



Enhancement of the e-Invoicing Systems by Increasing the Efficiency of Workflows via Disruptive Technologies

Hiruni Gunaratne^(✉) and Ingrid Pappel

Tallinn University of Technology, Akadeemia tee 15a, 12618 Tallinn, Estonia
hirunigunaratne@gmail.com, ingrid.pappel@taltech.ee

Abstract. E-invoicing is a rapidly growing e-service in Europe as well as in the world. It is identified as a substantially significant element in progressing towards the goals of ‘Digital Economy’ in the European Union. This paper focuses on identifying inefficiencies in e-invoicing systems currently in use and the opportunities to apply emerging technologies such as artificial intelligence and robotic process automation, in order to increase efficiency and level of automatization. The study incorporates expert opinions and users’ perceptions in e-invoicing systems on the status quo and the necessities for higher automation. We focus on e-invoicing systems in the Baltic region consisting of the countries Estonia, Latvia and Lithuania. Based on the conducted research, the drawbacks in e-invoicing systems were identified related to operational, technological and information security-related. Furthermore, the automation opportunities and general requirements for automation were identified. The functionalities that can be improved are discovered as well discussed in this paper and the advantages of using emerging technologies in the context are explained. Based on research outcomes we propose a conceptual e-invoicing ecosystem and present recommendations for its application along the future work needed in that field.

Keywords: E-invoicing · Artificial intelligence · Robotic process automation · Automatization · Efficiency

1 Introduction

1.1 The Background

Electronic invoicing is defined as “an invoice that has been issued, transmitted and received in a structured electronic format which allows for its automatic and electronic processing” [1]. According to Salmony and Bo Harald, “the e-invoice is a pivotal document in the supply chain whose digitalization will generate savings in its own right, as well as contributing to many other benefits along the supply chain” [2]. Thus, the e-invoices should consist of fully structured data, therefore it can be automatically processed.

E-invoicing was known to be growing rapidly in the world with over 400 e-invoicing service providers active in Europe, transacting 3.3 billion Euros worth of e-invoices globally in 2017, predicted to be 16.1 billion Euros in 2024 [3].

Given that e-invoicing is one of the main e-services in e-commerce and e-governance [6], the study revolves around e-invoicing.

In 2014, a directive on electronic invoicing in public procurement was voted by the European Parliament and Council which is known as DIRECTIVE 2014/55/EU. This directive emphasizes on defining a common standard for e-invoicing which will develop interoperability within the European Union [1]. The key target is to process the invoice automatically. As the bigger picture of the above directive, the European Union aims to create a ‘digital single market’ with no online barriers to flows of goods, services and data with the Europe 2020 ten-year plan [3]. According to the European Union’s six strategic priorities for 2019–2024, ‘A European Green Deal’ (Striving to be the first climate-neutral continent) and ‘A Europe fit for the digital age’ (Empowering people with a new generation of technologies) [4] directly benefits from the usage of e-invoicing within the member states. Emerging technologies such as Artificial Intelligence (AI), Internet of things (IoT) and Robotic Process Automation (RPA) hold great significance when they are amalgamated with specific systems. Digital revolution is taking place globally enhancing the global markets concerning industries. Business sectors such as industrial manufacturing, healthcare, financial services, food services, automotive etc. are progressively adopting AI, IoT and RPA technologies. The assimilation of these emerging technologies holds the aptitude of generating smarter, safer, efficient, and more secure systems. Solution providers seem to be more confident in applying several technological developments to answer volatile, uncertain, complex, and ambiguous challenges in the systems [9].

The Baltic countries share common features and history similar to each other. According to Aurélien Poissonnier, a quantitative analysis of the economy of three Baltic countries reveals that there is an integrated Baltic economy which consists of a sizable part by common factors and economic links among the three countries [5]. Hence, we decided to scope the research within the Baltic region because study results can be generalized to the whole region. In addition, Estonia is quite well known in terms of both state and local digitalization, where important aspects are related to data sharing, data quality [21] and also understanding of digital capability [22].

