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# E-Invoice Adoption in the Czech Republic (Forms, Exchange Channels, and Formats)

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## Abstract:

The e-invoicing market is experiencing growth propelled by the global trend towards digitalization and automation. This paper aims to assess the status of e-invoice usage in the Czech Republic in the context of recorded usage trends, with a particular emphasis on whether the formats most widely used are suitable for automated processing. The research is based on both primary data obtained from 258 Czech companies and secondary data sourced from the Czech Statistical Office. Our data have shown that 63.19% of invoices are sent electronically compared to 36.81% in a hard copy. Among invoices exchanged electronically, 1.23% were downloaded from a supplier's system, 58.36% were exchanged via email in a non-structured format, 3.07% in a structured format, and finally, only 0.52% were sent through the official data box, endorsed by the Czech government. Surprisingly, a downward trend regarding machine-readable invoicing was identified in the available data. For data analysis, linear regression, confidence interval and descriptive statistics were used.

**Keywords:** e-invoice; machine-readable; digitalization of accounting; digitalization of invoices; automation of accounting.

**JEL Classification:** M0; M41; M48

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## 1. Introduction

Electronic invoicing or e-invoicing can be defined as an information system service that gathers data from a business transaction and transmits it through a network (Lian, 2015). Thus, it is a digital approach which involves creating, sending, receiving, and processing invoices among businesses. In contrast to traditional paper-based invoicing, which involves physical documents, e-invoicing relies on electronic formats and allows automated systems to partially or fully manage the invoicing process.

Both manufacturing and non-manufacturing businesses shall '*apply lean concepts across all organizational functions*' (Zemanová & Slavík, 2016) in order to streamline operations and boost efficiency. Alongside global trends toward digitalization and automation, traditional paper-based invoicing is supposed to be gradually substituted with quicker, more precise, and cost-effective electronic alternatives. The concept of e-invoicing arises as a contemporary, dependable, and effective approach for managing and processing invoices related to products, services, taxes, and various goods, eliminating the necessity for paper (Matus et al., 2017). The ongoing digital transformation initiatives within businesses involving key

processes such as resources management, stock management and production are contributing to the adoption of e-invoicing as part of broader digitization efforts. For example, e-invoicing may be aligned with automated payment control and payment processing solutions (Sungkur et al., 2016).

In addition to time and cost savings, e-invoicing supports privacy, security, reliability, and resolution of potential disputes (Sungkur et al., 2016), authentication, content integrity, non-repudiation of origin and receiver, confidentiality and privacy, sequence integrity, and relevant policies (Cuylen et al., 2016). Increased accuracy and reliability of invoicing contributes to trust among stakeholders. As companies expand their operations across borders, the inefficiencies, delays and other limitations of traditional paper-based invoicing become even more evident (Abidin et al., 2016). E-invoicing facilitates seamless and real-time exchange of invoices between international partners, thus helping overcome geographical barriers. The emphasis on cloud-based solutions, mobility, and remote work is further highlighting the necessity for electronic and interconnected invoicing processes. E-invoicing is becoming an important technology in facilitating faster and more efficient financial transactions within increasingly interconnected business environments.

Both businesses (Olaleye & Sanusi, 2019) and the public sector (Fuka & Bařa, 2022) are acknowledging the environmental impact of paper-based processes, including resource consumption and waste generation. As a result, the growing emphasis on sustainability and environmental responsibility is also contributing to the expansion of the e-invoicing market.

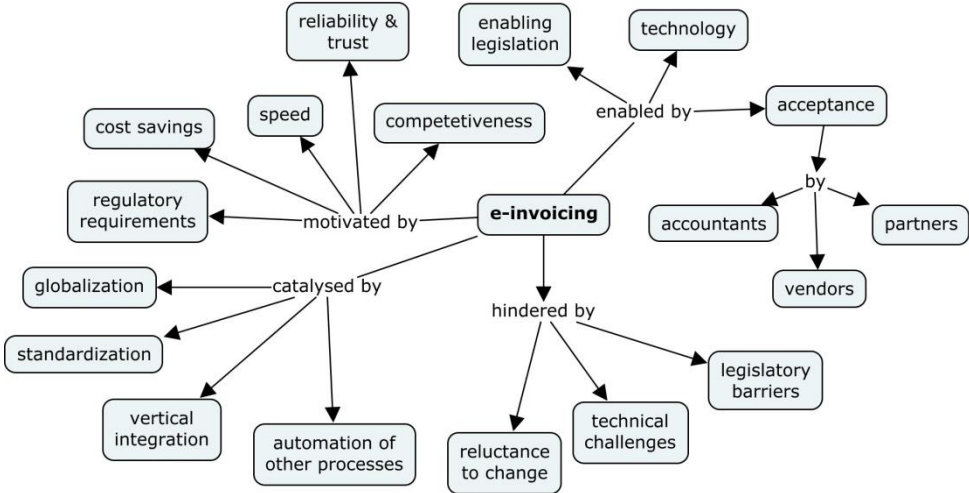
Since e-invoices may serve as a tax collection and reporting instrument, numerous governments and regulatory bodies are encouraging or mandating businesses to adopt electronic invoicing primarily to combat tax evasion, mitigate fraud, and enhance overall financial transparency. For example, automated electronic systems are being deployed for value-added tax (VAT) reporting (Zorina et al., 2022). As more convenient, integrated, transparent, and fast such tax reporting systems made tax collection and tax administration more effective and efficient (Wagiman et al., 2023). Related regulations may serve as catalysts for the whole e-invoicing market, compelling businesses to embrace e-invoicing to maintain compliance and avoid potential penalties (Nalcaci, 2016).

