cronbach’s Alpha can range from 0 to 1. The higher the value, the greater the reliability. A minimum value of 0.7 is recommended, still, since Cronbach’s Alpha depends on the number of items on the scale, in cases when the number of items is fewer than 10 (which is our case), according to Pallant (2020), Cronbach’s Alpha should be greater than 0.5.

The values of Cronbach’s Alpha for all analyzed dimensions are greater than 0.5 and even greater than 0.7 (except for the Culture dimension, for which it is close to 0.7), confirming good reliability or internal consistency (consistency across a set of questions for each participant).

**Table 2.** Digital maturity scores

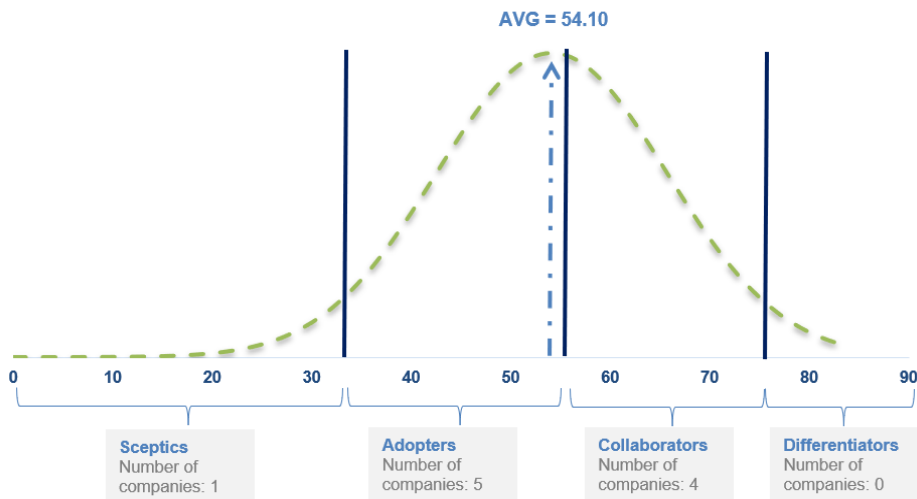
Insurer	Digital maturity score	Insurer	Digital maturity score
DMU1	41	DMU6	54
DMU2	54	DMU7	60
DMU3	50	DMU8	62
DMU4	51	DMU9	70
DMU5	32	DMU10	67

Note: DMU indicates an insurance company.

Source: Authors’ calculations based on survey data.

According to the results of the analysis of insurers’ digital maturity, the average score of 54.10 (out of 84) implies that the surveyed insurance companies have achieved the second level of a four-level digital maturity scale. One out of 10 companies belongs to the Sceptics; five are Adopters, while four have reached the third level of digital maturity, Collaborators. There is no insurance company with the highest level of digital maturity or differentiators (Table 2 and Figure 1).

**Figure 1.** Digital maturity model scores' distribution curve of Croatian non-life insurance companies



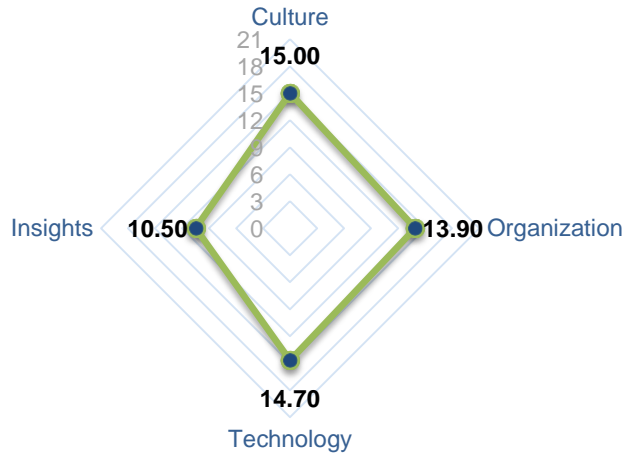
Source: Authors' calculations based on survey data.