In Europe, the initial progress of e-invoicing was driven by the private sector whereas in the present it is being very much supported by the governments [7]. Given that the governments are introducing the initiatives for e-invoicing through moves such as mandates [1] and the businesses are requesting the technologies to be upgraded and the services to be better [7], the requirements and opportunities in a comprehensive e-invoicing platform should be identified. Even though the e-invoicing in Estonia has reached a considerable level of effectiveness which can also be considered somewhere in between digitization and automated e-invoicing, there are many prospects to improve. Rapidly growing emerging technologies which could be used for disruptive innovation also lay a heavy base for strategic drivers. These technologies take a completely new approach for some of the existing problems and can act as a substitution for old solutions [8]. In order to approach this challenge, we have formulated our research question as **how to enhance e-invoicing systems and increase the efficiency of workflows with higher levels of automation?**

Thus the research question aims to find out what kind of inefficiencies are in the e-invoicing systems and process currently, what kind of and to what extent automation is present in the current e-invoicing systems, find out how can emerging technologies help to overcome the barriers and achieve higher levels of automation in e-invoicing.

This paper is structured as follows. The first section gives an understanding about domain and the second section discusses the relevant work along the existing research. In the third section, we present results and discuss them based on findings and analysis. Finally, the fourth section is aimed to present the eco-system that we believe would help application of disruptive technologies for the future work and we summarize our research in Sect. 5 based on the outcome of our research.

1.2 Methodology

The study incorporated a qualitative research approach. To find answers for the research problem, we required subject matter experts' opinions. This data was collected with 6 semi-structured interviews held via Skype. The perceptual feedback from e-invoicing application users were collected via a survey shared publicly among employees of organizations operating within the Baltic region. In pursuance of analyzing interview data, a systematic approach based on thematic mapping was followed after transcribing the interviews. Patterns among the interview data were explored iteratively using NVivo 12 software for qualitative data analysis. For Experts interviews, purposive sampling was used by our own experience and discussions with relevant stakeholders. From the shared survey, 224 employees (varying from different designations) responded based on their thoughts and feedback. There were 114 respondents from Estonia, 54 from Latvia and 36 from Lithuania. In addition to primary data, the secondary data in terms of literature overview has been applied. The questions to measure the user perceptions were carried out under 5 main perceptions namely perceived ease of use, perceived usefulness, perceived risk, perceived trust and perception on information security. The format of the questions were in the Likert scale format, simple 'Yes, No, May be' format and format of 'options selecting'. For the survey results, Microsoft Excel have been used to analyze data with simple excel formulas. For the sampling method, a non- probability sampling method has been used for the survey. The sampling method is a mix of convenience sampling (sample includes individuals who happen to be most accessible to the researcher) and voluntary sampling (sending a survey via e-mail and posting on related LinkedIn forums).

2 Literature Review

2.1 E-invoicing Market in the Baltics

A commercial invoice is the most significant document exchanged between trading partners. Along with the commercial significance, the invoice is an accounting document which has legal insinuations being the basis of calculating VAT (value-added tax) [10]. When we consider market adoption of e-invoices Baltics, Estonia is one of the leaders in the e-invoicing market.

Latvia and Lithuania are in the second-tier with average market penetration [10]. As an example, good e-invoicing practices are currently followed in the Estonian public sector. From 2011, invoicing was transitioned from paper-based management to solely digital. With financial support from the Estonian government, document management systems (DMS) as well as the required APIs and functionalities were developed making the digitalization and automatization of invoicing possible. These projects enabled local municipalities to apply digital workflows in terms of e-invoicing. As a result, since 2017 the whole public sector deals with digital invoices [11]. This process of digitalization has drastically decreased inefficient manual work by eliminating paper-based management. Additionally, the resulting level of automation has laid the foundation needed for the development and application of disruptive technologies.