In an e-invoicing system, invoices are electronically generated and can be transmitted to recipients through various digital channels, such as email, online portals, or electronic data interchange (EDI) systems. These invoices follow standardized formats, enabling seamless integration with accounting software, enterprise resource planning (ERP) systems, and other financial management tools. Software tools created to support e-invoicing are gradually available in various countries (Pugliese et al. 2021; Rubio and Gaitan, 2021; Pinheiro & Frega, 2016).

The ongoing digital revolution and swift progress in technologies and concepts such as industry 4.0, cloud computing, artificial intelligence (AI) and machine learning (ML) are further reshaping the landscape of the e-invoicing market. Advanced automation technologies incorporated into e-invoicing platforms may fundamentally streamline and optimize the entire invoicing process (Azman et al., 2021). These technologies facilitate the extraction of pertinent information from invoices, validation of data accuracy, and even

prediction of potential discrepancies. Blockchain and digital ledger technologies (DLT), capable to offering secure and immutable records of transactions, are being examined in the context of e-invoicing, to ensure data integrity and diminish the risk of fraud (Narayanam et al., 2020; Liu, 2018). Computational fraud-detecting methods such as Benford Analysis may be integrated in e-invoicing systems (Nalcaci, 2017). Advanced automated systems may sieve correct invoices reasonably accurately e.g. by Chang et al. (2020) whose system demonstrated sensitivity above 95%.

Despite its positive effects such as automation of routine processes, time and savings, teamwork, information sharing and simplicity, e-invoicing adoption face challenges such as conservatism and resistance, (overly) fast technological progress, insufficient legislation, disrupting impacts on labor market, or issues related to document conversions (Stefanovova et al., 2020). Because of the multi-criteria nature of reasoning about complex data such as an invoice, user-friendly interface and visualization of data processing results of an automated invoicing solution are vital prerequisites of its adoption (Sedlák et al., 2015). The e-invoicing landscape has been visualized as a conceptual map (Fig 1).



**Figure 1.** Conceptual map of the e-invoicing landscape from the perspective of a business owner;  
Source: authors, using CmapTools

In 2009, ISDOC (Information System Data Object Content) was declared a standardized format of invoices (electronic tax documents) in the Czech Republic, replacing various proprietary formats. As a free-to-use format, it allows the transmission of tax documents among parties, including small businesses and self-employed individuals, without additional costs. ISDOC complies with Czech VAT law requirements and may include a qualified electronic signature, issued by a qualified certification authority, allowing easy verification of the authenticity of the document.

ISDOC documents can be exchanged via various channels, such as by an email or a government-endorsed data box (Digital and Information Agency, 2023), made downloadable over the Internet, or even on physical storage media. Current versions of ISDOC format mostly follow an internationally recognized e-invoice format UBL, adjusted mainly to reflect Czech specifics, such as the tax advance payment list. Besides the standard

tax invoice, ISDOC offers 5 additional document types; however, it does not support related types of documents such as orders or receipts.

Technically, ISDOC is in XML format with a signature implemented according to the XML Signature standard. The structured invoice file name in ISDOC format usually ends with a *.isdoc* extension and is readable by an ISDOC reader software. Commonly a printable and human-readable version of the invoice, which may carry the visual identity of the issuing party, is shared together with ISDOC, either as a separate PDF file or in a hybrid invoice file format. The first hybrid file format is ISDOCX, technically an ISDOC together with PDF and other possible attachments compressed in a ZIP archive with *.isdocx* extension, which is a similar approach as for OpenDocument (e.g., *.odt*) and Office Open XML (e.g., *.docx*). A slightly newer approach makes use of PDF A/3 format, where ISDOC is directly embedded in a PDF file, directly readable by any PDF reader. Though not as versatile as ISDOCX, ISDOC in PDF A/3 is gaining popularity, possibly for its user-friendliness.

The strive for process efficiency both in the private and public sector, globalization challenges, and environmental concerns, together with advancement in relevant enabling technologies, such as cloud computing, digital signing, AI and ML are among the factors in the uptake of e-invoicing. The paper evaluates the use of e-invoices in the Czech Republic in the context of past development. Therefore, a hypothesis is established: in the monitored years, there is no development in the use of e-invoices. Furthermore, it assesses whether these formats allow automated processing or not.

