REAL-TIME ECONOMY: DEFINITIONS AND IMPLEMENTATION OPPORTUNITIES

Final research report

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## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of abbreviations</td>
<td>4</td>
</tr>
<tr>
<td>Executive summary</td>
<td>5</td>
</tr>
<tr>
<td>Introduction</td>
<td>7</td>
</tr>
<tr>
<td>1. What is real-time economy? A glance into literature</td>
<td>9</td>
</tr>
<tr>
<td>1.1. Definitions and benefits</td>
<td>10</td>
</tr>
<tr>
<td>1.2. Building blocks and enablers</td>
<td>13</td>
</tr>
<tr>
<td>1.3. Barriers to adopting RTE solutions</td>
<td>15</td>
</tr>
<tr>
<td>1.4. RTE in brief</td>
<td>17</td>
</tr>
<tr>
<td>2. Estonian stakeholders’ views of real-time economy</td>
<td>18</td>
</tr>
<tr>
<td>2.1. What building blocks exist in Estonia?</td>
<td>24</td>
</tr>
<tr>
<td>2.2. Barriers and challenges for Estonia</td>
<td>29</td>
</tr>
<tr>
<td>2.3. Are the businesses on board?</td>
<td>31</td>
</tr>
<tr>
<td>3. RTE initiatives in Europe</td>
<td>34</td>
</tr>
<tr>
<td>3.1. Standard Business Reporting in the Netherlands</td>
<td>34</td>
</tr>
<tr>
<td>3.2. RTE initiatives in Finland</td>
<td>35</td>
</tr>
<tr>
<td>3.3. E-invoicing and business reporting in Denmark</td>
<td>37</td>
</tr>
<tr>
<td>3.4. Nordic Smart Government</td>
<td>38</td>
</tr>
<tr>
<td>3.5. EU-level interoperability initiatives</td>
<td>39</td>
</tr>
<tr>
<td>3.6. Implications for Estonia</td>
<td>41</td>
</tr>
<tr>
<td>4. Ideas for moving forward</td>
<td>43</td>
</tr>
<tr>
<td>4.1. The potential of RTE</td>
<td>43</td>
</tr>
<tr>
<td>4.2. Drivers and barriers</td>
<td>46</td>
</tr>
<tr>
<td>4.3. Possible risks of RTE</td>
<td>48</td>
</tr>
<tr>
<td>4.4. Key opportunities for Estonia</td>
<td>49</td>
</tr>
<tr>
<td>4.4.1. Real-time financial accounting and reporting</td>
<td>50</td>
</tr>
<tr>
<td>4.4.2. Real-time economic forecasting</td>
<td>52</td>
</tr>
<tr>
<td>4.4.3. Stimulating RTE in business and industry</td>
<td>54</td>
</tr>
<tr>
<td>Conclusions and recommendations</td>
<td>57</td>
</tr>
<tr>
<td>Bibliography</td>
<td>61</td>
</tr>
<tr>
<td>Annex 1. List of interviewees</td>
<td>66</td>
</tr>
<tr>
<td>Annex 2. Expected opportunities and impacts of RTE</td>
<td>67</td>
</tr>
</tbody>
</table>
# LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>API</td>
<td>Application Programming Interface</td>
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<td>B2B</td>
<td>Business-to-business</td>
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<td>B2G</td>
<td>Business-to-government</td>
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<td>CRM</td>
<td>Customer Relationship Management</td>
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<td>e-CMR</td>
<td>Electronic consignment note</td>
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<td>EDI</td>
<td>Electronic Data Interchange</td>
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<td>ERP</td>
<td>Enterprise Resource Planning</td>
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<tr>
<td>G2G</td>
<td>Government-to-government</td>
</tr>
<tr>
<td>MoEAC</td>
<td>Ministry of Economic Affairs and Communications</td>
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<td>PEPPOL</td>
<td>Pan-European Public Procurement Online</td>
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<td>RTE</td>
<td>Real-Time Economy</td>
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<tr>
<td>SBR</td>
<td>Standard Business Reporting</td>
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<tr>
<td>SCF</td>
<td>Supply Chain Finance</td>
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<tr>
<td>SME</td>
<td>Small and medium-sized enterprise</td>
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<td>UBL</td>
<td>Universal Business Language</td>
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<tr>
<td>VAT</td>
<td>Value-added tax</td>
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<tr>
<td>XBRL (GL)</td>
<td>Extensible Business Reporting Language (Global Ledger)</td>
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<td>XML</td>
<td>Extensible Markup Language</td>
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</tbody>
</table>
EXECUTIVE SUMMARY

‘Real-time economy’ (RTE) is an emerging concept which refers to the idea of transferring standard business transactions and administrative procedures from paper-based human-to-human communication to digital, automated machine-to-machine data exchange. This is seen as promising various opportunities for saving time, money and human resources and for creating new economic value.

As part of Estonia’s efforts to foster digital innovation in government and business, the Estonian Ministry of Economic Affairs and Communications (MoEAC) commissioned this study to take a snapshot of the existing ideas and visions on RTE and to provide a basis for discussing possibilities for developing RTE in Estonia. As such, this study is the first exploratory attempt in Estonia to map the concept of RTE as it is understood in the world right now – in all of its variety. This main aims of this inquiry were:

- to learn how RTE is defined in academic literature and by Estonian stakeholders;
- to map the expected benefits, drivers, enablers, barriers and potential risks of RTE;
- to identify opportunities for Estonia to advance RTE and propose the first steps which could lead the way towards RTE.

The study discovered that stakeholders’ understanding of the benefits, building blocks and barriers of RTE largely correspond to the ideas put forward in academic literature. The benefits of RTE are mainly associated with efficiency, acceleration of information and financial flows, and improved quality of decision-making. Estonia’s high level of digitalization and the recent emergence of key RTE enablers puts Estonia in a good position to advance RTE nationwide. In this context, the study identified three key areas in which RTE solutions have a high potential to yield savings and create benefits:

1. Real-time accounting and reporting;
2. Real-time economic forecasting;
3. Real-time supply chains in business (in particular industry).

When devising the next steps, Estonia could prioritize the following six activities:

- Developing a comprehensive RTE roadmap outlining a vision for RTE and the steps required to achieve this vision. This includes engaging businesses in developing standards, technical infrastructure and governance models for RTE;
- Piloting and developing a technical platform for secure real-time business-to-business (B2B) and business-to-government (B2G) data exchange;
- Taking an active role in European-level standardization and interoperability efforts, in particular by early adoption of business-relevant cross-border services within the Single Digital Gateway initiative;
- Supporting the digitalization of Estonian business and industry through creating financial incentives, training programs, networking and other support measures;
• Mobilizing a critical mass of RTE adopters by prioritizing the development and piloting of real-time data-driven services for businesses and citizens which are used frequently and provide clear user value;

• Investing in new technologies that use and add value to real-time data, for example by enabling blockchain-based Smart Contract technologies for widespread use to reduce the need for human intervention in ongoing machine-to-machine communication.
INTRODUCTION

The idea of being able to conduct business completely within an interconnected network has been discussed for some time now, but with the new millennium these ideas became more concrete. ‘Real-time economy’ (RTE) – a concept which we will define in more detail later but which essentially means a country or a system that is able to replace all paper-based communication such as orders or invoices with electronically mediated exchange between business partners – became a more likely reality.

Estonia and its northern neighbor Finland have taken an active role in creating an enabling environment for RTE through providing unique identifiers, electronic identity and a national data exchange layer. All these contribute to a digital ecosystem that in parts already allows for replacing human interaction with machine-to-machine communication. However, to date, no country in the world is able to provide a blueprint for developing real-time economy at a national scale. Hence, countries that are interested in harnessing the benefits of real-time economy need to develop their own understanding of what RTE means in practice.

This study was commissioned by the Estonian Ministry of Economic Affairs and Communications (MoEAC) and is one of the first exploratory attempts to map the concept of RTE as it is understood in the world right now. As such, it can only be seen as a beginning. The aim of this study is to take a snapshot of the ideas out there, provide a basis for starting further discussions and create food for thought for policy-makers and other stakeholders. Its content and conclusions are the responsibility of the authors alone and do not represent an official opinion or position of the ministry.

This effort is to be seen in the wider picture of the developments around digitalization in the European context, where the European Union is working to establish a Digital Single Market through initiatives such as the Single Digital Gateway Regulation. Article 14 of this regulation contains a set of 21 procedures for citizens and enterprises, which should be cross-border by default using machine-to-machine communication by mid-2023. Moreover, this study is timed to be finalized during the Finnish presidency of the European Council, which will give the topic a further impetus. We are also seeing more and more efforts to enable interoperable cross-border solutions on a global scale, most notably in the area of e-invoicing and integration of bookkeeping efforts. All these initiatives will help realizing a real-time economy.

The research was driven by the following questions:

1) How is RTE defined according to academic literature and how is it seen by Estonian stakeholders and international experts?

2) What are the enablers, drivers and barriers to RTE? Which risks are involved in developing RTE?

3) Which business processes could be automated based on real-time data?

4) What are the potential effects of RTE on companies’ competitiveness and savings?
5) How could AI-enabled data-driven forecasting affect the efficiency of industrial companies’ supply chains and risk monitoring?

6) What could be Estonia’s vision for RTE and which steps could be undertaken to achieve this?

These questions were addressed by applying a qualitative and interdisciplinary research approach. We started out by conducting a systematic literature review of RTE across the related research fields, followed up by qualitative interviews with Estonian stakeholders and experts and an analysis of real-life RTE initiatives. The study also used input from an online survey investigating Estonian businesses’ interest and readiness for adopting RTE solutions, which MoEAC kindly contributed to this study.

We want to highlight that this study is only a first exploration of the topic and it is limited in scope. In particular, while the study gives some insights into the potential effects of RTE as regards the expected gains and savings for companies, it does not provide a detailed assessment of the impacts of RTE solutions. Any such analyses would require narrowing the concept down to several specific technological solutions and extensive collection of empirical data, which was not possible in the given resource and time constraints. Therefore, the potential qualitative and quantitative impacts of RTE are only discussed at a general level, relying on secondary sources and expert opinions. However, the conclusions of this study encourage the impacts of RTE to be studied at a detailed level as part of Estonia’s next steps towards developing real-time economy in Estonia.

The report is structured as follows. First, we will provide an overview of how the concept of real-time economy is understood in academic and policy literature. We will then move on to explore Estonian stakeholders’ and expert’s views of RTE in Section 2. In Section 3, we will discuss Estonia’s readiness to develop an RTE ecosystem, focusing on the existing building blocks and barriers in the national context. Section 4 relates Estonia’s efforts to similar initiatives in the region and Europe more broadly. Section 5 synthesizes the findings and proposes three main areas where Estonia could consider taking steps to advance RTE. Lastly, Section 6 provides concluding remarks and recommendations for next steps.
1. WHAT IS REAL-TIME ECONOMY?
A GLANCE INTO LITERATURE

First ideas around ‘real-time economy’ (RTE) were developed almost two decades ago but the concept is still relatively unknown in policy and research. We therefore started exploring this concept by conducting a systematic review of literature. The review of existing literature enabled us to explore the main research trends (Moro et al, 2015), develop a theoretical understanding of the topic, identify domains where studies already exist, and discover new fields where more work is required (Webster & Watson, 2002). Our study employed a meta-synthesis method for qualitative research. This method provides an interpretive approach for integrating findings from different qualitative articles in the research domain (Walsh & Downe, 2005; Wilder, 2014). We used Walsh and Downe’s (2005) seven-step approach of to guide our research.

As a first step, we conducted a keyword search in the leading academic knowledge databases of Web of Science and SCOPUS. Since academic research on RTE is still scarce, the same query was repeated in Google Scholar to avoid missing potentially important contributions beyond the two key databases. The following keywords were used for searching literature:

- “real-time economy”
- “just-in-time economy”
- “now economy”
- “real-time”+“enterprise”
- “real-time”+“extended enterprise”
- “real-time”+“network”
- “real-time”+“platform”
- “real-time”+“public service”
- “real-time”+“business collaboration”
- “real-time”+“supply chain”
- “real-time”+“enterprise interoperability”
- “real-time”+“XBRL”

Our initial query retrieved 323 articles. Since Walsh and Downe suggest that the meta-synthesis method be limited to qualitative research, we went through several review sessions to check the relevance of the articles to our study. First, 20 articles were ruled out as they were either identified as duplicates or quantitative research. We then conducted detailed abstract and keyword scanning of the remaining 303 articles. As a result, we excluded 219 articles due to their limited relevance for the study. With 84
articles left, the last stage of filtering included full-text scanning, in the end qualifying 47 articles for a detailed review. These 47 articles were analyzed in depth to recover the meanings, keywords, and concepts put forward in the original sources. We then synthesized the findings into higher and more abstract concepts and categories (Ang et al., 2019; Walsh & Downe, 2005) to develop an understanding of the possible definitions of RTE, the benefits associated with the concept, its key building blocks and enablers as well as barriers. The findings are summarized below.