2.2 Robotic Process Automation and Artificial Intelligence

When we discuss about the emerging technologies, Robotic Process Automation (RPA) is a novel dimension of upcoming technologies. According to Madakam et al., “It is a combination of both hardware and software, networking and automation for doing things very simple”. There are examples of usage of RPA such as repetitive processing of transactions in e-invoice processing, rules-based processing in error checking and handling a large number of transaction volumes in orders processing. RPA brings direct cost-effectiveness while enhancing precision across businesses. Software robots who are trained to perform a variety of repeating functionalities can interpret, prompt replies and connect with different interfaces or systems just like human beings. Software robots are known to be “only substantially better: a robot never sleeps, makes zero mistakes and costs a lot less than an employee” [12].

In 2016, at the World Economic Forum, the significance of AI was stressed and the impact of AI on the governments where it makes the governments agile [13]. There are different methodologies and techniques of AI which can be classified as techniques which rely on the mathematical enhancement, network-based approaches wherein represents problems are sets of possible states and transitions in between them, agent-based methodologies and multi-agent system interactions, automated reasoning-based approaches on present knowledge and big data and machine learning analytics [17].

2.3 User Perceptions Towards Using an e-Invoicing System

Jiunn-Woei Lian has described seven “Critical factors for e-invoice service adoption in Taiwan according to Unified Theory of Acceptance and Use of Technology 2 (UTAUT2)” [14]. It was decided that five of those factors to be used to measuring the user perception in this study. Out of the 7 factors, facilitation condition is taken out assuming the users work in a corporate structure where all the facilitation conditions are fulfilled such as internet connections, training on the system etc. Social influence condition is taken out assuming there is no social influence in a corporate environment, as it is a business requirement to use an e-invoicing system at the workplace.

Perceived ease of use or Effort Expectation is “The degree of ease of use with the use of e-invoice” according to Davis. Even it can be defined as ‘the degree which the user can effortlessly use an e-invoicing system’ where it has an inverse relation with the notion of complexity [15].

Perceived usefulness or Performance expectation describes the degree to which users of e-invoicing systems will consider that its use will improve their performance, also providing advantages in the organizational level. Perceived usefulness can modify user behavior and predict the continuous usage of the service [15].

Perceived risk is known to be “the degree to which people perceived risk when using e-invoice” [18]. Perceived risk is known to be affected by the perceived trust. Then the perception of risk is affecting the actual usage of a technology or a system [15]. There are many different types of perceived risks such as functional, physical, financial, psychological and social. Perceived risk can involve possible social consequences, financial loss, physical danger, loss of time and ineffective performance [19].

Perceived trust is “the degree to which people trust government e-invoice policy and service” [16]. Some researchers have analyzed the role of trust in different stages such as trust before the use of the system (pre-use trust) and after use of the system (post-use trust). In the pre-use the users are not familiar with the technology and the systems, hence trust is based on their tendency to trust. Once the users have used the system or the software, experience and previous perceptions determine the level of trust they have [17]. This study analyses post-use trust since the users is already using some sort of e-invoicing system.

Perceived Security reflects a perception of reliability of the methods of data transmission, storage and access [14]. Deficiencies in security are one of the most noteworthy barriers in the development of e-commerce related software products. If the knowledge of IT systems is low in users, the fears of hackers or a third party will tamper the information is high. E-invoicing must adhere to the requirements imposed by Directive 2011/115/EC in the Baltic region. These requirements include the relationships with other agents in terms of authentication and non-repudiation of transactions. Other requirements of security can be derived from company policies and national level requirements such as archiving digital content for a while [1].

3 Results and Discussion

3.1 Interview Outcomes

We investigated the current inefficiencies in terms of scope and operational gap, performance, security and technology in the e-invoicing systems. Also, the automation requirements related to technological effectiveness and functional effectiveness were investigated. With respect to the inefficiencies in current e-invoicing systems, there were three sub themes identified with the thematic analysis of interview results which are operational, technological and information security (referred to as InfoSec) (Table 1).

Table 1. Thematic analysis of inefficiencies of current e-invoicing systems.