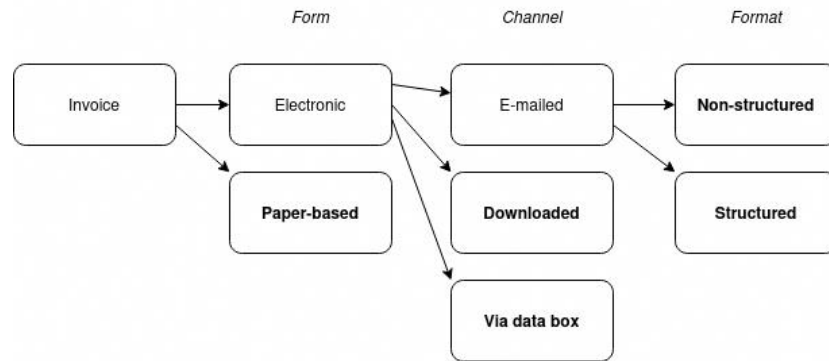
## **2. Data and methodology**

The research is based on both secondary data from the Czech Statistical Office (2013; 2014; 2015; 2016; 2017; 2019; 2020) and primary data from our own research. Linear interpolation was used to fill in the missing years in the Czech Statistical Office data series. Other available relevant studies were used to compare our results (EY, 2019; Koch, 2020). As above mentioned, hypothesis is established: in the monitored years, there is no development in the use of e-invoices. This hypothesis will be confirmed or refuted by the Friedman test (Friedman, 1937). The Friedman test is a non-parametric statistical test developed by Milton Friedman. Similar to the parametric repeated measures ANOVA, it is used to detect differences in treatments across multiple test attempts. The Friedman test is widely supported by many statistical software packages and generally used.

Primary data collection was necessary due to the absence of secondary data covering years beyond 2021. The primary research in the field of invoice formats in the B2B sector involved 258 Czech companies with 10 or more employees. The sample of companies was obtained by randomly selecting companies from the entire Czech Republic through students of the Faculty of Economics and Administration during the autumn 2023.

At first, the invoices were classified according to their form as paper-based or electronic; electronic invoices were classified according to the exchange channel as downloaded from a supplier's system, sent via an official data box, referred to also as a data locker, or via email; invoices sent via email were classified according to the format used as structured or non-structured (Fig 2). Since the share of invoices delivered via data box or downloaded from a

supplier's system was negligible, the format of invoices delivered via these two channels was not determined.



**Figure 2.** Form, channel, and format classification system with resulting used categories highlighted;  
Source: authors, using drawio.com

The final classification system consisted of lists of the classification graph (Fig. 1):

1. Invoices in paper-based form (hard copy),
2. Electronic, downloaded through the supplier's application,
3. Electronic, sent through an official data box,
4. Electronic, sent via email, only in a non-structured format, such as *.pdf* (not PDF A/3) or *.docx*, *.doc*, *.odt*, *.tif*, *.jpeg*, *.png*;
5. Electronic, sent via email, in a format containing structured data, suitable for automatic processing such as *.edi*, *.xml*, *.csv*, *.json*, or the aforementioned *.isdoc* and its variants (*.isdox*, *.pdf* with ISDOC in its PDF A/3 extension).

After calculating descriptive statistics on our dataset, linear regression analysis has been conducted in Statistica Software. The confidence interval  $\pi$  for the empirical study was determined according to Pacáková (2003):

$$P\left(p - z_{1-\frac{\alpha}{2}} * \sqrt{\frac{p(1-p)}{n}} < \pi < p + z_{1-\frac{\alpha}{2}} * \sqrt{\frac{p(1-p)}{n}}\right) = 1 - \alpha \quad (1)$$

where:

- $p$  – found frequencies of forms of sending invoices in percentages,
- $n$  – the size of the base  $\pi$  (the number of companies in the data sample),
- $\alpha$  – determined at the level of 5%.

### 3. Results

We have divided the research into a part dealing with the invoice forms and exchange channels and a part dealing with invoice formats (structured vs. non-structured).

#### 3.1. Forms of invoices and exchange channels

Our research has shown that 63.19% of invoices are sent electronically and 36.81% of invoices are sent in hard copy, delivered either in person or by post. The invoices sent electronically contain both structured and non-structured formats. The predominant usage of electronic form of invoices matches the results of other relevant available studies (Czech Statistical Office, 2016; EY, 2019; Koch, 2020), see Tab 1.

**Table 1.** Forms of sending invoices

Form	Czech Statistical Office (2016)	EY (2019)	Koch (2020)	Own research (2023)	Own research (2023) - confidence interval $\pi$
Paper	23.10%	32%	30%	36.81%	(30.92; 42.70)
Electronic	76.90%	68%	70%	63.19%	(57.30; 69.08)
$\Sigma$	100.00%	100%	100%	100%	x

Although the results seem positive, a large proportion of companies use the paper form, possibly alongside an electronic delivery (Tab 2). It might be due to the legislative regulation in Czechia which requires the customer's prior consent to electronic form of invoice. For 2016 a dataset with a different structure was available (Czech Statistical Office, 2016), showing the paper-only form of invoicing with a weighted average of 23.1% among all sectors (Tab 2).