Considering the dimensions of digital maturity, as shown in Figure 2, the surveyed insurance companies have their highest score in the Culture dimension, 15.00 on average. This is followed by Technology, 14.70, and Organization, 13.90, on average. The lowest level of maturity (10.50 on average), significantly below the results achieved in the other dimensions, is shown in the Insight dimension. The results of the survey show that the process of evaluating the results and improving digital strategies is still to be done. Croatian insurers should improve on measuring the effectiveness of the implementation of their digital strategies. Moreover, Croatian insurers should prioritize measuring user experience (as an essential input parameter for creating a digital strategy and implementing digital transformation) through effective metrics to obtain the expected effects of digitalization in the planned period.

In general, respondents perceive the concept of digital transformation as narrower than it is. Four out of ten insurers do not have a strategy for digital transformation. Investments of insurance companies in digital transformation account for 25% of all their investments on average, and respondents stated that financial resources are the main challenge to digital transformation. As a comparison, insurers from the EMEA region allocated an average of 49% of their investments to InsurTech in 2019, 61% in 2020, and 33% in 2021 (Goldman Sachs, 2021). Besides financial resources, significant obstacles to digital trans-

formation include a lack of skilled staff and regulatory requirements (high level of regulatory requirements or undetermined regulation, and in some cases, the lack of regulation).

**Figure 2.** Average score of digital maturity according to the dimensions



Source: Authors' calculations based on survey data.

Considering the types of digital technologies, cloud computing is used by most of the companies. The next most used technologies are advanced analytics and robotics. Artificial intelligence and the Internet of Things are very modestly exploited by Croatian insurance companies. The areas of technology implementation are mainly related to selling activities and claims adjustments. The majority of insurance companies do not use digital innovations in their risk underwriting activities. According to the data collected from the websites of Croatian insurance companies, most of the insurers offer the option of online insurance distribution for motor, health, property, and travel insurance. There is also a trend in developing mobile apps, which, besides being used for buying insurance, provide options for reporting and reviewing the status of claims. Mobile apps offered by some insurance companies also provide the option of paying the insurance premium, as well as additional forms of interaction with the insurer (e.g., exchange of files when handling claims or filing a complaint) (Duvnjak, 2022).

According to the respondents, improvements are especially required in the context of the evaluation of users' experiences, the development of digital skills, as well as the expert knowledge of the teams that perform the activities of digital transformation.

Taking into consideration the level of digital transformation of Croatian non-life insurance companies and the potential benefits of digital innovations, there is a question about the relationship between the achieved level of digital maturity and the efficiency of insurance companies in Croatia. Thus, Data Envelopment Analysis and correlation analysis are performed in the next stages of the empirical research.

To calculate efficiency coefficients, we applied a BCC input-oriented model while using Performance Improvement Management Software (PIM-DEA). Still, due to the small number of insurers, the results of DEA analysis showed that most were positioned on the efficiency frontier (in other words, they had a coefficient equal to 100%). A potential relationship between digitalization and efficiency may be spurious in that situation. Therefore, to distinguish between more and less efficient insurers, super-efficiency has been calculated. This type of analysis allows the efficiency coefficient to obtain values higher than 100%, thus permitting the identification of the most efficient insurers. The results of redirection from the BCC model to the CCR super-efficiency model are presented in Table 3.

**Table 3.** Super-efficiency scores

Insurer	Super-efficiency score	Insurer	Super-efficiency score
DMU1	100.95	DMU6	98.31
DMU2	106.34	DMU7	100.53
DMU3	119.53	DMU8	91.11
DMU4	69.81	DMU9	62.03
DMU5	117.53	DMU10	78.59

Source: Authors' own calculations.

From Table 3, it can be seen that half of the insurers (5 out of 10) were efficient.<sup>2</sup> The lowest efficiency score (recorded by DMU9) amounted to 62.03%, suggesting that this insurer can reduce its inputs by 37.97% to achieve the efficiency frontier and to become efficient (i.e., reach an efficiency score of 100%). Aside from DMU9, inefficient insurers were also DMU4, DMU6, DMU8, and DMU10.