Sub theme	Inefficiencies under the theme	Frequency of references
Operational	Bad e-invoicing model Problems in e-invoicing standards Cost related problems Business logic problems Data quality problems E-invoice receiving problems Difference in businesses and e-invoicing systems Human errors E-invoice roaming problems Less awareness related to e-invoicing No e-invoicing post processing functionalities Not supporting small or micro companies	58
Technological	ERP partner related problems Data extraction from different systems Use of old technologies and legacy systems	10
InfoSec	Relying on e-invoice service providers Less awareness of information security Data integrity Information security problems related to roaming activities In-house built systems and their issues Identification, authentication and authorization problems	13

The nodes for each sub-theme and the frequency (number of occurrences of the sub-theme in dataset) of references to each category (node) of problems are depicted by the above table. Operational inefficiencies are the most category out of all the inefficiencies. One major problem is with the e-invoicing standards which was mentioned in all the interviews. The standards are not strongly imposed for e-invoicing as they are in payments, securities trading or telecom. Some companies are still using older standards and there are compatibility issues with the formats and the data fields. Another standard related issue is that all of the standards do not cater to every type of businesses. Standards can be loosely validated, the receivers might end up interpreting non-mandatory field data in their way, paving the way for larger problems.

There was a lot of instances identified where PDF or images used as invoices which cost a lot to be digitized. They can be erroneous, not validated and inefficient. The above issue could be mostly observed in Latvia and Lithuania than in Estonia. Several functional elements in e-invoicing process are not supported and one of them is not having an approval process in the system after receiving the e-invoice. Quoting an expert opinion on this, “Lithuanian government have their public self-service platform ‘eSaskaita’ for e-invoicing and e-invoice are sent via the portal. There are many drawbacks such as absence of approval flows. Hence most of the times e-invoices are printed and approvals take place manually”. The stakeholders have less awareness about e-invoicing. The information

contained in an e-invoice and the structure is not known by users. The awareness in Latvia and Lithuania seems to be lesser than Estonia.

Human mistakes are known to happen in the e-invoicing realm because there is manual intervention in the process such as sending the e-invoice to the wrong party. E-invoicing roaming in the Baltics is built on peer to peer connections with agreements between the operators. Also, this is burdened by different web services for each operator. Regarding the content of e-invoices operators have their own validation rules and standards, even within the standard different versions are used. Most of the times the status of the roaming-invoice is not visible to all the parties while roaming.

E-invoicing receiving has issues such as having to always reconfigure the systems to receive e-invoices from different suppliers especially when the supplier count is high, some suppliers sending e-invoices through a centralized portal (in Lithuania), not having messages delivered upon receiving or not-receiving e-invoices and accepting wrong e-invoices or-invoices with errors.

Businesses are different from each other and it appears to be very hard to maintain one generalized e-invoicing system for all the businesses. e-invoicing operators are only supporting mid and large-sized companies but not small or Micro companies in many instances because they have to customize the solutions. Another major problem is the quality of data in e-invoices. This is a closely related issue with e-invoicing standards. Currently, there is a lot of non-validated data which are erroneous in the e-invoices. Different stakeholders interpret these data in different ways.

There are non-mandatory fields in e-invoices which carry invalid data. There are cost-related problems, especially affecting the small and micro businesses where the cost of connecting to an e-invoice operator and cost per e-invoice is high. This can affect the ERP partners as well, which was identified as a reason for the volume of B2B e-invoicing not developing as expected. Business logic problems were also significant. Some of these are related to wrong tax calculations, lack of information on the e-invoice and erroneous values.

When talking about Latvia and Lithuania, the e-invoicing market model seems unsatisfactory. Centralized portals in Lithuania hinders fully automated e-invoicing processes and also B2B market restrictions. It works well with the B2G market. When compared to Estonia; Latvia and Lithuania do not have a central registry for companies to register for e-invoicing use. And the roaming infrastructure seems to be deficient. Another significant inadequacy in Latvia and Lithuania is the awareness and knowledge distribution compared to Estonia.

One of the main problems identified with respect to technologies and systems is that they are outdated and the technology in the transportation layer seems to be old which makes it very hard to upgrade. Even integrating with customers who has legacy software is a problem. In the e-invoicing realm, the accounting system or ERP system should be connected to the e-invoicing system to achieve automation and other benefits. Some ERPs are quite costly to be connected to an e-invoicing service provider.