**Table 2.** Companies that also send invoices in paper form (%)

Sector – CZ NACE	2015	2016 <sup>1</sup>	2017	2018 <sup>2</sup>	2019 <sup>2</sup>	2020	Trend <sup>3</sup>
C (10–33) Manufacturing industry	65.4	18.7	87.9	85.5	83.0	80.5	Decline
D. E (35–39) Energy	64.6	19.0	88.0	90.9	93.8	96.7	Growth
F (41–43) Building industry	55.7	29.4	96.9	93.4	89.8	86.3	Decline
G (45–47) Wholesale and retail sale; Repair and maintenance service of motor vehicles	63.0	20.9	90.8	87.7	84.5	81.4	Decline
H (49–53) Transport and storage	48.8	40.7	91.7	90.9	90.1	89.3	Moderate decline
I (55–56) Accommodation, Food and Beverage	45.0	30.2	87.6	82.5	77.4	72.2	Decline
J (58–63) Information and commun. activities	65.7	10.6	78.3	73.4	68.4	63.4	Decline
L (68) Real Estate Activities	46.6	32.4	90.2	88.3	86.5	84.6	Decline
M (69–75) Scientific and technical activities	62.1	18.3	88.5	85.3	82.2	79.0	Decline
N (77–82) Administrative and support activities	58.1	23.7	75.6	76.1	76.5	77.0	Moderate growth
Total (weighed average)	60.0	23.1	88.8	86.1	83.4	80.8	Decline

<sup>1</sup>Companies sending paper-only invoices. <sup>2</sup>Values determined by linear interpolation from 2018 and 2020.

<sup>3</sup>Linear trend determined from values over the last 4 years.

In the case of the form of sending invoices via official data boxes, the Czech Statistical Office data do not distinguish structured or non-structured formats. The advantage of using government-endorsed data boxes is increased confidence in the authenticity of the sender (invoice issuer) and the integrity of the invoice contents. However, their use is rather negligible (Tab 3).

**Table 3.** Companies sending invoices via data boxes (v %)

Sector – CZ NACE	2013	2014	2015	2016	2017	2018 <sup>1</sup>	2019 <sup>1</sup>	2020	Trend <sup>2</sup>
C (10–33) Manufacturing industry	1.8	2.5	2.9	4.9	4.7	4.8	5.0	5.1	Decline
D. E (35–39) Energy	4.9	7.3	3.8	10.6	6.5	8.4	10.4	12.3	Growth
F (41–43) Building industry	1.6	3.8	1.7	5.9	7.8	8.1	8.5	8.8	Moderate growth
G (45–47) Wholesale and retail sale; Repair and maintenance service of motor vehicles	2.1	2.7	3.0	4.0	6.2	5.3	4.3	3.4	Decline
H (49–53) Transport and storage	2.5	2.6	2.8	3.5	3.8	4.4	5.0	5.6	Growth
I (55–56) Accommod., Food and Beverage	2.2	3.9	2.0	6.5	7.5	6.6	5.7	4.7	Decline
J (58–63) Information and comm. activities	6.3	8.1	9.0	12.1	15.2	14.4	13.7	13.0	Decline
K (64–66) Banking and Insurance	5.4	4.0	3.0	5.3	7.4	6.9	6.3	5.7	Decline

L (68) Real Estate Activities	3.8	7.4	8.4	9.9	16.9	15.0	13.1	11.2	Decline
M (69–75) Scientific and technical activities	1.7	3.8	3.6	4.6	7.7	8.2	8.6	9.1	Growth
N (77–82) Administrative and support act.	2.3	3.5	3.4	5.6	7.2	6.9	6.6	6.4	Decline
Total (weighed average)	1.8	2.5	2.9	4.9	4.7	4.8	5.0	5.1	Decline

<sup>1</sup>Values determined by linear interpolation. <sup>2</sup>Linear trend determined from values over the last 4 years.

### 3.2. Formats of sending of invoices

Surprisingly, the usage of structured invoice formats (i.e., *.edi*, *.xml*, *.csv*, *.json*, *.isdoc*) suitable for automatic processing has declined over the years 2013–2020 among most sectors (Fig 3, Tab 4), except CZ NACE Manufacturing and distribution of energy, gas, water, heat, and related waste management activities – D, E (35–39). Conversely, usage of either paper invoices or electronic invoices in non-structured formats (i.e., *.docx*, *.doc*, *.odt*, *.tif*, *.jpeg*, *.png*, *.pdf* which is not a PDF A/3) must have increased among most sectors.