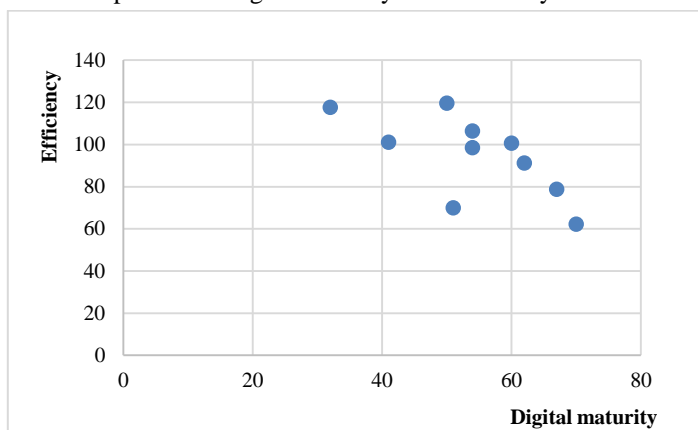
<sup>2</sup> DEA analysis enables the distinction between *efficient* DMUs (achieving efficiency scores of 1.0 or 100%) and *inefficient* ones with scores below 1.0 or 100%. However, if one wants further to *differentiate the efficient* DMUs (DMUs that are positioned on the efficiency frontier), super-efficiency can be calculated, and in this case, a separation between *efficient* and *super-efficient* DMUs is made.



Furthermore, although DMU1, DMU2, DMU3, DMU5, and DMU7 are efficient (i.e., the baseline CCR model indicated a value of 100% for these DMUs), an application of the CCR super-efficiency model revealed that among them, the most efficient insurer was DMU3, as it has achieved the highest efficiency score (119.53). A closer look into the inputs and outputs of this insurer reveals that although DMU3 uses (on average) almost 2.6 times more inputs than some of its counterparts, e.g., DMU9, it realizes (on average) more than five times larger outputs than DMU9.

The relationship between digital maturity and the efficiency of insurance companies is shown in Figure 3. Although we expected a positive association between insurers' digital maturity and achieved efficiency, the graphic analysis indicates a negative relation between these two variables. We additionally calculated the coefficient of correlation. However, due to a small number of observations, the results should be taken with caution and just as a starting point for further research on the relationship between digital maturity and efficiency.

**Figure 3.** Relationship between digital maturity and efficiency



Source: Authors' own calculations.

**Table 4.** Correlation analysis

Nonparametric correlation	Efficiency	Digitalization
Spearman's rho	1	-0.717*
Sig. (2-tailed)		0.020
N	10	10
Spearman's rho	-0.717*	1
Sig. (2-tailed)	0.020	
N	10	10

\* Correlation is significant at the 0.05 level (2-tailed).

Source: Authors' own calculations.

The results of the correlation analysis are presented in Table 4, in which a statistically significant and negative correlation coefficient value can be observed. To some extent, the results align with Lanfranchi and Grassi (2021). The maturity and efficiency scores of DMU5 and DMU9 significantly drive the result of the correlation analysis, and some other factors may influence this relationship (e.g., size of the company, ownership, product diversification, and leverage). However, due to the sample size, multiple regression analysis is not applicable, and thus, there was no possibility to consider control variables.

As stated in the introduction, digital transformation projects are usually multi-year and require complex preparation, significant financial resources, and expert teams. Thus, it takes a certain time to achieve the benefits of the innovations. Since most of the insurance companies in Croatia are at lower levels of digital maturity, it could be expected that the positive influence of these investments on efficiency will be realized after a certain period. Additionally, as stated by Lanfranchi & Grassi (2022), investing in technology alone does not guarantee success, as the expected benefits may not materialize naturally, and the investment might not be justified. As some of the insurers do not have a strategy for digital transformation, they may undertake ad-hoc activities and not be able to verify if the activities are properly implemented and managed, if all available sources are engaged, and if these investments result in the expected effects. Additionally, when we consider the types of technologies and insurers' functions in which these technologies are implemented, it could be concluded that the digital transformation of insurance companies is not taken comprehensively. However, Bohnert et al. (2019) found that companies with a comprehensive approach to digital innovations have achieved the strongest effect of digital transformation on performance. Thus, insurance companies need to adopt digital innovations in both internal and external contexts.

## 5. Conclusions

The main aim of this research was to examine the relationship between the digital maturity of insurers and their efficiency. Digital transformation changes the ways insurance companies interact with their customers and perform their operations, potentially contributing to the efficiency of these financial institutions.