Also, ERP systems can be less capable when it comes to integration and fulfilling the requirements of e-invoicing systems still use data entering manually or extracting with digitization services which are not that accurate as stated by the experts. It is mentioned that there are no index files when the information comes through PDF or other formats.

There are several authentication, authorization and identification problems discussed by the interviewees. It is evident that there are problems such as no electronic signing, not having fully automated systems, some still arrive as PDF or Paper and getting extracted to e-invoicing systems and having to manage different channels of access to a system. Also, it was mentioned that there are data integrity problems, that the information can be changed during the transportation layer. Currently, companies just rely on e-invoicing service providers for data integrity. There is another major functionality that the e-invoice operators perform which is e-invoice roaming. This is not controlled by any authority currently. The problem arises when the market grows or broadens outside Estonia or Baltic region respectively. Regarding the small systems built in-house by the companies, they lack information security aspects (Table 2).

Table 2. Thematic analysis of requirements/automation opportunities in e-invoicing systems.

Sub theme	Inefficiencies under the theme	Frequency of references
Automation opportunities	Workflow automation E-invoice sending and receiving automation Rule based automation E-receipt Automation of VAT reporting E-ordering Payment reconciliation automation Payment receival automation	15
General requirements	User friendliness requirement Reuse of components Use of bank infrastructure in e-invoicing systems Information security requirements	9

Currently e-invoice sending and receiving is quite automatic, but the processes around it need more automation. Many of the automation requirements were identified as 'Rule-Based Automation' which were, pre-posting of the documents, matching the invoices with orders, assigning workflows to an e-invoice, and automated journal entries for recursive invoices.

E-ordering was pointed out as an enhancement which proactively contributes to the e-invoicing and real-time economy. As e-ordering has very special benefits, e-receipt was brought out to be the following step after e-invoicing, because it uses the same semantic and technical standards which is also an example from Finland. Experts have stated that payments automation and reconciliations of payments received are also the next steps in automation. E-invoice workflow automation is already available with some e-invoice operators up to some level but some functionalities are yet to be implemented (Table 3).

Table 3. Sentiments analysis of using AI and RPA.

Technology	Positive occurrences	Negative occurrences
AI	11	4
RPA	7	4

The ideas from the experts about using the emerging technologies were both positive and negative. According to the above table of sentiments (made with Nvivo12) expressed about applying emerging technologies where positive sentiments are more than the negative sentiments. The number depicts the number of references which had positive or negative sentiment in the dataset.

Artificial Intelligence (AI) is considered to be implemented by several e-invoicing operators in the Baltics but not yet executed. Most answers were towards using AI in purchase invoices, not sales invoices. And the challenges such as training the AI and making proper data sets for training, cost of implementing AI, trust in AI was discussed by experts. It emerged that AI can be used to analyse the e-invoices and get the necessary information as a solution for e-invoicing standard issues (e-invoice receiving), checking data quality, analyse and compare accounts posting templates, automating accounting entries and data analysis and predictions.

RPA was not implemented by any of the companies currently, but it is considered in future. The uses and challenges of using RPA were discussed. It emerged that RPA can be put to use to insert data into e-invoicing systems, data matching, order matching with e-invoices, e-invoice approval process automation, e-invoicing formats translation, extracting data from several different systems such as banking system, web shop interfaces etc. without integrating all these systems and preparing orders. As per our thoughts, it can be the reason that many stakeholders are not very familiar with the AI and RPA technologies, for them these technologies seem very far away from being implemented in the near future. On the other hand, some of the experts mentioned that the cost of these technologies is high. But when compared with the benefits in the future, this cost may be recovered with time.

3.2 Survey Outcomes

Based on the responds, we looked at the user's perceptions under each element described in Sect. 2 and tried to understand the automation requirement from users' perspective.