### 1.1. DEFINITIONS AND BENEFITS

Our review revealed that the concept of “real-time economy” is still in its infancy in academic research, lacking a well-established and comprehensive definition which would cover the various components of RTE. Different definitions exist, obscuring the boundaries of RTE and giving us little reason to consider RTE as an established academic field (Camarinha-Matos & Afsarmanesh, 2006). Nevertheless, despite conceptual differences, the majority of RTE definitions originate from the same source. The concept of ‘Real-Time Economy’ first appeared in an article published Ludwig Siegele in The Economist in 2002. Siegele used the term ‘real-time’ to denote a ‘new’ type of economy, where physical location is less relevant than in the traditional economy, and emphasized the potential of emerging information and communication technologies to reduce process latencies to a minimum (Siegele, 2002).

Since then, this concept has evolved, passing through many changes. Three dominant perspectives on RTE can be identified from the range of concepts which exist (see Table 1 for examples):

**Financial Perspective.** A significant number of RTE articles try to envision what financial accounting and reporting will look like in the future. This perspective involves literature focusing on the financial part of RTE, especially automated accounting, automated auditing, and continuous quality assurance. Following Siegele’s (2002) original interpretation, this group of articles takes a narrower view of RTE and concentrates on the level of an individual enterprise. Articles in the financial perspective associate the deployment of RTE solutions with an extensive list of potential benefits for businesses, such as automation and integration of financial management processes (Trego et al., 2014; Vasarhelyi & Alles, 2008; Vasarhelyi, 2011; Vasarhelyi et al., 2010; Vasarhelyi et al., 2005), improvements in overall organizational efficiency (Eulerich & Kalinichenko, 2018; Trego et al., 2014; Vasarhelyi et al., 2010), improvements in the decision-making quality (Eulerich & Kalinichenko, 2018; Trego et al., 2014; Vasarhelyi & Alles, 2008; Vasarhelyi et al., 2010), improvements in the quality of information (Appelbaum et al., 2016; Eulerich & Kalinichenko, 2018), and improvements in the prediction capabilities and time responding to market changes (Appelbaum et al., 2016; Trego et al., 2014; Vasarhelyi & Alles, 2008).

**Business Network Perspective.** This group of articles also builds upon Siegele (2002) but takes a broader view of RTE as a network of integrated systems reducing business latencies (Chan, 2006; Davenport et al., 2004; Kuhlin & Thielman, 2005; Reichwald et al.,...
REAL-TIME ECONOMY: DEFINITIONS AND IMPLEMENTATION OPPORTUNITIES

2005; Siegele, 2002). At the heart of this paradigm is a modern business model, the ‘real-time enterprise’ (Kuhlin & Thielman, 2005; Siegele, 2002). The business network perspective provides a wider approach to RTE, introducing additions such as cross-organizational service integration (Kuhlin & Thielman, 2005; Siegele, 2002), additional communication channels between partners (Kuhlin & Thielman, 2005; Reichwald et al., 2005; Siegele, 2002), the free flow of data between business partners (Kuhlin & Thielman, 2005), and uniform design and common communication standards (Kuhlin & Thielman, 2005). This group of articles associates RTE with benefits such as the enhanced exploitation of the existing ICT infrastructure (Davenport et al., 2004; Kuhlin & Thielman, 2005), competitive advantages for RTE participants (Kuhlin & Thielman, 2005; Reichwald et al., 2005; Siegele, 2002), real-time services and products, including real-time monitoring of delivery (Chan, 2006; Siegele, 2002), organizational differentiation in the market (Chan, 2006; Kuhlin & Thielman, 2005; Reichwald et al., 2005; Siegele, 2002), real-time access to additional sources of information (Chan, 2006; Davenport et al., 2004; Hope 2006; Kuhlin & Thielman, 2005), and reducing transaction costs (Kuhlin & Thielman, 2005; Siegele, 2002).

**Extended Perspective.** This perspective provides the broadest interpretation and expands the application of RTE to state agencies. Articles in this category tend to focus on merging roles and responsibilities between public and private agencies, and depict RTE as a joint digital environment where financial and administrative transactions take place as close to real-time as possible (Harald, 2018). From this perspective, the expected impacts of RTE solutions also concern the public agenda. Benefits associated with RTE solutions cover further developments in the field of Artificial Intelligence (Harald, 2018), environmental benefits (Harald, 2018; Penttinen, 2008), improved business transparency (Harald, 2018), further progress in the European Union’s (EU) Digital Single Market agenda (Harald, 2018), and enhanced EU competitiveness on a global level (Harald, 2018).

**Table 1. Perspectives on RTE in literature**

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<thead>
<tr>
<th>Definition characteristics</th>
<th>Sources</th>
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<tr>
<td><strong>FINANCIAL PERSPECTIVE</strong></td>
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<tr>
<td>RTE accelerates business measurements, assessments and processes.</td>
<td>Vasarhelyi, 2011; Vasarhelyi et al., 2010</td>
</tr>
<tr>
<td>RTE requires new ICT empowered business models where information is collected, processed and presented in real-time.</td>
<td>Eulerich &amp; Kalinichenko, 2018; Vasarhelyi &amp; Alles, 2008</td>
</tr>
<tr>
<td>RTE solutions reduce process latencies to almost one-tenth of the current rate.</td>
<td>Vasarhelyi &amp; Alles, 2008</td>
</tr>
<tr>
<td>RTE solutions permit financial data to move across organizational boundaries and in real-time.</td>
<td>Vasarhelyi, 2011; Vasarhelyi &amp; Alles, 2008</td>
</tr>
<tr>
<td>RTE solutions facilitate 24/7 and remote monitoring of enterprises.</td>
<td>Siegele, 2002; Vasarhelyi &amp; Alles, 2008</td>
</tr>
<tr>
<td>Financial management practices such as accounting, reporting, auditing and assurance are fully automated and take place in real-time.</td>
<td>Trego et al., 2014; Vasarhelyi &amp; Alles, 2008; Vasarhelyi, 2011; Vasarhelyi et al., 2010; Vasarhelyi et al., 2005</td>
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<tr>
<td><strong>BUSINESS NETWORK PERSPECTIVE</strong></td>
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<tr>
<td>RTE is the network where real-time enterprises perform their activities.</td>
<td>Siegele, 2002</td>
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## Definition characteristics

| RTE is a network where real-time enterprises collect real-time information in order to monitor their status and improve reaction times to unexpected events. | Kuhlin & Thielman, 2005; Reichwald et al., 2005; Siegele, 2002 |
| RTE enforces cross-organization software integration. | Kuhlin & Thielman, 2005; Siegele, 2002 |
| RTE optimizes value generation practices on cross-organization level. | Kuhlin & Thielman, 2005 |
| RTE facilitates real-time business administration practices. | Siegele, 2002 |
| RTE improves communication channels between participants. | Kuhlin & Thielman, 2005; Reichwald et al., 2005; Siegele, 2002 |
| RTE facilitates real-time practices for exchanging data and documents. | Kuhlin & Thielman, 2005 |
| RTE eliminates process latencies. | Reichwald et al., 2005; Siegele, 2002 |
| RTE enforces uniform design and communication standards at a cross-organizational level. | Kuhlin & Thielman, 2005 |

### EXTENDED PERSPECTIVE

| RTE represents a virtual environment where transactions are performed as close as possible to real-time. | Harald, 2018; Penttinen, 2008 |
| RTE environments connect citizens, businesses and government. | Harald, 2018 |
| RTE environments facilitate financial and administrative transactions. | Harald, 2018; Penttinen, 2008 |
| RTE environments permit transactions to be executed in real-time. | Harald, 2018; Penttinen, 2008 |
| In an RTE environment, transactions are structured and standardized in digital formats. | Harald, 2018 |
| In an RTE environment, transactions are generated automatically. | Harald, 2018 |

This variety of definitions points to fragmentation in RTE literature and a lack of academic consensus on what is considered ‘in’ and what is regarded as being ‘outside’ the concept of RTE. In order to develop a working definition of RTE, we applied the ‘semantic decomposition’ approach (Akmajian et al., 2017), aggregating existing interpretations, extracting their core meanings and forming a new and more comprehensive definition encompassing these core ideas. We noticed that despite their variety, most definitions do not contradict one another and all place new information and communication technologies at the center of RTE. Three basic components or ideas recurred in most definitions: 1) machine-to-machine communication; 2) free movement of data on a cross-organizational level; 3) real-time products and services.
Based on these insights, we could derive the following overarching definition of RTE:

Real-Time Economy is a digital ecosystem where transactions between diverse economic actors take place in or near real-time by way of an increasingly automated exchange of digital, structured and machine-readable data in standardized formats.

The resulting acceleration of information exchange and improved access to information is expected to reduce process latencies, save resources and transaction costs, increase organizational efficiency and business competitiveness, increase the speed and quality of decision-making, improve transparency, and stimulate economic and social innovation.

Therefore, RTE could be regarded as a broad concept encompassing different types of activities (transactions between business partners, internal planning and decision-making within an organization, interactions between business and government, service delivery to customers) that can be performed automatically in real time or with a minimal time lag without human intervention thanks to technologies supporting the real-time collection, exchange and usage of data.

1.2. BUILDING BLOCKS AND ENABLERS

RTE literature maintains a strong technical focus, referring to ICT as the main component which enables the development and functionalization of RTE solutions. The centrality of ICT is understandably due to the ‘real-time’ aspect as digital technologies enable turning data into valuable information in real time (Davenport et al., 2004) and give rise to new approaches for real-time service delivery, where customers can experience speed and immediacy in service consumption (Weltevrede et al., 2014). Literature lists several technological building blocks and enablers which facilitate the development of RTE in general:

- **Business software applications** that facilitate real-time and automated business processes, including ERP (enterprise resource planning), CRM (customer relationship management) and EDI (electronic data interchange) systems (Appelbaum et al., 2016; Chan, 2006; Vasarhelyi, 2010). While ERPs serve as an important source of business data, EDIs facilitate machine-to-machine data exchange across organizational boundaries.

- **Hardware for automatic data collection**, such as wireless sensors, RFID, QR scanners, or GPS (Vasarhelyi, 2011; Vasarhelyi et al., 2005).

- **Emerging digital technologies** such as Artificial Intelligence (AI) and smart technologies. Emerging technologies are viewed as creating opportunities for RTE, mostly as these enable routine and non-routine tasks being automated (Van der Aalst et al., 2018). Existing RTE-specific literature does not give definitive answers as to what business functions can be automated with the help of such technologies.
This creates the need to closely monitor developments in machine-learning and AI (Van der Aalst et al., 2018).

- **Machine-to-machine (M2M) communication standards and networks** which improve connectivity between end-users, devices, and servers (Nikaein & Krea, 2011), as well as machine-to-machine applications for processing and visualizing information in as close to real-time as possible (Nikaein & Krea, 2011).

- **Standards** which enable the recording and exchange of data in machine-readable formats (Alles et al., 2002; Kuhlin & Thielman, 2005; Vasarhelyi et al., 2010). Common data exchange standards are one of the main enablers of RTE (Al-Mashari et al., 2003; Chituc, 2017; Umble et al., 2003; Molina et al., 2007; Narayanan et al., 2009; Nurmiilakko & Kotinurmi, 2004; Penttinen, 2008; Kirchmer, 2004; Vasarhelyi, 2008) and are associated with improvements in the overall internal data consistency (Topçu et al., 2014). RTE literature regards **eXtensible Markup Language (XML)** based standards as central to the management of real-time data (Chituc, 2017; Eierle et al., 2014; Jones and Willis, 2003; Gray and Miller, 2009). XML essentially involves machine and human readable meta-languages which are used for e-document management, web publishing and data formats (Chituc, 2017). XML provides the formal syntax for assigning codes and tags to define the meaning of text and is used as a basis of specialized languages, such as the **eXtensible Business Reporting Language (XBRL)** (Jones and Willis, 2003).

  XBRL is an XML-based format tailored specifically for reporting and communicating business information (Eierle et al., 2014). It offers a common language to assign tags to information and exchange data between diverse systems (Eierle et al., 2014). Although XBRL is still under development, it is already in use for purposes such as web-based financial reporting, financial analysis, tax and regulatory filings, internal reports, and consolidations (Gray and Miller, 2009). XBRL is also seen to have a high potential to support continuous computer-based auditing (Eulerich & Kalinichenko, 2018). To date, XBRL has primarily been used for external reporting (Amrhein et al., 2009; Cohen, 2009; Eierle et al., 2014; Gray & Miller, 2009). However, as not all information can be accurately coded through XBRL (Gary & Miller, 2009), the XBRL Global Ledger (GL) taxonomy has been developed as an extension of XBRL. The XBRL GL taxonomy is recognized as a standard for representing financial and non-financial data at a high level of detail, which allows exchanging data between different systems and provides means for drilling down XBRL reports to a detailed level (Amrhein et al., 2009).