Digital Maturity Model 5.0 by Forrester Research, Inc., based on data collected through a survey of insurance companies, shows that the surveyed Croatian non-life insurance companies have reached the second level of a four-level

digital maturity scale, on average, while correlation analysis indicates a negative relationship between digital maturity and the efficiency scores that were obtained by the Data Envelopment Analysis. The result might be explained by the fact that digital transformation projects are long-term projects and require significant financial and human resources. In other words, it is expected that the positive influence of these investments on efficiency will be realized after a certain period. The fact that Croatian insurers are at the start of this process might also imply that already efficient insurers are still skeptical about the need to increase their digitalization investments and that insurers that have already invested in digitalization, are pushed by the will to improve their low-efficiency starting point, have not yet enjoyed the effect of their effort.

Even though complex, as the results we offer testify, investing in digitalization is of the utmost importance for insurers. As stated above, digital technology benefits are numerous and include a wide range of aspects of the business. For example, technology allows a company to easily measure user experience regularly and consistently and evaluate the quality of the relationship with clients and their satisfaction with products and services. It allows insurers to offer tailor-made insurance products and make insurance coverage and pricing more understandable for policyholders, improving relationships and customer retention. At the same time, insurers should satisfy the preferences of those clients who prefer traditional ways of buying insurance and filing a claim.

To shift to a higher level of digitalization and achieve efficiency gains, insurance companies should conduct comprehensive activities in a wide range of digital transformation areas. This refers to the implementation of their digital strategies and the implementation of new technologies, building a digital culture throughout the company, developing the digital ecosystem, enhancing the digital skills of their employees, encouraging innovations, and continually evaluating customer insights and experiences. Since the insurance market is highly regulated, while the Digital Economy and Society Index of Croatia is below the EU average, insurance companies' digital transformation should be supported by an adequate regulatory framework and the more rapid development of digital society in general.

As clearly stated throughout the paper, our effort is exploratory in nature and has some limitations. The first objective limit of the research refers to the measure of digital maturity since it is self-assessed by the employed representatives of insurance companies, and it could be biased to some extent. The research results are limited to the Croatian insurance market only, and due to

objective limitations related to the small number of insurance companies, it was not possible to apply more sophisticated methods to analyze the relationship between digital maturity and the efficiency of insurance companies. We were only able to investigate the correlation between our variables of interest and could not check for the influence of other factors. However, our work could be a starting point for future research, for which several suggestions are presented in what follows. We encourage future studies to apply other measures of the digital maturity of insurance companies; moreover, as digital maturity is not a static concept, but a dynamic one, future research may analyze changes in the digital maturity of insurance companies and its impact on their efficiency. As more data become available, more sophisticated methods could be applied. Additional work could be done on the sample encompassing employees at different hierarchy levels and departments in insurance companies. A comparison of the impact of digital maturity on the efficiency of life and non-life insurers is also suggested for future research.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## References

- Allianz Global Corporate & Specialty [AGCS]. (2023). *Allianz risk barometer. The top business risks for 2024*. <https://commercial.allianz.com/news-and-insights/reports/allianz-risk-barometer.html>
- Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*, 30(9), 1078-1092. <https://doi.org/10.1287/mnsc.30.9.1078>
- Berdak, O., & Williams, J. (2021). *The State of Digital Insurance, 2021. Landscape: The Digital Insurance Strategy Playbook*. Forrester Research. <https://www.onespan.com/sites/default/files/2021-03/OneSpan-AnalystReport-Forrester-State-of-Digital-Insurance-2021.pdf>
- Berghaus, S., & Back, A. (2016). *Stages in digital business transformation: Results of an empirical maturity study*. Proceedings of Association for Information Systems/MCIS 2016 (Vol. 22). <https://aisel.aisnet.org/cgi/viewcontent.cgi?article=1022&context=mcis2016>