Perceived Ease of Use. In Estonia, more than 60% among the respondents have rated 4 and 5 which illustrates that they are considerably happy with how effective and user-friendly their current e-Invoicing system is. In Latvia and Lithuania, 52% and 64% of the respondents respectively have rated 3 which reveals that they neither agree nor disagree with how effectively the current e-Invoicing system performs and 33% and 25% of the respondents respectively have rated 4 and they are somewhat happy with the e-invoicing systems. It is observable that most of the respondents' organizations use minimal labor force to get involved in day-to-day invoicing operational activities in all the countries but it is not zero. Around 64%–71% of the respondents' organizations use

a labor force up to 5 people for e-invoicing operations while less than 5% of the respondents represent organizations using over 10 employees for manual invoicing activities.

Perceived Usefulness/Performance Expectation. In Estonia, most of the respondents (above 65%) agree that their current e-Invoicing system covers most of their day-to-day invoicing operational activities while 24% of respondents neither agree, nor disagree with the current functionalities. Only 7% express their disagreements on how useful the current features exist in their invoicing systems. In Latvia, it is observable that around 45% of the respondents vote in favor of current system functional coverage whilst another 40%–45% of respondents neither agree to that statement nor do they disagree. With the 11% of respondents voting otherwise, it is safe to conclude that though a certain population among the respondents disagree with their system functional coverage, yet a considerable set of respondents do embrace the current feature set positively leaving room for further improvements in the current invoicing systems. In Lithuania, most of the respondents (above 70%) neither agree nor disagree. Among respondents, only 20% accept the fact that their invoicing system does provide their expected functional coverage. Only 5% express their disagreements on the usefulness.

Perceived Risk. This was a “Yes, No, May be” type question about the e-invoicing user’s perception of risk. There were more than 50% of ‘May Be’ answers which shows that users have a doubt or they simply do not know. It can be stated as they are not denying the fact that there can be risks related to e-invoicing solutions. Also, about 48% of users said that there are definite risks.

Perceived Trust. When taking the Baltic region in general, more than 50% of answers contain ‘maybe’ which means the users are not sure where they trust the e-invoicing solutions or not. But when we take the percentage of users who have said ‘yes’ which is about 40% to the above question, it means they trust e-invoicing solutions. A very few percentages of the users do not trust the e-invoicing systems and in Estonia this number is 0.

Perceived Information Security. More than 60% of the respondents from Latvia and Lithuania think that the e-invoicing system is fairly secure, while about 25% think there is good security. Almost none think either it is very poor or excellent in information security. A majority of Estonian respondents about 60% thinks that information security is good in e-invoicing systems and 27% of the respondents think information security in e-invoicing systems is just moderate. About 10% of the Estonian e-invoicing users think that the information security aspect is excellent in e-invoicing.

Automation Requirement on E-invoicing. 50% of the Estonian respondents would like to have fully automated systems while 50% of them would like to have nearly automated systems. In Latvia again similar to Estonia, 50% of the users would like fully automated systems, where 25% of them would like to have somewhat automated and 25% of them would like lower automated level in e-invoicing systems. In Lithuania, only 25% of the respondents would want to have a fully automated system, and about 39% of the respondents would like to have somewhat automated and 36% of the respondents like to have lower level of automated systems.

There may be various reasons that some users do not like fully automated systems. We think one of them is that they might be that the users think they will lose control over the systems.

4 Suggested e-Invoice Conceptual Ecosystem with AI and RPA

Based on the survey findings and a thorough analysis of the secondary data from literature we propose an eco-system. We see the eco-system as a conceptual view which can be taken for the further development. Suppliers, buyers, trading partners such as financial institutions and government institutions such as tax authorities are the entities that participate in the eco-system. In the diagram only one entity from each supplier, buyer etc. is depicted, but in reality, there are many contact points where many participants can join to the data exchange which is depicted with item 1 (Fig. 1).