- **Supporting ICT infrastructure** such as eID, e-address, e-signatures, or e-payments, which are seen to facilitate data exchange in different fields (Harald, 2018, Penttinen, 2008).

Together with technology, RTE literature also reveals several **organizational mechanisms** which play an important role in establishing the existence of RTE. According to literature, the majority of RTE services are multifaceted and very complex in nature. Therefore, they can rarely be delivered merely by one independent entity. Consequently, **organizational collaboration** is recognized as the core principle upon which RTE
institutions should be built. Apart from this, literature in this field proposes a list of organizational building-blocks and enablers which support RTE initiatives:

- **Business process re-engineering** is regarded as a precondition for a functional RTE (Trego et al., 2014; Vasarhelyi et al., 2005; Vasarhelyi et al., 2010). In essence, public and private organizations must be able to redesign their business processes and establish organizational policies which enable aligning ICT strategies with general organizational orientation. Moreover, organizations in RTE environments need to be able to aggregate data from different sources and integrate these into continuous measurement, monitoring, control and assurance processes, and to enact advanced analytics systems (Vasarhelyi, 2010).

- **Integrating human and automated decision-making.** Recent technological advances allow several business tasks to be automated and executed without human intervention. Yet, with the current cognitive capacities, these technologies are not fully independent when it comes to non-routine tasks. As human beings still play a key role in decision-making, it is important to achieve the complete integration of human and automatic decision-making processes (Vasarhelyi, 2010).

- **Platforms** which enable the integration of business processes on a cross-organizational level (Kuhlin & Thielman, 2005).

- **Digital nervous systems** connecting enterprise, customers, employees, ICT, production, products and suppliers (Chan, 2006; Siegele, 2002).

- **Reorganizing risk monitoring and assessment.** A distinguishing feature of RTE ecosystems is the usage of different ICT-based sensors for real-time response, XML-based technologies, and automation of monitoring and control processes (Vasarhelyi et al., 2005). As organizations obtain access to real-time information about changes in the business environment, fundamental changes in risk monitoring and assessment are expected to take place (Vasarhelyi et al., 2005; Vasarhelyi et al., 2010).

The key building blocks and enablers therefore concern several different levels, from the availability of technologies for producing, storing and exchanging data up to rules and processes to govern the usage of these data.

### 1.3. BARRIERS TO ADOPTING RTE SOLUTIONS

RTE literature also uncovers a set of barriers hindering and obstructing the adoption and realization of a real-time economy. Among the most prevalent barriers are those related to the **scarcity of resources**, i.e. the lack of resources in the right place, at the right time, or allocated to the right people (Knapp et al., 2006). Scarcity results in financial and economic barriers, such as:

- lack of resources for developing, instigating and operating RTE solutions (Al-Mudimigh et al., 2004; Narayanan et al., 2009; Nurmilaakso & Kotinurmi, 2004; Penttinen, 2008),
• lack of resources allocated for RTE solutions by SMEs (Al-Mudimigh et al., 2004; Penttinen, 2008),

• lack of time and resources for reengineering business processes (Hope, 2006),

• lack of access to knowledge and cost of trainings (Al-Mudimigh et al., 2004).

A set of technological barriers hinders attaining RTE objectives. Despite the reduced costs of ICT, developing a sufficient portfolio of technical solutions is still one of the key barriers in the field. The technical barriers and obstacles identified within RTE literature are as follows:

• technical difficulties in connecting RTE network participants (Molina et al., 2007; Rabin, 2003),

• barriers occurring from offline and legacy systems (Belfo et al., 2015; Hope, 2006),

• incompatible technical applications among participants (Ducq et al., 2012; Navarrete et al., 2010; Vera-Baquero et al., 2016),

• lack of common standards for information representation (Navarrete et al., 2010) and data-exchange (Rabin, 2003; Navarrete et al., 2010; Molina et al., 2007),

• syntax and semantic differences (Ducq et al., 2012),

• differences in the degree of digitalization (Ducq et al., 2012).

Lastly, organizational barriers emerge as a result of different types of partnerships required for implementing RTE initiatives. RTE literature reveals five dominant organizational barriers hindering implementation of RTE applications:

• structural incompatibilities among solution implementers (Appelbaum et al., 2016; Al-Mudimigh et al., 2004; Chituc, 2017; Lam, 2005),

• resistance of business to relinquish autonomy and ownership (Alles et al., 2002; Meijer, 2015; Gray & Miller, 2009),

• division of work, tasks and responsibilities amongst participants (Chituc, 2017),

• contradicting values between the public and private sector (Pang et al., 2014),

• changes that are required in management (Appelbaum et al., 2016; Al-Mudimigh et al., 2004).

Although RTE-specific literature makes almost no mention of the effects of regulatory frameworks and legal constraints on RTE, other sources still imply that RTE solutions may face legal issues in different implementation stages. For example, research in the field of e-invoicing shows that while there are no fundamental legal barriers that hinder e-invoice implementation, the legislative requirements of different European Union Member States cause complexities when it comes to cross-border e-invoices (European Commission, 2016). Even though states are implementing supportive legislation, variations in national rules require a through consideration in regards cross-border initiatives (Karantjias et al., 2007).
1.4. RTE IN BRIEF

From an academic point of view, the concept of RTE is attracting increasing attention, although its interdisciplinary nature and early stage of maturity are a source of conceptual confusion and operational barriers. Out of the diverse definitions that exist, the broad vision developed foremost by Finnish researchers and practitioners seems to best encompass the different aspects of RTE. As an ideal, RTE could be seen as an ecosystem of stakeholders and interactions that is based on diverse applications of structured and standardized business data.

The main enablers and building blocks of RTE can be divided into three layers: the core technological infrastructure (base solutions for RTE), e-services that are based on the core building blocks, and lastly the business processes and management decisions around the use of data for organizational purposes. The building blocks are summarized in Table 2.

**Table 2. RTE building blocks in literature**

<table>
<thead>
<tr>
<th>Core technological infrastructure</th>
<th>E-service layer</th>
<th>Management layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-organization integration platforms (Kuhlin &amp; Thielman, 2005)</td>
<td>Continuous reporting, risk monitoring and assessment (Harald, 2018; Varsarhely, 2011; Varsarhely et al., 2005; Varsarhely et al., 2010)</td>
<td>Business process re-engineering (Trego et al., 2014; Varsarhely et al., 2005; Varsarhely et al., 2010)</td>
</tr>
<tr>
<td>Hardware/software that allows automatic data collection (Varsarhely, 2011; Varsarhely et al., 2005)</td>
<td>E-address, e-ID, e-Signature (Harald, 2018)</td>
<td>Trust between participants (Chan, 2006)</td>
</tr>
<tr>
<td>XML languages for specialized reporting (Alles et al., 2002; Varsarhely et al., 2010)</td>
<td>E-Payment, e-Procurement and real-time forecasting (Harald, 2018)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Real-time income register, real-time taxation and asset reporting (Harald, 2018)</td>
<td></td>
</tr>
</tbody>
</table>

As to the barriers to RTE, the difficulties mentioned in literature are often also evident in many other digitalization initiatives. The emergence of RTE can thus be regarded as another manifestation of the ongoing digitalization of economy and society, although its high potential and ambition comes with particularly high complexities. The findings of the review of literature point to the potential of RTE to transform business-as-usual and yield diverse benefits to different actors, from savings to new business value. However, the success of ambitious digitalization projects such as RTE often depends on specific national contexts and countries’ ability to build an ecosystem interconnecting all relevant stakeholders.
2. ESTONIAN STAKEHOLDERS’ VIEWS OF REAL-TIME ECONOMY

In order to identify the expectations of key stakeholders in Estonia and map areas which Estonia should focus on in its efforts towards RTE, we conducted personal and group interviews with 35 stakeholders and experts, who were selected based on their expertise and experience with issues relevant to RTE (see the list of interviewees in Annex 1). Respondents were selected from three categories:

1) Estonian policy-makers and public sector representatives, including officials from the Ministry of Economic Affairs and Communications, Ministry of Finance, Statistics Estonia, and Estonian Tax and Customs Board;

2) Representatives of Estonian companies and business networks, including individual companies operating in RTE-related fields such as e-invoicing (Omniva, Fitek, Telematika, Tieto, Intepia) as well as business associations and networks (Estonian Chamber of Commerce and Industry, Estonian SME Association, PROLOG);

3) Estonian and foreign experts representing academic and practitioner communities.

The interviews were semi-structured and were based on a prepared interview guide, while also involving room for free-flowing discussion and new issues raised by the interviewees. The topics discussed during the interviews involved interviewees’ definition and vision of RTE, its expected benefits and impacts, existing cases and potential implementation opportunities for RTE solutions, perceived barriers and risks associated with the adoption of RTE, and proposals for ways to advance RTE in Estonia. Depending on the interviewees’ profile, we posed additional questions related to their field of expertise (e.g. accounting, taxation, e-invoicing, interoperability, standards).

Based on the interviews, Estonian stakeholders see RTE as a promising concept and associate it with a number of benefits. From the stakeholders’ point of view, RTE is not so much a new type of economy but a digital network or ecosystem that harmonizes public-private collaborations and enables new forms of interaction and service delivery to take place. Stakeholders relate RTE to different real-time solutions that improve the connectivity between participants engaged in economic or administrative interactions, help automate business transactions and reporting, provide secure channels for real-time data exchange, and enforce the same standards for all participants in the network.

The majority of interviewees were optimistic about the positive impacts of RTE. Emerging solutions which constitute RTE ecosystems are viewed as a way to address various challenges that the Estonian public and private agencies face today, such as the efficiency of back-office operations, prediction capabilities, quality of services, coordination, bureaucracy, and administrative and financial burdens. Stakeholders tend to believe RTE can open new opportunities both for businesses and public agencies, fundamentally transforming the way how B2B and B2G interactions take place in Estonia.

The main anticipated benefits and impacts of RTE can be summarized as follows:
Efficiency through automation. One of the benefits attracting the largest stakeholder interest is the efficiency of business processes. For instance, officials from the Estonian Ministry of Finance claim that in general, organizations are struggling with efficiency issues and businesses are not as efficient as they could be. RTE solutions are seen to alleviate the problem of unproductive work, i.e. working time filled with inputting data from one medium or system to another, compiling reports, fulfilling administrative obligations, etc. This can be replaced by the automation of most routine and possibly also certain non-routine tasks. RTE solutions are anticipated to automate business and administrative processes to a previously inconceivable extent, allowing companies to replace routine tasks where humans receive inputs from various systems and process these through particular routines, with machine-to-machine communication. The emerging data extraction processes may then allow organizations to discard the existing manual tasks (Sujatha et al., 2016).

The stakeholders interviewed regard accounting as the first process in which RTE solutions can deliver considerable saving of time and money. According to the Finnish accounting expert Vuokko Mäkinen, as much as 90% of accounting could be automated thanks to RTE solutions. As a first step, solutions such as e-invoices enable firms to easily automate accounts payable and accounts receivable, moving on to other bookkeeping and accounting functions. Interviewees proposed several ways in which automated accounting can increase efficiency. First, many believe complete automation of accounting processes will translate into saved resources. Currently, vast amounts of money is spent for routine tasks that are carried out by ‘data entry clerks’, whose main occupation is to interpret transactions one-by-one and convert business information from paper or files in PDF and CSP formats into machine-readable formats. As emerging RTE solutions can automate such routine tasks, the demand for bookkeepers will fall considerably. In Estonia, the work of accountants is currently estimated to constitute 0.7%-0.9% of the overall national GDP (interview with Margus Tammeraja, Association of Estonian Accountants). Should businesses shift to automated accounting operations, a huge amount of financial resources would become available for further optimization and redistribution for principal business activities that generate added value.

At the same time, some experts are skeptical about the feasibility and even desirability of automating the majority of accounting and reporting processes. For example, Lehte Alver from the Tallinn University of Technology suggested that while typical everyday transactions can be easily automated, more complex functions such as changing the methods of calculations, valuations, or the use of special methods such as inventory accounting or management of intangible assets, still need human intervention. From the small businesses’ perspective, Marina Kaas from the Estonian SME Association expressed caution about fully automating payments and emphasized the need to retain human control over individual transactions. As small companies often have tight cash positions, a careful planning and hands-on management of cash flows may be important for SMEs to avoid risks such as liquidity problems or tax debt. This presumes business managers’ continued ability to approve and prioritize individual payments and negotiate delays if this is deemed necessary.
Automated accounting also enables the **automation of a large part of business reporting**, reducing companies’ reporting costs and administrative burden. Due to the potential of automated B2G reporting, efficiency gains are also evident for public sector agencies. For example, the Estonian Tax and Customs Board (TCB) are already considering abandoning declarations as a form of interaction between businesses and the government: “In RTE, you essentially just have the data. As such, a declaration is the conversion of the same data into one format – data which are later also decrypted by the Tax and Customs Board into their own format.” (Interview with Dmitri Jegorov, Ministry of Finance). According to Jegorov, if collaboration is established between government, banks and businesses, it is possible that “when firms make transfers to their employees they just need to provide their employee’s identity number and salary, and then banks can deduct all taxes automatically and declare them to the Tax and Customs Board”. Pilots of such RTE services are already in place in Estonia. As the first step towards automated reporting, businesses need to reveal their data to the TCB, giving the TCB access to information regarding income, expenses, salary data, etc., and allowing the TCB to acquire a complete overview of a company’s accounts. Nevertheless, interviews reveal that considerable work is still needed in this field, as there is no solution in place to enable entirely automated accounting and reporting procedures.