**Table 4.** Companies sending invoices in automated data processing format (%)

Sector – CZ NACE	2013	2014	2015	2016	2017	2018 <sup>1</sup>	2019 <sup>1</sup>	2020	Trend <sup>2</sup>
C (10–33) Manufacturing industry	13.2	14.7	15.6	21.8	15.4	15.3	15.2	15.0	Decline
D, E (35–39) Energy	11.0	8.7	10.8	20.8	10.4	10.6	10.8	11.0	Growth
F (41–43) Building industry	6.9	5.8	5.2	13.9	6.5	5.7	5.0	4.2	Decline
G (45–47) Wholesale and retail sale; Repair and maintenance service of motor vehicles	15.5	17.7	16.6	22.4	22.1	20.5	19.0	17.5	Decline
H (49–53) Transport and storage	8.0	7.5	9.5	13.5	11.1	10.9	10.7	10.5	Decline
I (55–56) Accommodation, Food and Beverage	7.1	7.5	8.9	13.7	9.2	8.3	7.3	6.4	Decline
J (58–63) Information and comm. activities	14.1	15.1	13.9	23.4	16.9	16.7	16.4	16.2	Decline
K (64–66) Banking and Insurance	7.9	9.0	x	x	x	x	x	x	x
L (68) Real Estate Activities	5.4	6.8	7.7	8.3	6.4	5.8	5.1	4.5	Decline
M (69–75) Scientific and technical activities	7.7	9.3	11.7	11.5	13.2	11.9	10.6	9.4	Decline
N (77–82) Administrative and support act.	9.1	11.1	12.9	15.8	11.4	11.0	10.5	10.0	Decline
Total (weighed average)	11.3	12.5	12.9	18.4	14.4	13.7	12.9	12.2	Decline

<sup>1</sup>Values determined by linear interpolation. <sup>2</sup>Linear trend determined from values over the last 4 years.

The latest recorded weighted average of use of ISDOC, a standardized and dominant e-invoicing format in Czechia, for issuing invoices (Czech Statistical Office, 2020) is 5% with a noticeable downward (Tab 5). These data are tested with the statistical Friedman test, which is used to verify the hypothesis: in the monitored years, there is no development in the use of e-invoices. The tested criterion was found to have a value of 35.04, with a critical limit of 9.49. It follows from this that individual years differ statistically, i.e., that we reject the null hypothesis. From this it can be deduced that a downward trend is observed across sectors.

**Table 5.** Average share of e-invoices sent by companies in a standardized format in the total number of issued invoices (%)

Sector – CZ NACE	2016	2017	2018 <sup>1</sup>	2019 <sup>1</sup>	2020	Trend <sup>2</sup>
C (10–33) Manufacturing industry	9.6	6.3	6.5	6.7	6.9	Moderate growth
D, E (35–39) Energy	5.9	4.1	4.2	4.4	4.5	Moderate growth
F (41–43) Building industry	5.0	2.8	2.1	1.5	0.8	Decline
G (45–47) Wholesale and retail sale; Repair and maintenance service of motor vehicles	9.4	7.1	6.7	6.2	5.7	Decline
H (49–53) Transport and storage	3.9	4.4	4.0	3.7	3.3	Decline

I (55–56) Accommodation, Food and Beverage	5.1	3.8	3.6	3.3	3.1	Decline
J (58–63) Information and communication activities	14.4	8.6	8.6	8.6	8.6	Stagnation
L (68) Real Estate Activities	4.7	2.1	1.9	1.8	1.6	Decline
M (69–75) Scientific and technical activities	7.2	4.6	4.5	4.4	4.2	Decline
N (77–82) Administrative and support activities	7.9	6.6	6.2	5.9	5.5	Decline
Total	8.0	5.6	5.4	5.2	5.0	Decline

<sup>1</sup>Values determined by linear interpolation. <sup>2</sup>Linear trend determined from values over the last 4 years.

Since official statistics on electronic invoice usage for years 2021+ are not available, primary research was carried out with a focus on forms of invoices, the exchange channels and their format (structured vs. non-structured), see Tab 6.

**Table 6.** Forms, exchange channels and formats of invoices in the Czech Republic in 2023

Category <sup>1</sup>	Modus	Q1	Median	Q3	Min	Max	Average
1. paper	30	27	37	55	9	84	36.81%
2. download	0	0	1	3	0	10	1.23%
3. non-s. email	57	49	59	78	9	90	58.36%
4. s. email	0	0	2	7	0	17	3.07%
5. databox	0	0	0	1	0	7	0.52%

<sup>1</sup>1. Paper-based invoice forms. 2. Electronic invoice forms downloaded through the supplier's application. 3. Electronic invoice forms sent via email in an unstructured format 4. Electronic invoice forms sent via email in a structured format 5. Electronic invoices sent through an official data box; Source: authors

Non-structured formats include paper-based (1) and sent via email in a non-structured format (3). Since the share of invoices downloaded through the supplier's application (2) and invoices delivered through a data box (5) were found negligible, their format (structured or non-structured) was not distinguished. The share of invoices are sent via e-mail in a structured format (4) was only 3.07%.