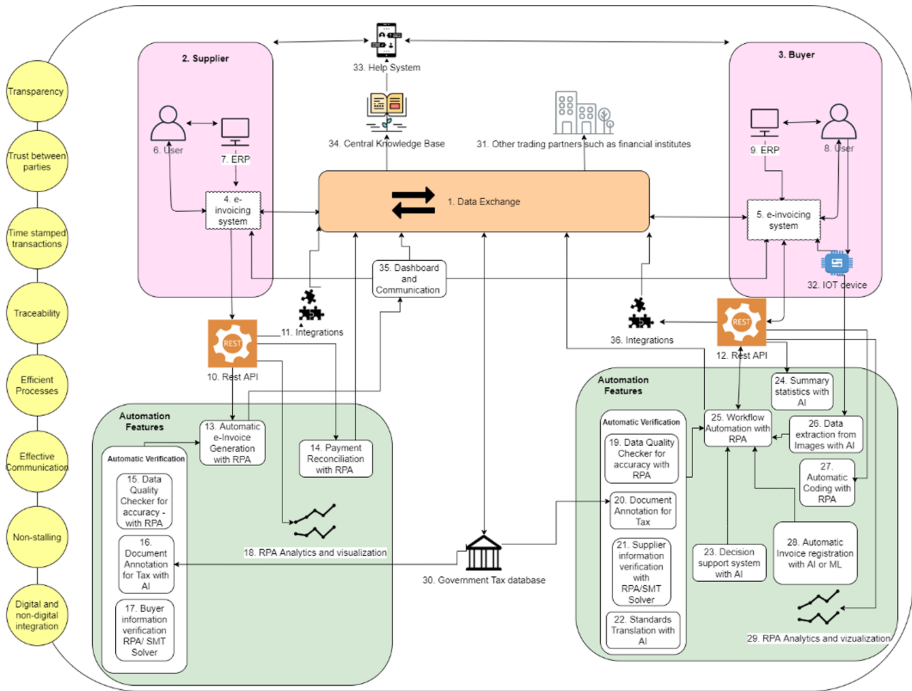


Fig. 1. Proposed ecosystem for e-invoicing.

The items 4, 6, 7 shows how a user from the supplier company is connected to their own ERP/accounting system and the e-invoicing system front end. The items 5, 9, 8 shows how a user from the buyer company is connected to their own ERP/accounting system and the e-invoicing system front-end. A user usually uses the ERP system but

there are user interfaces in the e-invoicing system for e-invoicing process related tasks. These two systems are separated because not all the ERP systems have e-invoicing functions available and it is easy to maintain. Just the integration between the two systems is necessary. The e-invoicing system/systems of the users would be connected to the RPA, AI and other components with web services, which is depicted as the Rest API (item 10 and item 12).

With the item 11, 36 - integrations are capable of the e-invoicing systems to be integrated into other software or tools as the requirements arise. Also, these integrations can have transactions stored on the knowledgebase, also under the requirements of each company/ organization.

When describing the item 13-automatic e-invoice generation which is an RPA service, it includes getting necessary data from the ERP of the supplier. 56% of the e-invoice users said they would prefer to have this functionality in an e-invoicing system. RPA is suggested in this case because invoice generation is rule-based, matched with an order. Also, RPA can perform collecting data from different systems and generating one document which answers the problems of using different systems by the company. While the e-invoice is getting generated, the verification on the e-invoice can be done by the sub-module labelled as 'Automatic Verification'. This includes data quality checking with RPA (item 15), especially the syntaxes and semantics according to the required standard. Since different buyers can be using different standards as mentioned in the thematic analysis of this study. The rules for data quality checks should be identified before designing the functionality and could be enhanced with the usage. Another component of the automatic verification is document annotation for tax (item 16). The tax values can be calculated against the government tax database rules and this component should have a connection with the government tax database. The other component is buyer information verification (item 17), which could be done with a simple rule-based matching process with RPA or SMT solvers (Satisfiability Modulo Theories) which includes higher degree verifications [20].

The payment reconciliation of e-invoices (item 14) can be done by matching with payments received against an e-invoice. This is a simple rule-based process.

With RPA analytics and visualizations (item 18), there can be a dashboard of summary statistics of invoices, taxations, goods, buyer related information etc. During the study, 47% of the e-invoicing users stated that they would prefer to have this feature of summary statistics.