- Bohnert, A., Fritzsche, A., & Gregor, S. (2019). Digital agendas in the insurance industry: The importance of comprehensive approaches. *The Geneva Papers on Risk and Insurance – Issues and Practice*, 44(1), 1-19. <https://doi.org/10.1057/s41288-018-0109-0>
- Chanas, S., & Hess, T. (2016). *How digital are we? Maturity models for assessment of a company's status in digital transformation*. LMU Munich Management Report 2/2016. Munich School of Management. <https://epub.ub.uni-muenchen.de/57622/>
- Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, 2(6), 429-444. [https://doi.org/10.1016/0377-2217\(78\)90138-8](https://doi.org/10.1016/0377-2217(78)90138-8)
- Cummins, J. D., & Xie, X. (2013). Efficiency, productivity, and scale economies in the U.S. property-liability insurance industry. *Journal of Productivity Analysis*, 39, 141-164. <https://doi.org/10.1007/s11123-012-0302-2>
- Cummins, J. D., & Weiss, M. A. (2013). Analyzing firm performance in the insurance industry using frontier efficiency and productivity methods. In G. Dionne (Ed.). *Handbook of insurance* (pp. 767-829). Springer. [https://doi.org/10.1007/978-94-010-0642-2\\_24](https://doi.org/10.1007/978-94-010-0642-2_24)
- Duvnjak, M. (2022). *Procjena digitalne zrelosti društava za osiguranje na tržištu Republike Hrvatske* [Assessment of digital maturity of insurance companies in Croatian insurance market] [Unpublished Postgraduate Specialist Study Thesis]. Faculty of Electrical Engineering and Computing, University of Zagreb. Digital Academic Archives and Repositories (DABAR). <https://urn.nsk.hr/urn:nbn:hr:168:730962>
- European Insurance and Occupational Pensions Authority [EIOPA]. (2023). *Customer Trends Report 2022*. <https://www.eiopa.europa.eu/system/files/2023-01/eiopa-consumer-trends-report-2022.pdf>
- Eling, M., & Lehmann, M. (2018). The impact of digitalization on the insurance value chain and the insurability of risks, *Geneva Papers on Risk Insurance – Issues and Practice*, 43(3), 359-396. <https://doi.org/10.1057/s41288-017-0073-0>
- Eling, M., & Luhnen., M. (2010). Frontier efficiency methodologies to measure performance in the insurance industry: Overview, systematization, and recent developments. *The Geneva Papers on Risk and Insurance-Issues and Practice*, 35(2). 217-265. <https://doi.org/10.1057/gpp.2010.1>
- Eling, M., Nuessle, D., & Staubli, J. (2022). The impact of artificial intelligence along the insurance value chain and on the insurability of risks. *Geneva Papers on Risk Insurance – Issues and Practice*, 47(2), 205-241. <https://doi.org/10.1057/s41288-020-00201-7>
- Gajsek, B., Marolt, J., Rupnik, B., Lerher, T., & Sternad, M. (2019). Using maturity model and discrete-event simulation for Industry 4.0 implementation. *International Journal of Simulation Modelling*, 18(3), 488-499. [https://doi.org/10.2507/IJSIMM18\(3\)489](https://doi.org/10.2507/IJSIMM18(3)489)
- Golany, B., & Roll, Y. (1989). An application procedure for DEA. *Omega*, 17(3), 237-250. [https://doi.org/10.1016/0305-0483\(89\)90029-7](https://doi.org/10.1016/0305-0483(89)90029-7)