**Standardization and interoperability.** Interviews revealed standardization as the next major RTE benefit. The adoption of common standards for data representation and exchange is closely linked with improvements in the accuracy of how interacting parties understand the data. Since the adoption of common standards for data exchange among businesses (but also between businesses and governments) is a key prerequisite for RTE, many of the benefits that RTE is expected to create are regarded as “the result of standardization and the ability to securely transfer high-quality data content” (Interview with Margus Tammeraja). If, for example, all B2B and B2G interactions use the same standards, reporting and transactions can be arranged in such a format that they will occur automatically in the background. Therefore, future executives will not need to worry about reporting and transactions but can focus their efforts on improving other aspects of the business and take more accurate and faster decisions about their enterprise.

Complimentary to this, the level of standardization required for RTE solutions promises to **improve system and data interoperability on the national and international level.** Some RTE solutions are already part of the European Union’s Digital Single Market strategies – for instance, the European Parliament approved the Directive 2014/55/EU for the purpose of establishing common standards and enforcing e-invoices in such a way that every state agency is able to accept them. Standardization developments are very important for RTE agenda as they can translate into a sharp increase in the number of cross-border initiatives. Stakeholders expressed the belief that “RTE would definitely give a boost for exporting services and opportunities for growth, […] as these services can be provided in a cross-border level without the need to physically have any local service point present on site” (Interview with Margus Tammeraja). For example, if the Estonian e-Residency program enables foreigners to start a business in Estonia, the same channels may be used to provide them with RTE solutions and open new market opportunities for service providers.
Improved analytics, forecasting and decision-making capabilities. Another benefit uncovered in the interviews is the use of data for analysis, economic forecasting, risk assessment, planning, and decision-making both in the private and public sectors. In the short term, the right analytical skills are expected to grant businesses diverse opportunities, including improvements in target predictions, setting up flash-transactions, enhancing decision-making, optimizing production, and enhancing general process efficiency.

As for the public sector, RTE is expected to greatly reduce the latencies between economic events and the decisions reached based on these events. The current financial reporting practices provide information about the past – the information in accounting and auditing reports is often up to one year old. As another example, most of the data that is currently used by Statistics Estonia originates from secondary sources (Interview with Mart Mägi). RTE solutions are seen to allow government institutions to get as close as possible to the events and observe the latest developments in the economy as they happen, while also generating new sources for harvesting high-quality financial data. Significantly, RTE solutions are expected to address the shortcomings of the current forecasting models used by Estonian agencies. The existing models are considered outdated, which makes the results these models produce problematic. Because of that, agencies “are not good at anticipating unexpected occurrences, or even at modeling and explaining how certain types of events come into existence” (Interview with RTE expert Bo Harald). Estonian stakeholders believe that circulating real-time data can improve existing forecasting models, and the responsiveness of decision-making. There is strong support among RTE stakeholders for the idea that integrating real-time data into traditional forecasting models will result in better outcomes and more reliable prediction models.

In addition to this, RTE solutions also allow capturing additional data upon which new real-time indicators can be developed. Therefore, greater access to information about the forthcoming events is predicted. For example, during warm days, these indicators can show how the weather influences the sale of drinks and how fast people consume them. The results can be used to inform businesses in advance that together with the changes in the weather, drinks sales will rise or fall by a certain percentage.

Improved data quality. Another significant aspect emphasized by respondents’ interviews appertains to improvements manifested in quality of data as a result of RTE solutions. In this regard, interview results reveal a high-level of optimism commonly arising from two dominant aspects. In the first place, automation of business-to-government interactions is expected to reduce data errors on different operational levels, and also minimize the need for human intervention in reporting processes. For example, many routine tasks which at present require human interpretation may be automatized and replaced by technical solutions. And secondly, RTE ecosystems are expected to provide with all the necessary preconditions which improve quality of data thanks to unification, standardization, and development of reliable channels where high-quality data content may be exchanged.

Innovation in public services. Real-time access to business data is also expected to translate into new forms of collaborations, partnerships, public services and roles for public agencies. As the accessibility and quality of data improves, in the long run, public agencies
can develop capabilities to provide intelligent and proactive services to businesses. For example, instead of reporting VAT to tax authorities through a separate process, businesses will only check if the recommendation made by state-run agencies is correct and confirm. As a result, instead of thinking about financial reporting and interacting with the government, “business owners can direct their efforts in other directions and work on generating new ideas which improve existing business processes” (Interview with Janek Rozov, MoEAC). At the same time, as indicated above, improved real-time analytics and prediction capabilities in government agencies may also enable the government to develop innovative personalized services for businesses and citizens.

**Digitalization of business.** Despite Estonia’s high level of e-government maturity, studies such as the Digital Economy and Society Index (DESI) point to the low level of digitalization of the business sector. According to the 2019 edition of DESI, Estonia still ranks below the EU average, i.e. 16th out of 28 EU Member States, despite some recent progress. The concern that Estonian business is still lagging behind in terms of digitalization was also echoed in interviews. Interviewees related the limited integration of digital technologies in the business sector to the costs of adopting digital technologies as well as mentality (focus on saving money but not time). The development of an RTE ecosystem and providing an infrastructure for data exchange is seen as a way for the government to help accelerate digitalization of the private sector, creating new prospects for growth. Given that SMEs are expected to be the main beneficiaries of RTE solutions, even businesses that traditionally have not been able to afford digital solutions will be granted an opportunity to transform back-office processes, reduce service costs, improve service quality, increase compliance with standards, and improve delivery times (Lacity et al., 2015). Due to such conveniences, the overall feeling about doing business in Estonia and entrepreneurs’ hesitation to seizing the initiative can improve.

**Higher business revenues.** Although the current discourse on the benefits of RTE tends to gravitate towards emphasizing savings and efficiencies generated by process automation and optimization, stakeholder interviews also pointed to the need to take a broader view and also explore the added value emerging RTE solutions are creating for the business environment in Estonia. From the business perspective, RTE solutions are expected to result in new business opportunities, new business models, new forms of partnerships, and open new markets. As businesses are constantly under pressure to preserve their market competitiveness (Veit et al., 2014), one of the main questions is how do businesses increase their revenues through RTE solutions? Interview results uncover three possible answers. To start with, process automation and the resulting efficiency gains allow enterprises to optimize their expenditure and provide products/services with higher quality and at more competitive prices. Hence, RTE applications can reduce the need to hire human resources and enable them to execute business tasks better, faster, and cheaper (Willcocks et al., 2015). On top of this, opportunities can be created by the expected improvements in data quality.

Lastly, RTE initiatives can increase business revenues by providing open access to a portfolio of technical solutions that used to be accessible only for big players in the marketplace. For example, only a small number of SMEs can afford technical solutions

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such as EDI, CRM, or ERP systems. Standardized and accessible RTE solutions, if provided by the public sector free of charge or at a minimal cost, can essentially replace existing proprietary solutions. Interview results reveal that SMEs are anticipated to be the biggest beneficiaries of such solutions.

**New (cross-border) business opportunities.** RTE solutions are believed to provide added value by way of opening new cross-border business opportunities. If common data-sharing standards are established at the regional level (e.g. within Baltic or Nordic countries) or EU-wide level, “Estonian enterprises can quickly adapt and utilize new markets for providing cross-border services without physically having to be on the spot” (Margus Tammeraja). This engenders new business opportunities and business models and also provides lucrative opportunities for Estonian e-residents. Despite regulatory differences, interviewees believed that standardization can enable Estonian service providers, including in the field of accounting, to expand their operations to neighboring countries. Nevertheless, accounting represents only one of the many sectors that may benefit from RTE, as RTE is expected to boost the export of services more generally.

**Environmental benefits.** RTE solutions are expected to support environmental agendas as well. The transformation of analog services into digital formats permits reducing operational processes with a high level of residual carbon footprints. For example, research in the field shows that the shift from paper-based invoices to e-invoices can have a significant environmental impact by reducing the carbon footprint by 63% (Tenhunen & Penttinen, 2010). The positive impact of RTE on environment was also emphasized in interviews with representatives of the Ministry of Finance. As environmental issues are becoming more prominent, replacing manual work with digital services can be an important pathway towards environmental goals (Tenhunen & Penttinen, 2010).

**Increase in transparency and trust.** Interview results underline business transparency and trustworthiness as an area where RTE solutions can lead to added value. For instance, according to Margus Tammeraja (Association of Estonian Accountants), a general common classification can be established for specific areas such as working time records, asset accounting or liability accounting, which would simplify obtaining the respective information about companies. Moreover, Tammeraja expects business accounting information to become more transparent, businesses to have better opportunities for obtaining capital thanks to an accurate history and detailed information about business partners. The quick exchange of data from system to system without human intervention is believed to lead to an accelerated circulation of money, which leads to increased trust between business partners but also between businesses and credit institutions. If transactions are completed digitally and banks have access to data about accepted payments, the bank’s risks of financing are reduced and companies that conduct their business in a transparent manner may have improved access to credit. Nevertheless, the sensitive nature of business transparency is the main reason why decisions in this field can be very delicate. In many industries, it is the asymmetry of information that gives companies competitive advantages. Therefore, interviewees considered it crucial for RTE solutions to be able to protect business secrets, patents, and other rights that affect business competitiveness.
Impacts on labor market. At the core of RTE solutions is automation, i.e. programming computers to mimic human behavior by navigating through applications and processing data in accordance with predefined rules (Barnett, 2015). It is expected that in the accounting context, “in ten to fifteen years [...] accounting algorithms will do the posting, i.e. creating nominal ledger records according to conceptual XBRL Global Ledger taxonomy framework, without any human intervention, just based on standardized content of transactional data.” (Margus Tammeraja). Although experts believe that the automation of accounting will inevitably reduce the need for human labor, this does not necessarily mean that the accountants’ profession will vanish. While a huge number of accountants is expected to be left without a job, others will potentially redirect their competences towards non-routine tasks requiring cognitive capabilities that machines do not possess yet, acquiring the role of strategic advisors rather than data entry clerks. RTE-induced changes are also expected to lead to changed requirements for the workforce in general, for example through requiring basic ICT skills from employees.

Overall, Estonian stakeholders and international experts associate real-time economy solutions with a variety of benefits, ranging from the reduction of bureaucracy at the organizational level to broad societal impacts concerning the economy, workforce and environment. As such, stakeholders’ views largely reflect the variety present in literature. At the same time, this variety also points to the complexity of the ‘real-time economy’ phenomenon. In order to realize the vision and benefits that stakeholders put forward, we therefore need to identify the key building blocks of the RTE ecosystem and understand what already exists and where the gaps and barriers lie. The next sections will look further into these issues.

2.1. WHAT BUILDING BLOCKS EXIST IN ESTONIA?

As the literature review and interviews revealed, RTE could be seen as a data-driven ecosystem consisting of stakeholders such as governments, businesses and customers/citizens as well as the interactions and feedback loops between them. RTE literature outlined a set of technical and organizational building blocks that are seen as enabling the collection, storage, transfer and use of real-time data for business administration and transactions between different actors. In particular, research emphasizes the need for software, standards and infrastructures that would facilitate secure machine-to-machine cross-organizational data sharing. At the same time, in order to integrate and harness benefits from RTE solutions, the adoption of technological solutions needs to be accompanied with organizational change, from restructuring business processes to reviewing and rebuilding whole business models. The interviewed Estonian stakeholders and experts had a similar understanding of the building blocks, mostly highlighting the technical and governance elements of RTE but also stressing the need for a proper legal framework. The following components were frequently mentioned:

E-invoices, i.e. the shift from paper- or PDF-based invoices to the exchange of structured invoice data directly between information systems. E-invoices are regarded as a base solution upon which many other business functions can be automated.
Automation of business reporting. The majority of interview respondents highlighted the automation of business reporting functions as one of the most significant aspects of the implementation of the RTE vision. Interviews also highlighted the need for establishing rules that allow governing these systems and predicting how such rules will look like on a macro and micro level.