Item 26 which is data extraction from images with AI, this can include PDFs and other non-machine-readable formats. In an e-invoicing system, an image or a PDF is not counted as an e-invoice but there is some percentage of non-readable invoices still circulating in the Baltic region. AI is capable of training to read these invoices and convert them to an e-invoice until all the B2B invoices become fully electronic. This can have inputs from an IOT device where the users are out of office scenarios with the integration of item 32.

Summary statistics with AI (item 24) would help to show the buyer a condensed summary of very long invoices such as invoice for electricity in different locations of a huge retail chain. That in turn helps to make decisions without having to read the whole invoice.

Under the automatic verification module of the buyer's side, all the items except standards translation using AI (item 22) are the same as the supplier's automatic verification module. This will be the solution for significant standards related problems emerged in the study, where there is no proper standard to be used and different versions of the standards are being used by companies.

With AI, there is no requirement to have one proper standard for everyone, instead each standard can be analysed and translated into other standards as required.

Item 28 which is automatic invoice registration to the ERP or accounting system that can be based on AI or machine learning. It can be trained with the exceptions for each supplier etc. Also, this feature can include the invoice returning.

E-Invoicing workflow would be automated with RPA (item 25) as it is a rule-based process and this can be complemented with a decision support system with AI (item 23). The decision making can be either the decision to be taken by AI or the decision can be prompt to the user, so that the user can either go ahead or not in the workflow.

Automatic coding is simply another rule-based process which is automated with RPA where the accounting entries are made to the ERP or accounting system. As same as item 18 in the supplier's side, item 29 is RPA analytics and visualization for the buyer concerning all the e-invoices which were again a required feature to make informed decisions.

Dashboard and communication (item 35) would be a common functionality which is integrated into the whole ecosystem to solve the problem of visibility. This is an inefficiency mentioned by many experts during the study that buyers, sellers and e-invoicing operators do not know the status of an e-invoice or the ability to send e-invoices across the Baltic region.

The help system (item 33) which will be connected to a central knowledge base (item 34) is the presence of a chatbot to enhance the communication between trade partners. The main reason it being different from the dashboard is that the dashboard is a dynamic information display related to e-invoices, where the help system is capable of answering queries on trade-related matters. It was brought up by an expert during the interviews that the communication between trade partners regarding e-invoicing capabilities is very hard. As an example, a supplier can ask the help system to retrieve the agreements that need to be re-evaluated at the end of a period. The help system ought to be designed in a way that each participant has their limitations of accessing information.

4.1 Future Work and Limitations

The next stage of this research is to conduct a feasibility study of the proposed ecosystem for the Baltic region. Then it can be prototyped and tested paving the way for a real implementation if the tests bring positive results. It can also be the whole ecosystem or a part of it, which we think to be implemented step by step.

There were some limitations of the research such as the information collected through the survey and interviews may not be representing every e-invoicing user and expert in the Baltics. The data is generalized. Qualitative data gathering and analysis is limitless, where in this study it is limited to 6 interviews and only the data which needs to answer the research questions are studied. For more insights, views of ERP Partners and other integrated systems and stakeholders on e-invoicing can be considered in future work.

5 Conclusion

The study concludes that, in the Baltic region there are inefficiencies in e-invoicing systems and there is room for improvement. With respect our main research question, it can be emphasized that most of the inefficiencies are operational followed by technical and information security related problems. The perceptions of users regarding e-invoicing systems are moderate or fairly positive. Among the three countries, perceptions of Estonian users are generally more positive than Latvian and Lithuanian users. There is potential to use AI and RPA technologies in e-invoicing to minimize identified inefficiencies and introduce more automation to the e-invoicing systems. This benefits to increase the positivity of user perceptions related to all the angles considered in the study. Based on the results of the research, the guidelines and recommendation can be made to increase the efficiency of workflows to bring higher level automatization into existing e-invoice work routines. Consequently, the suggested eco-system can be researched further in the Baltic region as the next step.

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