#### 4. Discussion

E-invoicing has many notable advantages such as facilitating overall invoicing process optimization (Matus et al., 2017; Zemanová & Slavík, 2016). Potential billing cost savings have been demonstrated e.g. by Cedillo et al. (2018) who calculated the drop from €8.60 (paper form), through €2.11 (scanned), to €1.89 (e-invoice). E-invoicing may be connected with other automated systems such as for payment processing (Sungkur et al., 2016) or tax reporting (Nalcaci, 2016; Wagiman et al., 2023; Zorina et al., 2022). It may ensure authenticity and data integrity, thus diminishing the risk of fraud (Cuylen et al., 2016; Narayanam et al., 2020; Liu, 2018; Nalcaci, 2017; Chang et al., 2020) and reducing environmental impacts (Olaleye & Sanusi, 2019; Fuka & Bařa, 2022). The advantages are further highlighted for globalized businesses (Abidin et al., 2016). E-invoicing may go beyond simple data exchange thanks to promising relevant AI and ML technologies (Azman et al., 2021).

In the Czech environment, sending invoices via official data boxes has additional advantages, namely guaranteed authenticity and integrity. At the same time, it is a possible and somehow preferred way to comply with the obligation to submit invoices in electronic form, which applies to trading with state entities. However, this obligation applies only to

business entities defined by § 31 paragraph 2 letter a) of Act No. 235/2004 of the collection, on value-added tax. Sending B2B invoices via official data boxes is not free of charge, however. Though cheaper than postal services, the cost of 10 CZK per message may still discourage businesses which issue large quantities of invoices. Technical aspects of data boxes may prove as barriers of use for small non-tech businesses. A good prerequisite for the broader adoption of e-invoicing in structured form in Czechia is rather the prevalent use of e-mail as the most common channel for invoicing (EY, 2019). Important is the availability of a standardized format of electronic invoice (ISDOC), supported to a certain degree by most ERP systems currently used in Czechia.

Despite the technological prerequisites, only around 3% of invoices in Czechia are exchanged in a structured, machine-readable format. Similarly, only 2% of respondents received structured electronic invoices in Poland in 2018 and their awareness and readiness to implement electronic invoicing was considerably low (Dobrzyniecka, 2018). Not only that the current level of e-invoice adoption in Czechia is low, but the research indicated a decreasing trend in sending electronic invoices in Czechia. In 2019, the share of electronic invoices in the total number of invoices among businesses in the Czech Republic was 32%, which was above the European average of 25% (EY, 2019). The survey also indicated that 57% of Czech companies planned to increase the share of electronic invoices in the next three years, which neither our survey nor other data confirmed. The share of electronic invoices in the total number of business-to-business (B2B) and business-to-government (B2G) invoices issued in the Czech Republic in 2020 was about 30%, which is slightly above the European average of 27% (Koch, 2020). Thus, the remaining 70% of invoices were in paper form. While the survey of the Czech Statistical Office showed a share of 76.9% in 2016, our current research indicates a decrease to 63.19%.

If true, the downward trend in e-invoicing in Czechia is not just surprising, but even alarming, given the ongoing automation and digitization of the whole society, and the availability of relevant technology. Slow adoption of automation in invoicing (or even de-automation, as indicated by the trends) might affect the competitiveness of the Czech economy. Croatia may serve as an interesting use case for comparison and inspiration, where bolder normative acts which regulate the use of electronic signatures and issuance of e-invoices were adopted a few years ago. Decman et al. (2019) analysed the state and trends in the digitalization of accounting and tax processes in the country; the research methodology included secondary research of relevant literature as well as primary desk research. Sources of inspiration may be found far beyond Europe, such as in Brazil, where successful adoption of e-invoicing was reported years ago (Pinheiro & Frega, 2016).

To find out the reasons behind the disappointing trend in Czechia, to predict to which extent and how quickly will businesses adopt e-invoicing and automated e-invoice processing, or how to support the adoption either legislatively or technically, subsequent research will have to follow. Known barriers to e-invoice adoption, such as the accounting technicians do not know them and do not want to use them or technical limitations of e-invoice import functions of current ERPs (Stefanovova et al., 2020) will have to be

considered. The limited adoption of structured-format invoices might also be attributed to the following two factors.

Firstly, for the purpose of potential scrutiny by tax authorities, maintaining data integrity is crucial, a guarantee achievable only through an electronic signature or the use of official data boxes. There is no recent substantial change in Czech legislation on this matter which would follow either the technological advancements or legislative development in Europe and beyond. Czech legislation doesn't specifically mandate accounting entities to archive or exchange certain documents in digital form, such as those related to transactions above a certain value. However, it does impose requirements on maintaining the so-called immutability of electronic copies of documents and ensuring their conformity with the original. Limited durability of qualified electronic signatures may be an issue. Secondly, in accordance with prevailing legislation, the recipient must provide consent for electronically transmitted invoices, making further artificial barriers to broader e-invoice adoption. A significant shift toward the digitalization and automation of invoicing and accounting practices in Czechia will possibly have to be dictated by European directives.

## 5. Conclusions

As a main takeout of the research, e-invoicing allowing automated processing is underutilized in Czechia. Although ISDOC is a standardized format endorsed by the government and most current ERPs in Czechia can both issue and import it, only approximately 3% of invoices are currently issued in ISDOC or any other structured machine-readable format. Worryingly, the trend in adoption of e-invoicing in Czechia is rather downward, as indicated by various data sources and according to result of the tested hypothesis. With low numbers of invoices issued in structured formats, automated importing of machine-readable invoices is not commonplace.