Universal standards. One of the main components enabling the RTE vision to come into practice is the establishment of common standards. In the near future, the establishment of different RTE solutions will be dependent upon the type and qualities of the standards that stakeholders agree upon. The implementation of RTE requires stakeholders to agree on standards for structuring data, data exchange, trust, and security. One standard that was constantly mentioned throughout interviews was the XBRL Global Ledger taxonomy framework. As for now, it is known to be one of the most advanced standards allowing business transactions to be recorded as an accounting entry. However, there are many uncertainties regarding the adoption and agreement on standards as standardization choices are also expected to enable smooth cross-border interoperability and thus require agreement at the European level.

Base infrastructure and governance framework. Several interview respondents referred to the role of the state as the main stakeholder that should be in charge of developing the base infrastructure upon which businesses can further develop RTE solutions and applications. Moreover, the involvement of government is expected to provide different types of safeguards, establish a sufficient level of trust between participants, ensure data protection, put in place the required interoperability and governance framework, and guarantee equal access to RTE infrastructure.

Legal framework. The regulatory environment plays an important role in supporting the implementation of the RTE vision. Legislation was mentioned in particular as regards the shift to e-invoices and potentially e-receipts, but also in relation to creating a legal obligation for fully digital bookkeeping. One of the respondents suggests developing a law-based timeline within which the introduction of RTE solutions should become mandatory and transaction data would become fully standardized, paperless, and available in machine-readable formats. However, interviews revealed conflicting views on the role of regulation. A majority of respondents believe that regulation and legal obligation is the key to reaching widespread RTE adoption, while others argue that the adoption of RTE solutions must occur naturally and regulations do not ensure success as they risk over-standardization. One of the interviewees also suggested considering aspects that go beyond legal frameworks, such as ethics within RTE ecosystems.

The components of RTE that experts highlighted are well in line with the findings of the literature review. The main difference seems to be in the level of importance that stakeholders assign to e-invoicing as a core component of RTE and a building block that provides the basis for automating a number of business processes. Interviewees also demonstrated a slightly broader outlook on RTE than most of literature, going beyond the organizational level and emphasizing the governance and legal framework as important enablers. In this respect, stakeholders clearly see the government as having the role of creating and maintaining an enabling environment for RTE.
Some of the building blocks of RTE already exist in Estonia. In terms of a broader enabling environment, Estonia’s national data exchange layer X-tee (based on the X-Road technology) and the existence of unique identifiers for private persons and companies along with the widespread usage of eID all lay the groundwork for electronic data exchange and cross-organizational machine-to-machine communication. While this general infrastructure has already existed for close to two decades, steps have been taken in the recent years to increase the availability and reuse of company data in standard machine-readable formats. The following initiatives deserve particular attention:

**Internet of Business** (IoB, 2016-2018) was a project led by the Estonian Association of Information Technology and Telecommunications (ITL), which aimed to develop a platform and a stakeholder network to facilitate real-time cross-border business transactions in the Baltic Sea region. The first phase of the project, funded by the European Union Strategy for the Baltic Sea Region (EUSBSR) Seed Money Facility, lasted from 2016-2017 and focused on analyzing the baseline of real-time economy in the Baltic Sea countries and building a consortium of partners for the joint development of a digital platform for real-time business transactions. A particular aim of the project was to engage SMEs in the development and testing of the solution. The second phase started in 2017 with funding from the CEF Telecom Program’s e-Invoicing call and focused on the adoption of the EU Norm for e-invoicing and creating local PEPPOL Access Points to enable the use of the European e-invoicing and e-delivery services. As a result, Estonian e-invoice solution providers (Telema, Tieto, Omniva) were connected to the international PEPPOL network and Estonian document formats were harmonized with PEPPOL, giving Estonian private and public sector users the possibility to send and receive e-invoices from business partners abroad.

**Reporting 3.0** is an ongoing joint initiative of Statistics Estonia (SE), Estonian Tax and Customs Board (TCB) and Bank of Estonia (BE), which developed out of the national “Zero bureaucracy” initiative. Reporting 3.0 aims to create an automatic B2G data transfer solution to streamline business reporting on financial, workforce and statistical data. This means that instead of making companies submit declarations and fill out questionnaires for different authorities, data collectors would capture transaction-based data directly from business information systems for reporting and statistical purposes. As the first step of the project, data collectors (SE, TCB, EB) developed a unified ontology and adopted XBRL GL as the common standard for data exchange. In order to submit data, companies need to create an interface for XBRL-based data exchange in their accounting software, determine which data, when and with whom to share, and set up automatic data transfer to the respective data collectors. Based on the raw data received, reports are generated and all necessary calculations made automatically on the data collector’s side.

As of 2019, salary and workforce data can be submitted to Statistics Estonia directly from an enterprise’s accounting software via the national data exchange layer X-tee. In the next

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4 See [https://www.mkm.ee/en/zero-bureaucracy-0](https://www.mkm.ee/en/zero-bureaucracy-0) for more information
phases, taxonomies will be created and automatic data transfer will be enabled for statistical data on revenues and expenditures, foreign trade of goods and services, assets, liabilities, equity and prices. TCB currently already accepts VAT and income and social tax declarations in XML or CSV formats and enables machine-to-machine transfer of employee registration data from companies’ personnel management systems to TCB via X-tee. In the coming years, TCB plans to shift to XBRL GL-based data transfer.

Two pilots have been launched in this area in partnership with the LHV Bank. First, companies that have an account with LHV can submit salary data directly to TCB along with salary payments to employees. The TCB then helps companies calculate the eligible tax-free income for their employees. Secondly, the Entrepreneur Account\(^5\) service offers private entrepreneurs the possibility of virtually bureaucracy-free management of their incomes and expenses, provided that their income remains below 40,000€ per year. All income received to the account from the sales of goods and services is automatically taxed with 20% income tax rate (or with 40% rate if the amount exceeds 25,000€). When using the Entrepreneur Account, an entrepreneur is freed of the obligation to submit tax declarations and reports.

**Regulatory framework for RTE.** Since 2017, the Accounting Act\(^6\) encourages companies to use machine-readable source documents for accounting. In 2018, the government adopted a regulation defining an XBRL-based taxonomy for annual reports, allowing the submission of annual reports to authorities as an XBRL file\(^7\). The most recent amendments to the Accounting Act introduced the obligation for all suppliers to submit e-invoices to public sector organizations since 1 July 2019. According to the law, e-invoices need to comply with the European standard or follow the Estonian guidelines for e-invoices.\(^8\)

**DIGINNO** (Digital Innovation Network, 2017-2020) is a collaboration of governments and private companies in the Baltic Sea Region co-funded by the European Regional Development Fund. It is part of Policy Area Innovation of the EU Strategy for the Baltic Sea Region and aims to advance digital economy and the EU single digital market in the Baltic Sea Region. As part of the project, three cross-border pilot showcases have been launched in the areas of e-receipt, e-consignment notes (e-CMR) and ‘Know Your Customer’ (KYC).

In the area of e-receipts, Estonia already has basic technical readiness to implement digital receipts. For example, several companies (Omniva, Fitek, Tsekk.ee) provide the service of digitizing paper receipts, while mobile payment applications such as mTasku automatically issue real-time electronic receipts after each purchase. The implementation of e-receipts is also facilitated by the existence of e-invoicing standards and e-receipt guidelines developed in Finland. However, the current challenges include the lack of an agreed standard for e-receipts, lack of a legal basis and low interest from retailers. In order to tackle these challenges, the DIGINNO e-receipt showcase aims to conduct a feasibility study on e-receipts, provide funding for prototyping solutions for cross-border e-receipts and work with regulators for standardization and regulation activities.

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\(^6\) [https://www.riigiteataja.ee/akt/115032019012](https://www.riigiteataja.ee/akt/115032019012)

\(^7\) [https://www.riigiteataja.ee/akt/114122017012](https://www.riigiteataja.ee/akt/114122017012)

\(^8\) [https://www.riigiteataja.ee/aktilisa/1230/4201/9008/RM_18042019_m19lisa.pdf#](https://www.riigiteataja.ee/aktilisa/1230/4201/9008/RM_18042019_m19lisa.pdf#)

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Know Your Customer (KYC) procedures in institutions such as banks currently involve a lot of redundant data collection and multiple requests of data that already exists in a public or private database. The aim of DIGINNO’s KYC pilot is to find ways to streamline data collection from individuals and businesses by sharing data among public and private partners in or close to real time. The pilot activities involve conducting a feasibility study, development of frameworks and standards for national-level and cross-border data sharing, and the development of a joint KYC utility to enable secure data exchange.

The e-CMR pilot works in the area of logistics and aims to turn the currently heavily paper-based consignment notes in road transportation into a ‘living’ process-based dataset including all events in a cargo’s lifecycle and involving different modes of transportation. As part of the DIGINNO initiative, countries work together to conduct a feasibility study, prototype and develop a pilot to test the technical implementation of an e-CMR system. The realization of e-CMR is challenging as it requires bringing together hauliers, cargo senders and receivers, public registers containing tax and business information, and EDI/e-CMR service providers. The required steps involve agreement on national rules and standards and access rights to data, building an open infrastructure for data exchange that is interoperable at the EU level, and work on the unification of indexing codes at the national and, eventually, EU level.

Industry 4.0 is an initiative of Estonian ICT cluster (ITL) involving a number of companies and digital solution providers which aims to promote and support the digitalization of industrial companies. This initiative places a particular emphasis on the development of real-time supply chains to reduce workload and minimize unplanned costs. The cluster has launched several pilot projects to demonstrate the benefits of implementing new technologies in industry, including those facilitating the use of real-time data. As one pilot, a demo environment was created to analyze the supply chain and test industry digitalization solutions in the metal works company Hyrles OÜ. During the pilot, different pieces of enterprise software and communication tools were integrated into a single system to enable the real-time management of the company’s supply chain. ITL and its partners also work to share best practices in the field of industry digitalization from the Baltic Sea Region countries. Many of the success stories are based on integration and developing capabilities for exploiting real-time data.

SEPA instant payments. Real-time transactions are also becoming widely available in banking. The new instant payment solution (Instant Credit Transfer) within the single euro payments area (SEPA) allows European consumers, businesses and public administrations to make and receive payments almost in real time across Europe. The solution enables payments of up to €15,000 between European banks in less than 10 seconds 24/7. In essence this means that employees can receive salaries on their bank accounts even on a Sunday morning. In 2019 the Estonian stakeholder forum on retail payments (initiated by the Bank of Estonia, Ministry of Finance and Estonian Banking Association) adopted a roadmap towards the adoption of SEPA instant payment. The roadmap states that the majority of larger banks in Estonia already enable instant payments and instant payment is soon expected to become the norm. As the next step, the roadmap envisions

9 See https://itl.ee/industry
developing person-to-person (P2P) instant payment solutions and mobile applications that could replace cash payments between individuals and work as easily as “sending a WhatsApp message to a friend”. The roadmap also foresees the development of consumer-to-business (C2B) instant payment solutions that could replace cash and card payments at retailers and businesses in the services sector.

This brief overview above shows that a variety of RTE-relevant initiatives have emerged in different sectors, from accounting and reporting to supply chains and banking services. This serves as an important argument for adopting a broad approach to developing RTE in Estonia, i.e. one that goes beyond core solutions such as automated reporting and also embraces global trends in business digitalization that largely build on real-time data exchange.

2.2. BARRIERS AND CHALLENGES FOR ESTONIA

Despite the emerging building blocks and increasing stakeholder interest in RTE, interviews revealed a number of barriers and obstacles that are expected to challenge the further implementation of RTE solutions in Estonia. In many ways, the barriers do not seem to be RTE-specific but can be regarded as common across digitalization initiatives. Summing up, the following barriers were mentioned frequently:

**Conceptual complexity of RTE.** One of the biggest barriers relates to the lack of a common understanding of the concept of RTE. Firstly, even though the majority of interviewees agreed that RTE helps reduce process latencies, they defined the ‘real-time’ aspect differently, depending on the particular context. For instance, stakeholders engaged in the domain of e-invoices tend to measure process lags in seconds, or in some cases even milliseconds. However, the same is not evident for all transactions. As an example, interviewees raised the question of whether companies should bill as soon as a transaction occurs or whether additional accounting transactions are required in order to record the transaction in the accounting system. In these cases, ‘real-time’ may not mean instantly. Similarly, Vuokko Mäkinen, an expert engaged in RTE initiatives in Finland, explained that Finnish employers must upload salary calculations to the Income Register within five days of payment. After this, the Income Register office can share this information automatically with insurance companies and tax authorities. Despite a delay of several days, it is still considered to take place in real-time compared to how long it used to take before.

The second aspect leading to conceptual barriers is the definition of RTE itself. When asked about the current demand for RTE, Karl-Eric Schneider from Fitek (an e-invoice solution provider) replied asking “how can we have demand for something when we do not know what it is yet?”. Schneider also emphasized the need for a high-level vision of RTE and its value, so that specific solutions, such as real-time reporting, e-invoices, accounting or payments could be developed under the guidance of the overriding vision.