- Goldman Sachs. (2021). *Insurance survey 2021*. Goldman Sachs Insurance Asset Management. <https://qa.gsam.com/content/gsam/global/en/market-insights/gsam-insights/2021/insurance-survey-2021.html/1000>
- Hatami-Marbini, A., & Saati, S. (2020). Measuring performance with common weights: Network DEA. *Neural Computing and Applications*, 32, 3599-3617. <https://doi.org/10.1007/s00521-019-04219-4>
- Hrvatski ured za osiguranje [Croatian Insurance Bureau]. (2022). *Tržište osiguranja u Republici Hrvatskoj 2021* [Insurance market in the Republic of Croatia 2021]. [https://huo.hr/upload\\_data/site\\_files/godisnje\\_izvjesce\\_2021-web.pdf](https://huo.hr/upload_data/site_files/godisnje_izvjesce_2021-web.pdf)
- Huang, W., & Eling, M. (2013). An efficiency comparison of the non-life insurance industry in the BRIC countries. *European Journal of Operational Research*, 226(3), 577-591. <https://doi.org/10.1016/j.ejor.2012.11.008>
- International Association of Insurance Supervisors [IAIS]. (2017). *FinTech developments in the insurance industry*. [https://www.iaisweb.org/uploads/2022/01/Report\\_on\\_FinTech\\_Developments\\_in\\_the\\_Insurance\\_Industry.pdf](https://www.iaisweb.org/uploads/2022/01/Report_on_FinTech_Developments_in_the_Insurance_Industry.pdf)
- Ivančić, L., Suša Vugec, D., & Bosilj Vukšić, V. (2019). Robotic process automation: Systematic literature review. In C. Di Ciccio et al. (Eds.), *Business process management: Blockchain and Central and Eastern Europe Forum* (Lecture Notes in Business Information Processing, Vol. 361, pp. 280-295). Springer. [https://doi.org/10.1007/978-3-030-30429-4\\_19](https://doi.org/10.1007/978-3-030-30429-4_19)
- Jurčević, B., & Žaja, M. M. (2013). Banks and insurance companies efficiency indicators in the period of financial crisis: The case of the Republic of Croatia. *Economic research-Ekonomska istraživanja*, 26(1), 203-224. <https://doi.org/10.1080/1331677X.2013.11517598>
- Kaffash, S., Azizi, R., Huang, Y., & Zhu, J. (2020). A survey of data envelopment analysis applications in the insurance industry 1993-2018. *European Journal of Operational Research*, 284(3), 801-813. <https://doi.org/10.1016/j.ejor.2019.07.034>
- Kelley, C., & Wang, K. (2021). *InsurTech: A Guide for the Actuarial Community*. Willis Towers Watson and Society of Actuaries. <https://www.soa.org/49bb46/global/assets/assets/files/resources/research-report/2021/insurtech-guide-community.pdf>
- Kirmizi, M., & Kocaoglu, B. (2023). Design features of digital transformation maturity models: A systematic literature analysis and future research directions. *Journal of Modelling in Management*, 19(2), 313-341. <https://doi.org/10.1108/JM2-11-2022-0271>
- Kruljac, Ž., & Knežević, D. (2019). Modeli digitalne zrelosti poduzeća – objašnjenje, pregled literature i analiza [Digital maturity models – explanation, literature review and analysis]. *Obrazovanje za poduzetništvo*, 9(2), 72-84. <https://hrcak.srce.hr/file/335175>
- Lanfranchi, D., & Grassi, L. (2021). Translating technological innovation into efficiency: The case of US public P&C insurance companies. *Eurasian Business Review*, 11(6), 565-585. <https://doi.org/10.1007/s40821-021-00189-7>