The low share of invoices in a structured format might partly be attributed to the Czech legislation which states that for the purpose of tax office control, integrity of invoice data has to be ensured. Invoice integrity can only be guaranteed through an electronic signature or using official data boxes and neither of the options is free of disadvantages. Also, according to outdated legislation, the recipient must consent to electronically delivered invoices, forming an additional barrier to e-invoice adoption. Other reasons may be rather technical, such as the rather low quality of e-invoice import functions in current ERPs which are not user-friendly and comprehensive enough, or psychological, such as the resistance of accounting technicians. Further research might analyze more in detail both the reasons and potential solutions.

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## References

Abidin, T. F., Riyanda, F., & Dawood. R. (2016). Pembaruan Aplikasi Paperless Office Universitas Syiah Kuala. *Jurnal Rekayasa Elektrika*. 12(1). 16-20.<https://doi.org/10.17529/jre.v12i1.3246>

- Azman, N. A., Mohamed. A., & Jamil, A. M. (2021). Artificial intelligence in automated bookkeeping: a value-added function for small and medium enterprises. *JOIV: International Journal on Informatics Visualization*. 5(3). 224-230. <http://dx.doi.org/10.30630/joiv.5.3.669>
- Cedillo, P., García. A., Cárdenas, J. D., & Bermeo, A. (2018). A systematic literature review of electronic invoicing, platforms and notification systems. In *2018 International Conference on eDemocracy & eGovernment (ICEDEG)* (pp. 150-157). IEEE. <https://doi.org/10.1109/ICEDEG.2018.8372338>
- Chang, W. T., Yeh, Y. P., Wu, H. Y., Lin. Y. F., Dinh, T. S., & Lian, I. B. (2020). An automated alarm system for food safety by using electronic invoices. *Plos one*. 15(1). <https://doi.org/10.1371/journal.pone.0228035>
- Cuylen, A., Kosch, L., & Breitner, M. H. (2016). Development of a maturity model for electronic invoice processes. *Electronic markets*. 26(2). 115-127. <https://doi.org/10.1007/s12525-015-0206-x>
- Czech Statistical Office. (2013). *Electronic invoice*. [Data set]. Retrieved October 31, 2023, from [https://www.czso.cz/csu/czso/9702-13-r\\_2013-22641](https://www.czso.cz/csu/czso/9702-13-r_2013-22641)
- Czech Statistical Office. (2014). *Electronic invoice*. [Data set]. Retrieved October 31, 2023, from <https://www.czso.cz/csu/czso/elektronicka-fakturace5283>
- Czech Statistical Office. (2015). *Electronic invoice*. [Data set]. Retrieved October 31, 2023, from [https://www.czso.cz/csu/czso/elektronicka-fakturace\\_](https://www.czso.cz/csu/czso/elektronicka-fakturace_)
- Czech Statistical Office. (2016). *Electronic invoice*. [Data set]. Retrieved October 31, 2023, from <https://www.czso.cz/csu/czso/elektronicka-fakturace-c78ekqh0g6>
- Czech Statistical Office. (2017). *Electronic invoice*. [Data set]. Retrieved October 31, 2023, from <https://www.czso.cz/csu/czso/elektronicka-fakturace1>
- Czech Statistical Office. (2019). *Electronic invoice*. [Data set]. Retrieved October 31, 2023, from <https://www.czso.cz/csu/czso/elektronicka-fakturace-jgc3eqd5ss>
- Czech Statistical Office. (2021). *Electronic invoice*. [Data set]. Retrieved October 31, 2023, from <https://www.czso.cz/csu/czso/elektronickafakturace>
- Decman, N., Mališ, S. S., & Sacer, I. M. (2019). Digitalization of Accounting and Tax Processes-Challenges and Opportunities for Accountants and Tax Administrators. In *Proceedings of FEB Zagreb International Odyssey Conference on Economics and Business*. 1(1). 30-40.
- Digital and Information Agency (2023). *Data boxes*. [Website]. Retrieved October 31, 2023, from <https://info.mojedatovaschranka.cz/info/cs/>
- Dobrzyniecka, E. (2018). The level of electronic invoicing in public procurement in Poland. *E-MENTOR*. 3. 72-79.
- EY. (2019). *EY e-invoicing survey 2019: The state of e-invoicing in the Czech Republic*. [https://www.ey.com/Publication/vwLUAssets/EY-e-invoicing-survey-2019/\\$FILE/EY-e-invoicing-survey-2019.pdf](https://www.ey.com/Publication/vwLUAssets/EY-e-invoicing-survey-2019/$FILE/EY-e-invoicing-survey-2019.pdf)
- Friedman, M. (1937). The use of ranks to avoid the assumption of normality implicit in the analysis of variance. *Journal of the American Statistical Association*. 32(200). 675-701.
- Fuka, J., & Bařa, R. (2022). The role of public sector policy in sustainable energy efficiency: an application of dynamic modelling. *Territory, Politics, Governance*. „published online“ <https://doi.org/10.1080/21622671.2022.2055630>
- Koch, B. (2020). *E-Invoicing / E-Billing International Market Overview & Forecast electronic invoicing billing electronic tax reporting*. Billentis. [https://www.billentis.com/einvoicing\\_ebilling\\_market\\_overview\\_2020.pdf](https://www.billentis.com/einvoicing_ebilling_market_overview_2020.pdf)
- Lian, J. W. (2015). Critical factors for cloud based e-invoice service adoption in Taiwan: An empirical study. *International Journal of Information Management*. 35(1). 98-109. <https://doi.org/10.1016/j.ijinfomgt.2014.10.005>
- Liu, X. (2018). Research and application of electronic invoice based on blockchain. In *MATEC Web of Conferences*. 232. 4-12. <https://doi.org/10.1051/mateconf/201823204012>
- Matus, A., Guerra, E., Fuertes, W., Gómez, M., Aules, H., Villacís, C., & Toulkeridis, T. (2017). On the development of an electronic invoicing solution to integrate SMEs with a tax-collection e-government-platform. In *2017 Fourth International Conference on eDemocracy & eGovernment (ICEDEG)*. 94-101. <https://doi.org/10.1109/ICEDEG.2017.7962518>
- Nalcaci, I. G. (2016). Technical and communicational standards of e-invoicing: A Country Example: Turkey. In *2016 IEEE 10th International Conference on Application of Information and Communication Technologies (AICT)*. 1-4. <https://doi.org/10.1109/ICAICT.2016.7991785>
- Nalçaçı, İ. G. (2017). Implementation of Benford analysis for electronic invoice audit. In *2017 International Conference on Computer Science and Engineering (UBMK)*. 1036-1040. IEEE. <https://doi.org/10.1109/UBMK.2017.8093447>