**Lack of understanding of added value of RTE.** Several interviewees expressed concerns that entrepreneurs miss out on a clear picture of the value that RTE adds to their
business. Unless awareness of the benefits increases, lack of attractiveness is a barrier which may continue obstructing adoption of RTE. A good example in this context is the deployment of e-receipts in Estonia. As this is a new solution, companies do not yet understand how they could benefit from adopting e-receipts. Despite claims that the technical solution works well, acceptance of this service is very low as it currently lacks a business model that would attract business owners to join such initiatives. The number of digitalization initiatives labeling themselves as RTE projects is still moderately low. Due to that, several respondents emphasized the need for sharing knowledge about the very basics of RTE solutions.

**Costs of RTE.** Interview results touch upon several issues related to the price RTE stakeholders pay for developing RTE ecosystems. State-run agencies are the first to face the challenge of acquiring the right level of funding required to develop a sufficient portfolio of solutions (Lam, 2005). However, the involvement of the public sector in developing RTE solutions does not fully liberate businesses from their responsibility to invest in their capacity to join RTE ecosystems. The extent to which private businesses are willing to do this raises concerns. At present, over 98% of Estonian enterprises are registered as micro companies or SMEs (Statistics Estonia 2019) – in other words, companies with limited resources. Moreover, many of the respondents also claim that the cost of RTE solutions is not always smaller compared to traditional approaches to B2G interactions. For example, in the accounting context, it is more convenient for Estonian SMEs to continue hiring accountants at a cheap price rather than invest thousands of euros in buying software to automate the same functions. Another concern is the cost of maintaining RTE solutions. For instance, if financial reports are prepared by humans then companies can respond to possible changes in national financial reporting requirements through providing training. However, if reporting is automated, such changes may require major investments to upgrade information systems.

**Problems with data quality.** RTE presumes the collection of data from multiple disparate sources. Research shows that data management processes, including collecting, storing, retrieving, and processing data often give rise to data quality problems (Hazem et al., 2017). At the same time, the improvement of data quality is often associated with improving processes, rather than the data itself (Hazem et al., 2017). With machine-to-machine communication being the core component of RTE, respondents interviewed identified the absence of data standards as an obstacle in this context. For example, “most of the companies do not look beyond their own sphere or agreements with their partners […]. Therefore, large amounts of data that is moved today in the form of e-invoices, tend to be useless” (interview with Margus Tammeraja). As these data are needed for business reporting, data quality problems commonly increase the administrative burden for businesses requiring them to allocate additional resources to interpret the data in the corresponding reporting format. According to Margus Tammeraja, if data quality does not receive enough attention in the design phase of RTE, its implementation will be seriously hindered.

**Businesses’ resistance to sharing data.** Several interviewees identified the resistance and intransience of businesses to sharing data as one of the biggest barriers that may hinder development of RTE solutions. Recently, public and private organizations have increasingly been investing in improving their capacity to collect and process a broad
variety of customer data. As they commonly perceive themselves to be the legal owners of these data, they tend to be protective and refuse to share customer data with other companies (Lam, 2005). For this reason, building a strong and secure RTE ecosystem is a key factor for establishing trust among participants and encouraging adoption of this. Interviews proposed two approaches for dealing with this resistance. First, interview respondents demonstrate that there is sufficient awareness amongst RTE stakeholders concerning the importance of preserving business secrets and confidentiality. Therefore, RTE solutions should be designed in a format that during data exchange, business secret and intellectual rights are preserved through “what is called semi-public exchange of information” (interview with Margus Tammeraja). On the other hand, the way businesses perceive the idea of sharing commercial and confidential data with state agencies could be changed by creating incentives for sharing data – this means establishing a logic where the more data businesses share with trustworthy parties, including Tax and Customs Board, Bank of Estonia, or Statistics Estonia, the more benefits they will receive in return. At the RTE discussion seminar on 14.06.2019, participants proposed granting small tax breaks for those who share their data as a potentially powerful incentive. However, they noted that the costs of such incentives should be carefully weighed against the increase in tax revenues expected as a result of automated reporting and data-driven taxation.

**Businesses’ resistance to transforming business processes.** Digital transformation initiatives entail changes at different organizational levels (Henriette et al, 2016). Interviewees frequently emphasized that the changes brought about by RTE may encounter considerable resistance. Accordingly, respondents revealed three main reasons why resistance to change may occur. The biggest barrier is that people inherently tend to resist change. As stated by Marika Korka from Statistics Estonia, Estonian businesses are aware of the time that they can save thanks to automation; however, “as long as human labor is cheaper and safer, their faith in technology will still be low”. As the current low cost of labor makes the payback time of investments into IT solutions very long, companies prefer to hire human workforce. Secondly, respondents repeatedly stated that not every business will benefit equally from RTE solutions. As a rule, RTE initiatives improve the accessibility of different technological solutions even for enterprises that normally cannot afford them. This aspect may trigger resistance among big companies as equal access to RTE solutions can mean a loss of competitive advantages in the market. Lastly, resistance can arise from unwillingness to comply with all the changes that RTE initiatives require. Companies in Estonia currently report their taxes only once per month. Therefore, on a practical level, it may be burdensome or costly for businesses to reconsider their whole reporting operations rather than simply maintain what they have.

**2.3. ARE THE BUSINESSES ON BOARD?**

In order to examine Estonian companies’ awareness of RTE and their readiness to implement key RTE solutions in more detail, MoEAC conducted an online survey among Estonian businesses from April to May 2019. The survey invitation was openly disseminated among Estonian companies and business networks, yielding 153 responses. The majority of the respondents represented SMEs based in Harju County and Tallinn.
About 6% of respondents represented medium-sized companies with 50-249 employees and 8% large companies with over 250 employees. Due to the limitations of the sample drawn for the survey, the results are not statistically representative of the full population of Estonian companies but do give some indications of companies’ readiness and needs as regards RTE solutions.

Out of the 153 respondents, 58% had heard of ‘real-time economy’. Awareness of RTE was greatest among companies operating in Tallinn. The components that respondents frequently associated with RTE included e-invoices (91%), e-receipts (74%), e-consignment notes (77%), the Reporting 3.0 pilot (77%), automated reporting (58%), automated statements of economic transactions in the company’s accounting system (67%), e-procurement (65%), mobile ID, smart ID (61%) and instant payments (50%). Less commonly, respondents considered the XBRL GL standard, corporate account, e-ID, real-time economic forecasting and real-time taxation as parts of RTE.

The main benefits of RTE are seen in the opportunity to save time and money by automating manual administrative and support services (95%), simplifying reporting (73%), using real-time information for better risk management and forecasting (71%), monitoring business operations (62%) and digitalizing business processes (49%). Companies with over 250 employees also regarded reallocating labor to more productive work as a benefit. However, most respondents did not report spending a significant amount of their working time on manual administrative procedures, such as handling PDF invoices, entering and retyping data, drawing up reports manually, etc. This is likely due to the prevalence of SMEs among the respondents and their typically lower volume of business. The respondents also did not consider it very important to be able to automatically receive information on economic transactions to their accounting software or continuously monitor their business indicators and financial status based on real-time data. Companies exhibited even lower interest in being able to purchase products and services on a uniform procurement platform instead of each supplier’s own platforms.

When asked specifically about e-invoices, more than half of the respondents (less among smaller companies) believed their company’s information systems were ready to receive machine-readable documents. 22% of respondents reported using e-invoices, 49% use them to a limited extent and 28% not at all. Companies with up to 9 employees explained not using e-invoices by lack of software, lack of support, low volumes of invoices or business partners’ inability to accept e-invoices.

Most respondents did not favor the immediate adoption of mandatory e-invoices in business-to-business (B2B) transactions. Similarly, less than half of the respondents (41%) favored mandatory e-receipts. About one-fourth of respondents supported introducing a legal obligation for e-receipts and e-invoices in the future, while a fourth opposed both. Companies with over 250 employees seemed to have the strongest support to mandatory e-invoices and e-receipts, whereas companies with 4-9 employees were not in favor of mandatory e-receipts.

Respondents considered companies’ low readiness for digitalization and low awareness of real-time economy, technical functionality of the system, potential data leaks and need for excessive investment as the biggest barriers to RTE.
Although lack of trust in the potential users of the company’s data was not explicitly considered an important obstacle (mentioned by 29%), trust concerns frequently came up in open-ended answers to other questions. The main risks associated with RTE solutions were data leaks or system failures, whilst about a tenth of respondents did not see any risks. Representatives of companies with over 250 employees tended to agree that RTE allows optimizing their work processes, whilst smaller companies feared losing control over their own data and giving too much control to the government.

Companies still considered it possible to adopt specific RTE solutions. 75% of respondents thought it possible to submit annual reports automatically to the business register in the future and transfer their company data to the Tax and Customs Board in real time. 57% found it technically possible to submit their company’s data automatically to the Statistics Board. However, many respondents expressed uncertainty about how automatic reporting would work in practice (e.g. how to submit qualitative and subjective information or introduce corrections and adjustments). Moreover, small companies often still use Excel spreadsheets and do not carry out ongoing accounting. Some feared that automated reporting may require excessive investments, questioned the capabilities of the Tax and Customs Board and Statistics Estonia to request information according to the needs of RTE, expressed caution about increased state control and possible over-regulation as well as concerns about excessive workload and possible data leaks. Although not much can be concluded from this small sample about Estonian companies’ readiness and attitudes more broadly, the results still indicate that challenges are likely in the implementation of real-time technologies in the business sector.

In order to mitigate the risks and overcome barriers, respondents stressed that any RTE solution should be simple, safe and secure to use and usable on a cross-border level. Some also mentioned the importance of providing benefits for e-residents, for example by facilitating the submission of English-language reports. The next section will zoom in on the cross-border aspect of real-time economy and take a look at some of the existing and emerging initiatives in Europe that may be relevant for Estonia’s RTE efforts.
3. RTE INITIATIVES IN EUROPE

While the vision of a full-fledged real-time economy is not a reality yet, a number of initiatives have emerged not only in Estonia but in other European countries even as early as at the end of the 1990s to develop data exchange standards and digital communication channels. Over the last decade, the EU has also been devoting increasing attention to cross-border interoperability as part of its efforts to create an EU Digital Single Market. Stakeholder interviews pointed to cross-border interoperability and alignment of RTE efforts with neighboring countries as an important goal for Estonia; hence, the following section discusses a small selection of RTE-related initiatives in Europe.

3.1. STANDARD BUSINESS REPORTING IN THE NETHERLANDS

The Netherlands has long wanted to improve the relationship between the public sector and enterprises. In an effort to reduce administrative burden, provide reliable and comparable financial data, adoption of technology to facilitate regulatory compliance, and re-use information to avoid duplication of efforts, the Netherlands started first efforts on standard business reporting (SBR) as early as 2004, with an essential re-boot in 2009 (Dutch Government, 2017). In the Netherlands, SBR essentially helps to automate reporting efforts of enterprises, and thus stands at the end of the business process and yet provides an important building block for RTE.

The core idea of SBR is to streamline data definitions, processes and technology, and put emphasis on the use of XBRL for this purpose, including XBRL taxonomies and XBRL for structured information in reports. After an originally low take-up of SBR, recent years have seen a significant increase – 99.6% of the annual report submissions to the Chamber of commerce are done using SBR, 40% of the VAT declarations are already done using SBR, and 100% of the corporate tax is reported using SBR (Kuipers, 2018).

Several lessons can be learned from the success of Dutch case. Firstly, the adoption of SBR has been the result of a long process that started in 2004 with the National Taxonomy Project, a parliament-led effort to develop a common national reporting taxonomy based on XBRL. The choice to adopt a single national taxonomy (while allowing extensions) helped prevent the semantic heterogeneity in the taxonomies used by different agencies and the systems that store the original data (Bharosa et al., 2012). Secondly, the process has been coordinated centrally in collaboration with the key stakeholders. Although the Tax Administration in the Netherlands was one of the first agencies to start working with the XBRL taxonomy (Donnelley, 2017), SBR has not been an initiative of the tax agency but a cross-governmental policy priority led by a consortium of the Ministry of Justice and Ministry of Finance (Bharosa et al., 2012).
3.2. RTE INITIATIVES IN FINLAND

Finland has been a pioneer in promoting real-time economy at the national level. The Finnish approach to RTE has been focused both on the B2B and B2G transfer of real-time information on business transactions. In order to facilitate automated data exchange and real-time reporting, Finland has been among the first countries to work on making receipts and invoices available in electronic formats.