- Lanfranchi, D., & Grassi, L. (2022). Examining insurance companies' use of technology for innovation. *The Geneva Papers on Risk and Insurance – Issues and Practice*, 47, 520-537. <https://doi.org/10.1057/s41288-021-00258-y>
- Li, Z., Li, Y., & Zhang, W. (2021). Configuration analysis of influencing factors of operating efficiency based on fsQCA: Evidence from China's property insurance industry. *Chinese Management Studies*, 15(5), 1085-1103. <https://doi.org/10.1108/CMS-04-2020-0151>
- Lin, L., & Chen, C. C. (March, 2020). The promise and perils of InsurTech. *Singapore Journal of Legal Studies*, 115-142. <https://www.jstor.org/stable/27032603>
- Ma, Y. L., & Ren, Y. (2023). InsurTech – promise, threat or hype? Insights from stock market reaction to InsurTech innovation. *Pacific-Basin Finance Journal*, 80, 102059. <https://doi.org/10.1016/j.pacfin.2023.102059>
- McKinsey & Company. (2018). *Digital insurance in 2018: Driving real impact with digital and analytics*. <https://www.mckinsey.com/industries/financial-services/our-insights/digital-insurance-in-2018-driving-real-impact-with-digital-and-analytics>
- Medved, D., & Kavčič, S. (2012). An empirical study of efficiency in Croatia and Slovenia insurance markets. *Economic research – Ekonomska istraživanja*, 25(1), 87-98. <https://doi.org/10.1080/1331677X.2012.11517496>
- Naujoks, H., Mueller, F., & Kotalakidis, N. (2020). *Digitalization in insurance: The multibillion dollar opportunity*. Bain & Company. [https://www.bain.com/content/assets/4579389b9c134f03919cf840a5e7559e/bain\\_brief\\_digitalization\\_in\\_insurance\\_the\\_multibillion\\_dollar\\_opportunity.pdf](https://www.bain.com/content/assets/4579389b9c134f03919cf840a5e7559e/bain_brief_digitalization_in_insurance_the_multibillion_dollar_opportunity.pdf)
- Ochoa-Urrego, R. L., & Pena-Reyes, J. I. (2021). Digital maturity models: A systematic literature review. In D. R. A. Schallmo & J. Tidd (Eds.), *Digitalization approaches, case studies, and tools for strategy, transformation and implementation* (pp. 77-85). Springer. [https://doi.org/10.1007/978-3-030-69380-0\\_5](https://doi.org/10.1007/978-3-030-69380-0_5)
- Ostrowska, M. (2021). Does new technology put an end to policyholder risk declaration? The impact of digitalisation on insurance relationships. *The Geneva Papers on Risk and Insurance – Issues and Practice*, 46, 573-592. <https://doi.org/10.1057/s41288-020-00191-6>
- Pallant, J. (2020). *SPSS survival manual: A step by step guide to data analysis using IBM SPSS*. McGraw-Hill Education. <https://doi.org/10.4324/9781003117452>
- Pervan, M., Čurak, M., & Pavić Kramarić, T. (2021a). Has accession to the European Union affected the efficiency of Croatian insurance companies? *Zagreb International Review of Economics and Business*, 24(1), 67-98. <https://doi.org/10.2478/zireb-2021-0004>
- Pervan, M., Čurak, M., & Pavić Kramarić, T. (2021b). A comparative analysis of the efficiency of life and non-life sectors in selected CEE countries. *Ekonomski vjesnik/Econviews – Review of Contemporary Business, Entrepreneurship and Economic Issues*, 34(2), 279-290. <https://doi.org/10.51680/ev.34.2.3>

- Röglinger, M., & Pöppelbuß, J. (2011). What makes a useful maturity model? A framework of general design principles for maturity models and its demonstration in business process management. *Proceedings of the 19th European Conference on Information Systems*, 28. European Research Center for Information Systems (ERCIS), University of Münster. <https://fim-rc.de/Paperbibliothek/Veroeffentlicht/327/wi-327.pdf>
- Sheng, C., Kottman, D., Kang, L., Prestinari, I., Jiang, X., Chen, W., & Li, X. (2017). *Technology-driven value generation in insurance* (Industry Report). Oliver Wyman. [https://www.oliverwyman.com/content/dam/oliver-wyman/v2/publications/2017/jun/Technology\\_Value\\_Driven\\_o6.pdf](https://www.oliverwyman.com/content/dam/oliver-wyman/v2/publications/2017/jun/Technology_Value_Driven_o6.pdf)
- Škrinjarić, T. (2016). Analiza relativne efikasnosti industrije osiguranja europskih zemalja korištenjem analize omeđivanja podataka. [Relative efficiency of industry insurance in Europe: Data envelopment analysis approach]. *Ekonomski pregled*, 67(1), 3-26. <https://hrcak.srce.hr/file/227980>
- Sprenić, M. (2020). *Digitalna transformacija poslovanja* [Business digital transformation]. Faculty of Economics and Business, University of Zagreb.
- Teichert, R. (2019). Digital transformation maturity: A systematic review of literature. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 67(6), 1673-1687. <https://doi.org/10.11118/actaun201967061673>
- Učkar, D., & Petrović, D. (2022). Efficiency of insurance companies in Croatia. *Ekonomika Misao i Praksa*, 31(1), 49-79. <https://hrcak.srce.hr/file/403499>
- VanBoskirk, S., Gill, M., Green, D., Swire, J., Birrell, R., & Berman, A. (2017). *The Digital Maturity Model 5.0*. Forrester. <https://www.forrester.com/report/The-Digital-Maturity-Model-50/RES136841>