- Narayanam, K., Goel, S., Singh, A., Shrinivasan, Y., Chakraborty, S., Selvam, P., & Verma, M. (2020). Blockchain based e-invoicing platform for global trade. In *2020 IEEE International Conference on Blockchain*. 385-392. <https://doi.org/10.1109/Blockchain50366.2020.00056>
- Olaleye, S. A., & Sanusi, I. T. (2019). The need for green companies in Nigeria: a study of electronic invoicing. *The African Journal of Information Systems*. 11(1). 1.
- Pacáková, V., Pardelová, R., Sodomová, E., & Šoltés, E. (2003). *Statistics for Economists*. Bratislava: Iura Edition.
- Pinheiro, L. P., & Frega, J. R. (2016). IT performance: a survey of e-invoicing in companies. In *22nd Americas Conference on Information Systems (AMCIS)*.
- Pugliese, L. D. P., Guerriero, F., Macrina, G., & Messina E. (2021). A natural language processing tool to support the electronic invoicing process in Italy. In *11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS.)* 1. 397-402. <https://doi.org/10.1109/IDAACS53288.2021.9660987>
- Rubio, E. D. L. F., & Gaitán, M. G. (2021). Libredte: Software tools and support for electronic invoicing in Chile. In *40th International Conference of the Chilean Computer Science Society (SCCC)*. 1-6. <https://doi.org/10.1109/SCCC54552.2021.9650391>
- Sedlák, P., Komárková, J., Hub, M., Struška, S., & Pásler, M. (2015). Usability Evaluation Methods for Spatial Information Visualisation - Case Study: Evaluation of Tourist Maps, In *Proceedings of the 10th International Conference on Software Engineering and Applications*, SCITEPRESS (Science and Technology Publications, Lda.), 419-425.
- Stefanovova, Z., Bartkova, H., & Peterkova, J. (2020). Evaluation of the effects of digitization in the process of accounting operations in a selected manufacturing company. In *SHS Web of Conferences*. 74. 2-16. <https://doi.org/10.1051/shsconf/20207402016>
- Sungkur, R. K., Gangabaksh, Y., & Rutah, N. (2016, August). Cloud-based cross-platform push notification system for more informed learners. In *2016 IEEE International Conference on Emerging Technologies and Innovative Business Practices for the Transformation of Societies (EmergiTech)*. 229-234. <https://doi.org/10.1109/EmergiTech.2016.7737344>
- Wagiman, A. N., Aspasya, G. S., & Prawati, L. D. (2023). Net Benefit on E-Invoice Implementation: Applying the Delone & McLean Information Systems Success Model. In *E3S Web of Conferences*. 388. <https://doi.org/10.1051/e3sconf/202338804054>
- Zemanová, B., & Slavík, P. (2016). Implementation of Lean Tools Used in Logistics: A Case Study Approach. In *Proceedings of the 28th International Business Information Management Association Conference*. Norristown: International Business Information Management Association (IBIMA). 3372-3379. <https://doi.org/10.5171/2016.3372>
- Zornia, O., Yurchenko, O., & Petrakovska, O. (2022). Value Added Tax the Internet Trading: Features of Documentation. Accounting and Reporting. *Scientific Bulletin of the National Academy of Statistics. Accounting and Audit*. 1-2. 21-31. <https://doi.org/10.31767/nasoa.1-2-2022.03>