Finland is home to the world’s first academic competence center dedicated to RTE. The Real-Time Economy Competence Center (RTECC) was founded by the Aalto University’s School of Business and Tieto OY and involves a number of industry partners in its work. The RTECC defines RTE as “an environment where all the transactions between business parties are in digital format, increasingly automatically generated, and completed in real-time both from business and IT-processing perspectives”11. The center’s work is driven by the belief that RTE could bring “enormous” benefits to society, from increased productivity to environmental benefits. Over the years, RTECC and other stakeholders have launched a number of projects to advance RTE in Finland:

**The XBRL Finland Consortium** is a collaboration platform of Finnish private companies and public sector organizations established in 2012 to lead Finland’s XBRL taxonomy development, raise awareness and promote the use of the XBRL reporting language in financial and tax reporting. The consortium is part of the XBRL International network.12

**SME50** explored the possibilities to reduce SMEs’ administrative burden by 50 percent through the automation of the financial value chain. This included studying how to utilize structured data on business transactions to automate accounting and cash flow estimates, exploring a universal reporting interface to transfer structured data to authorities (using XBRL), studying the possibilities for complementing financial information with information about environmental sustainability, and building models for enterprise risk management.13

**TARU** (2014-2015) was a collaborative research and development program aiming at the full digitalization and automation of financial administration processes. By way of the standardization of message content, interfaces and data, TARU aimed to facilitate the real-time B2B and B2G data exchange and the automatic collection of administrative reporting obligations from corporate financial systems.14

**TALTIO** (2016-2017) promoted business digitalization, starting from developing a standard model for structured data that defines formats for entering invoice, receipt and account statement information into financial management systems without any manual work.15 The resulting TALTIO data model has already been used as input in subsequent RTE initiatives, such as the Nordic Smart Government project (see below).

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12 [https://oma.tieke.fi/display/XBRL/XBRL+Suomi](https://oma.tieke.fi/display/XBRL/XBRL+Suomi)
15 [https://taltio.net/](https://taltio.net/)
**RTECO** is a project launched by the Finnish technology industries’ network (*Teknologiateollisuus*) in 2017 bringing together companies and public administration organizations to help develop RTE ecosystems. The project has two subprojects: one promoting the adoption of e-receipts and the other one focusing on business digitalization.\(^{16}\)

**KATRE** (Income register project) is a joint project of the Finnish Ministry of Finance and the Tax Administration. It initially aimed to reduce the financial reporting-related administrative burden for SMEs but has expanded to a nation-wide initiative with the goal to simplify a number of reporting obligations and allow employers, citizens and public authorities to monitor data on earnings, benefits and pensions in real-time within their limits of access. The backbone of this initiative was the creation of a central national database, the Incomes Register, in 2018. As of 2019, the register contains information on wages and income but will also include information on pensions and social benefits by 2021. Employers report individuals’ earnings to the Incomes Register in real time whenever a payment is made, and public authorities, such as the Tax Administration, Social Insurance Institution, Employment Fund or Statistics Finland, will be able to use this information to fulfil their duties. This saves companies from the need to report the same information individually to different authorities.\(^{17}\)

Finland has also introduced legislative initiatives to support RTE. In 2010 the Finnish Government Program made **e-invoices** the default option in G2G and B2G transactions. In fact, early forms of electronic invoicing had already been in use among some Finnish companies and public sector organizations for several decades, using standards such as EDIFACT, and later Finvoice (a national e-invoice format based on XML). According to Vuokko Mäkinen, Finnish accounting expert, large companies, who already heavily used EDIs, drove the adoption of e-invoices due to their motivation to fully digitalize their financial administration processes. This also created pressure for their smaller business partners to shift from paper to e-invoices.

When introducing e-invoices, Finland started with low data validation levels and loose requirements to the formats to minimize the threshold for adoption. According to experts, this has led to substantial penetration over the years, especially in B2G invoices, but its downside has been the uneven quality and diversity of content of e-invoices – for example, an XML file could sometimes just carry an image as the content instead of structured data. The Finnish approach has therefore involved some trade-offs between data quality and rate of adoption.

According to the current statistics of the State Treasury, 92% of all invoices sent to the public sector in Finland are electronic.\(^{18}\) Although not mandatory, e-invoicing is also common between private companies.\(^{19}\) In April 2019, the government adopted a new e-procurement and electronic invoicing law to implement the European e-invoice directive\(^{20}\).

\(^{16}\) [https://teknologiateollisuus.fi/fi/rteco](https://teknologiateollisuus.fi/fi/rteco)
This established the European e-invoice standard in Finland, increased the number of mandatory data fields, and allows both public and private organizations to demand their suppliers to only submit e-invoices, should they decide so.

Currently, the most widespread standards are TEAPPSXML and Finvoice, both based on an XML. Both standards have been upgraded to meet the requirements of the European e-invoice directive. Economic operators can submit and receive e-invoices through their own accounting software or via platforms provided by the State Treasury free of charge. It is also possible to send e-invoices to government agencies using the PEPPOL network.

Regarding private persons, the Finnish Tax Board also enables self-employed citizens to sign up for receiving e-invoices from the tax office directly to their online bank. This allows their accounts to be automatically debited to pay real estate taxes, prepayments and back taxes without the need to enter additional information.21

As a more recent attempt, Finland is also aiming to introduce e-receipts in the near future. To this end, the e-receipt working group of the RTECO project has developed guidelines22 and organized information and discussion events to promote the solution. The Finnish Tax Board sees e-receipts as an important enabler of its vision to shift to automatic data-based VAT reporting. Although Finland has technical readiness to implement e-receipts, experts note that stakeholders – in particular large retail companies – have been reluctant to come along and give various parties access to their sales data.

### 3.3. E-INVOICING AND BUSINESS REPORTING IN DENMARK

Denmark was one of the first countries in Europe to establish mandatory B2G e-invoicing in 2005. In order to facilitate electronic invoicing, the Danish government develops and maintains the NemHandel platform as the mandatory infrastructure for sending e-invoices to the public sector. NemHandel is often also used in B2B transactions23. Currently, more than 51 000 public and private organizations have joined the NemHandel. Denmark uses the OIOUBL standard for e-invoices, which is based on UBL 2.0. Since May 2019, central government agencies are fully connected to the PEPPOL network, with local and other agencies aiming to join in 2020 to enable greater cross-border interoperability within the EU.

Compared to Finland, Denmark applied much stricter rules on the content and format of e-invoices. This has led to higher data quality but lower penetration of e-invoices than in Finland. By 2020, Denmark also plans to make B2B e-invoicing mandatory, seeing this as a key way forward for RTE.

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The Danish e-invoice system is based on the same architectural principles as PEPPOL and uses a four-corner model. The users of the NemHandel network are also able to reach users on the PEPPOL network. The Danish Business Authority supports the implementation of e-invoicing by providing IT vendors with guidelines, validation tools, open source components and information materials.\(^{24}\)

In 2011, Denmark introduced the obligation for certain categories of companies to submit their annual financial reports in the XBRL format, gradually shifting to full XBRL reporting for all companies in the following years. The availability of annual reports in XBRL has permitted the reports to be published as machine-readable open data and, more recently, testing machine-learning techniques to develop an early warning system for possible corporate failures using data from the XBRL financial statements.\(^{25}\) To this end, the Danish Business Authority uses historical data about failed companies, such as solvency ratios or lags in annual reporting, and applies analytical techniques and machine-learning algorithms to match a company’s data to its peers and predict its risk of closure or bankruptcy. The results from the testing phase have been reported as promising.\(^{26}\)

According to the interview with the Danish expert Christian Vindinge Rasmussen (e-Boks), the transition to RTE in Denmark has not been without challenges. Some of the key barriers have included the incompatibility of the new solutions with legacy systems, public sector fragmentation, resource constraints that SMEs typically face and the need to build new types of digital competences and skills. The government’s efforts in standardization and the decision to introduce new requirements through a legal obligation can be seen as important drivers of the change.

### 3.4. NORDIC SMART GOVERNMENT

Nordic Smart Government (NSG) is a joint RTE initiative of Nordic countries (Denmark, Finland, Iceland, Norway and Sweden).\(^{27}\) The project was launched in 2016 and the ongoing phase 3.0 started in 2018. The project aims to support growth and innovation in the region and reduce the administrative burden of SMEs by making business data available in real time across country borders. NSG envisions the development of an interoperable ecosystem of digital solutions by 2027 that will enable the real-time flow of business data between private and public actors in the Nordic region. This will allow automatic data sharing between business partners and real-time reporting to authorities. The project does not foresee the creation of a new database but instead facilitating the interoperability of data from existing ERPs and other digital systems through standardization and APIs.

As the main expected benefits for companies, NSG lists time savings, improved data quality, simplified cross-border business and easier credit validation. For governments,

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\(^{24}\) [https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/eInvoicing+in+Denmark](https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/eInvoicing+in+Denmark)


\(^{26}\) ibid.

\(^{27}\) This section is based on information from the project’s website: [https://nordicsmartgovernment.org/](https://nordicsmartgovernment.org/)
the benefits are seen in increased data quality, administrative efficiency, improved transparency, simplified tax auditing and reduction of paperwork. For financial institutions and other stakeholders, NSG promises better access to data for credit processes and risk assessment, improved data quality that can drive the creation of innovative data-driven services, minimized paperwork, reduction of fraud risks and better financial analysis. As an additional goal, NSG emphasizes a ‘democratic data policy’ and fair access to data. The value of making financial data available to Nordic SMEs is estimated to be 27 billion EUR yearly from 2027.

As a result of stakeholder, economic and technical analyses, the project aims to create a roadmap by 2020 for legislative and technical implementation of data exchange across the Nordic countries. Among other inputs, NSG makes use of the proof-of-concept from the Finnish TALTIO project to demonstrate the technical possibility of the automated generation of financial reports. According to the experts involved in NSG, the project does not aim to create any new standards but is going to refer to the European PEPPOL infrastructure and document taxonomies, including UBL as a common standard for e-invoices. This speaks of the importance that Nordic countries assign to interoperability at the European level.

### 3.5. EU-LEVEL INTEROPERABILITY INITIATIVES

Perhaps earlier than many others, the European Commission and the EU Members States identified interoperability as a key enabler for economic growth and technological development. The first time the EU explicitly stated interoperability as a common goal was the Council Decision of 23 April 1990 concerning the Framework Program of Community activities in the field of research and technological development. This decision set up the Third Framework Program for research and development, which lasted from 1990 to 1994. Interoperability between Member States and the development of common standards and protocols have been objectives of all subsequent framework programs.

However, standardization efforts already began earlier. The non-profit organization ETSI (European Telecommunications Standards Institute) was created in 1988 to coordinate the standardization of ICTs within Europe. In 2004 the European Commission launched the IDABC program (Interoperable Delivery of European eGovernment Services to public Administrations, Business and Citizens) to further ensure the interoperability of services. The program was followed by the ISA and ISA² Program. These programs have provided an umbrella for a number of interoperability projects over the years. Most importantly, the so-called Large-scale Pilots (LSPs) have been initiated to support the implementation of legislation and foster the use of ICTs in specific sectors. The first LSPs were domain-specific

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28 Council Decision of 23 April 1990 concerning the framework Programme of Community activities in the field of research and technological development (1990 to 1994); [ELI](http://data.europa.eu/eli/dec/1990/221/oj)
29 [https://www.etsi.org/](https://www.etsi.org/)
projects focusing on EU solutions for electronic identities (STORK), e-Invoicing (PEPPOL), the Service Directive (SPOCS), judicial area (e-CODEX) and e-health (epSOS):

- **SPOCS** aimed at building the next-generation electronic Points of Single Contact – intermediaries between private service providers and national public administrations. It was initiated to support the transition of the Directive 2006/123/EC on services in the internal market (Service Directive)\(^{30}\).

- **epSOS** attempted to offer seamless healthcare to European citizens by developing an e-health framework and service infrastructure for cross-border technical and semantic interoperability among different European healthcare systems. The outcomes are foreseen to feed into the framework for eHealth via the eHealth Network of the EU\(^ {31}\). The first areas involved patient summary, emergency datasets and medication records.

- **STORK** aimed to enable citizens to use their national electronic identities (eID) in any Member State. STORK first delivered common specifications and a common platform for interoperability of officially issued eID, then extended the solutions to legal persons to move towards a single framework and infrastructure for cross-border electronic identification and authentication. The technical outcomes of STORK are used in the eIDAS Regulation on electronic identification and trust services for electronic transactions in the internal market\(^ {32}\).

- **e-CODEX** aimed to improve citizens’ and businesses’ access to the judicial system of other countries in Europe and to link them to the European e-Justice Portal. It was an important step towards developing a common European interoperability layer. The electronic transport solution was the first version of the e-Delivery building block and was used as a technical basis for the interconnection of several registers in Europe, e.g. the business registers by Directive 2012/17/EU regarding the interconnection of central, commercial and company registers\(^ {33}\).

- **PEPPOL** was initiated to make public procurement easier and more efficient by improving electronic communication between companies and government bodies. The results of the project are used in the e-Procurement Directives 2014/24/EU\(^ {34}\) and Directive 2014/25/EU\(^ {35}\). E-Procurement is listed as one of five high-priority cross-border digital public services for the EU Digital Single Market.

The results of PEPPOL and its follow-up activities under the OpenPEPPOL Association also help European public administrations to comply with the recent obligation to accept machine-readable e-invoices set by the Directive 2014/55/EU\(^ {36}\) on electronic invoicing in public procurement. The PEPPOL network offers specifications and tools for public

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\(^{31}\) eHealth Action Plan 2012-2020 – Innovative healthcare for the 21st century (COM/2012/0736 final)


authorities – as well as other types of actors – to exchange e-invoices that are compliant with the European e-invoicing standard (European Norm).

To step beyond sector-specific projects, broader cross-sectoral initiatives have been launched with the aim of generalizing the technical building blocks from the LSPs into building blocks that can be used in different areas. The large-scale project e-SENS was launched in 2013 to develop a set of interoperable basic services (e.g. eID, e-Delivery) reusable in areas such as health, public procurement, business mobility or justice. The building blocks follow European and international standards and are consolidated under the Connecting Europe Facility (CEF) where the specifications and sample implementations are available for users for free.

Based on these technical building blocks, generic services can be implemented at the EU level that allow citizens and companies to save resources by providing their data only once to public administrations and other data consumers. The Single Digital Gateway Regulation (EU) 2018/1724 provides a legal basis for the infrastructure for implementing the once-only principle (OOP) and acts as a regulatory push that encourages public administrations to make digital evidence available to their peers and accept such evidence for their own purposes. SDRG allows business and governments to develop new cross-border online services, including business-relevant services such as filing reports to tax authorities and business registers. The ongoing TOOP project\(^\text{37}\) aims to test the solution for implementing OOP in operational conditions under the provisions contained in the Single Digital Gateway Regulation (SDGR).

### 3.6. IMPLICATIONS FOR ESTONIA

The EU-level initiatives described above have mostly started from the objective of making online public services widely available across Europe and simplifying cross-border administrative procedures for citizens and businesses. However, their results also facilitate business operations in the European single market. The existing building blocks serve as enablers of RTE both in terms of cross-border B2G and B2B data exchange. When making technological and standardization choices, Estonia should therefore consider compliance with European standards and examine possibilities of reusing European building blocks as a way of fostering a broader uptake of domestically developed RTE solutions. As is evident from the Nordic Smart Government initiative, the Nordic countries are also increasingly paying attention to European-level interoperability.

When bringing local businesses on board, the cases of Denmark and Finland suggest that both voluntary and mandatory approaches to introducing RTE solutions have certain benefits. While Finland’s flexible definition of e-invoice has led to high adoption, its downside has been problems with data quality and usefulness. At the same time, Denmark’s legal obligation along with stricter rules on e-invoices have secured better data quality at the expense of adoption rates.

\(^\text{37}\) [http://toop.eu/](http://toop.eu/)
The Finnish and Dutch cases point to the benefits of setting up well-coordinated long-term processes and prioritizing stakeholder engagement. The success of XBRL-based business reporting in the Netherlands has been associated with strong national coordination, while the Finnish experience shows the value of creating stakeholder consortia around standards and setting up multiple cross-sectoral collaborations. Estonia could therefore prioritize the involvement of diverse stakeholders into smaller thematic RTE initiatives pursuing a common long-term vision and set up a clear coordination system to guide the process.
4. IDEAS FOR MOVING FORWARD

4.1. THE POTENTIAL OF RTE

As indicated in literature and stakeholder interviews, RTE is a complex, ambiguous and elusive concept, yet one with an undoubtable appeal. Despite diverging views of what ‘real-time economy’ means (whether it is streamlining of financial accounting and reporting or a radical transformation of value production and decision-making processes), researchers, businesses and governments alike expect RTE to change ‘business as usual’ and create significant economic and societal benefits.

Both the study of literature and stakeholder interviews suggested that RTE should not so much be viewed as a new type of economy, but rather as a data-driven ecosystem where economic transactions and interactions take the form of a continuous exchange of structured data as soon as the data becomes available (although in some cases ‘real time’ may mean days and weeks, not milliseconds). This transforms the nature of a broad range of business processes in both private companies and public agencies as processes become increasingly continuous, automated and dynamic. Figure 1 shows a simplified representation of the stakeholders, relationships, building blocks and expected outcomes of this ecosystem.

![Figure 1. RTE ecosystem](image)

Key stakeholders in the RTE ecosystem are businesses and government agencies, whilst the role of citizens tends to be acknowledged to a lesser extent and is mostly confined to that of a customer or taxpayer rather than that of an active participant in RTE. According
to most accounts, the starting point for RTE is the availability of data on companies’ core business activities such as sales, purchases, assets or payroll in a digital and standardized format. If enterprises store and exchange data about orders, invoices and receipts in real time, they are able to **acquire a real-time overview of their business, use their resources more efficiently and improve their planning and risk assessment processes.** Real-time machine-to-machine data exchange and automated payments will also **accelerate cash flows**, allowing companies to **accelerate their production cycles** and increase turnover and profit. Moreover, the shift to fully digital transactions between business partners is believed to **increase trust and transparency**, which can reduce credit institutions’ financing risks and may improve companies’ **access to credit** and supply chain finance.

The same corporate data can also be used by state agencies to facilitate **automated business reporting**, **real-time taxation** or to **compile national statistics** without imposing reporting burdens on companies. Furthermore, as tools and technologies for data analytics and machine-learning become increasingly prevalent, governments can make use of real-time data from diverse sources, such as national or third party databases or IoT (‘internet of things’) sensors, which would allow governments to **build dashboards for continuously monitoring and assessing the country’s economic situation** and **develop predictive models** for forecasting economic events (e.g. company failures, changes in tax revenues) based on real-time data. This would allow governments to start providing customized services and **feedback to companies** (e.g. enabling companies to assess their indicators against their peers operating in the same sector or giving indications of possible risks) and to **develop early warning systems** for individual companies and the government.

Interestingly, stakeholder interviews suggest that the benefits of RTE for the public sector seem to be somewhat better understood than the potential gains for businesses. While the first steps in paperless invoice administration were led by large private companies (Koch, 2019), the current efforts around RTE in Estonia and Finland but also more broadly across the EU seem to be public sector-driven and focus on B2G initiatives such as mandatory e-invoicing in public procurement or XBRL-based business reporting. Our study identifies real-time B2G reporting as one of the key areas where the existing groundwork at the national and EU level allows progress to be made quickly, and with clear efficiency benefits for both business and the government. Nevertheless, the potential for unlocking real economic benefits in the form of increased revenues and innovative business models lies in **B2B transactions, full transition to e-procurement and real-time supply chain management**. These are areas where innovation needs to be driven by business and where the role of governments is limited to regulation and providing parts of the digital infrastructure. Some projects in this area are already emerging in Estonia, most notably Industry 4.0 and e-CMR initiatives.

Although academic literature associates RTE with a number of benefits, it tends to be less specific about the extent to which RTE solutions are expected to increase business efficiency and productivity. Some attempts to quantify the costs and benefits have, however, been made. For example, a 2007 analysis by Capgemini estimated electronic invoicing reduces the cost per invoice by 70-75 percent (Capgemini, 2007). According to Penttinen (2008), a micro company in Finland could save 25 euros per incoming invoice
by switching from manual processes to automated invoice handling, whilst savings for outbound invoices would be slightly less than 8 euros per invoice. The same study found moving to e-invoicing could free up a week’s worth of working time for a company (Penttinen 2008). Based on extensive research, Koch (2017) has estimated the savings from automated processing of e-invoices to amount to 60-80 percent compared to paper-based processing, with a typical payback time of 0.5 to 1.5 years. In total, he considers achieving savings of 1 to 2 percent of a company’s turnover to be a realistic goal. For the public sector, transitioning to e-invoicing could yield at least 40 billion euros of potential savings (Koch, 2017). All existing studies conclude that the major source of potential savings is the automation of handling inbound rather than outbound invoices.

Studies have also tried to estimate the environmental benefits of electronic invoicing. A recent report by Basware (2018) found that according to various studies, moving from paper-based to electronic invoicing may reduce the carbon footprint by 63 to 99 percent. Basware’s calculations of their own e-invoicing services based on 2017 data yielded an estimated 36 percent reduction in greenhouse gas emissions compared to paper-based services. However, research on the potential long-term environmental impacts of a large-scale transition to RTE is currently lacking. For this reason, very little is known about the possible negative environmental consequences of RTE caused by hardware production, maintaining data centers and pollution from electronic waste.

The Technology Industries of Finland (2018) has also provided a calculation of the benefits of adopting e-receipts. According to their estimates, the cost of data entry from paper receipts currently amounts to 5-7 euros per receipt. This means that a transition to e-receipts could yield some 900 million euros of annual savings for Finnish companies (take care to note, however, that these figures do not include the processing of cash purchase receipts due to lack of data).

Real-time information is expected to have a considerable positive impact on the operational effectiveness of supply chains. In 2016, McKinsey experts estimated the increasing transfer to real-time supply chains to reduce companies’ operational costs by 30 percent and lost sales by 75 percent (Alicke et al., 2016) already in the next couple of years. Moving from potential savings to value generation and access to capital, the possible benefits from RTE appear to be much greater. For instance, in addition to minimizing costs, e-invoicing is believed to create new market opportunities for supply chain finance (SCF) mainly by monetizing receivables and payables. The global market for SCF solutions is estimated to amount to some 1.3 trillion US dollars for receivables management services, 100 billion USD for dynamic discounting solutions and 340 billion USD for asset-based lending (Koch, 2017).

The actual costs and benefits of RTE solutions of course also depend on the existing level of digitalization and process automation in enterprises, size of the company and volume of invoices as well as variables such as labor costs in the respective country or region. In the Estonian case, where more than 90 percent of all companies are micro enterprises and the number of large companies with more than 250 employees is negligible (Statistics Estonia, 2019a), the majority of companies do not use ERP systems and still rely heavily on manual processes (Statistics Estonia, 2019b). The availability of corporate data in
digital formats is therefore one of the first hurdles we must overcome on Estonia’s path to a real-time economy.

4.2. DRIVERS AND BARRIERS

As can be seen from the long list of benefits highlighted in the previous section, the development of RTE solutions is driven by a number of hopes and expectations. Table 3 summarizes the main drivers from the literature study and interviews.

Table 3. Summary of RTE drivers

<table>
<thead>
<tr>
<th>Savings and efficiency</th>
<th>Decision-making quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Automating financial management</td>
<td>• Improving the quality of data and reducing fraud</td>
</tr>
<tr>
<td>• Automating business processes</td>
<td>• Developing accurate forecasting capabilities</td>
</tr>
<tr>
<td>• Speeding up business processes</td>
<td>• Improving decision-making quality</td>
</tr>
<tr>
<td>• Reducing process latencies</td>
<td>• Demand for evidence-based policy-making</td>
</tr>
<tr>
<td>• Increasing organizational and operational efficiency</td>
<td></td>
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<tr>
<td>• Demand for real-time response to market changes</td>
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<table>
<thead>
<tr>
<th>Competitiveness and innovation</th>
<th>Digital transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Utilizing emerging technologies to create competitive advantages</td>
<td>• Exploiting underutilized data and ICT infrastructure</td>
</tr>
<tr>
<td>• Technical solutions for cross-border services</td>
<td>• Developing a portfolio of technical solutions for SMEs</td>
</tr>
<tr>
<td>• Improving competitiveness at the international level</td>
<td>• Establishing universal standards for data exchange</td>
</tr>
<tr>
<td>• Developing new real-time products and services</td>
<td>• Developing digitalization agenda at the national level</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Sustainable development</th>
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<tbody>
<tr>
<td>• Environmental benefits</td>
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</table>

However, our findings show the realization of these expectations is constrained by barriers at the organizational, technical and national level. These are summarized in Table 4 below. Since the drivers have been discussed on several occasions in this study, we would like to highlight the barriers and limitations that deserve particular attention when developing RTE ecosystems.
One of the largest barriers that must be overcome is the high number of standards currently in use. In the field of accounting, over 35 international standards are in use today. Given that there are many forms and versions in which business transactions take place, the process of developing one overriding standard that covers them all is very complex. One solution experts in the field suggested relates to developing technical interoperability solutions which bridge systems using different standards and allow machine-to-machine communication regardless of differences in standards.

Another aspect which raises questions is the depth and feasibility of developing a fully automated accounting management system. In this context, stakeholders highlighted the size of the company and complexity of transactions as important factors. For small companies where most transactions are very simple and only take place a limited number of times each month, transaction and accounting processes can be automated and implemented in a machine-to-machine format relatively simply. Given that the majority of Estonian enterprises are SMEs, the potential for automated accounting is very high – provided that the data exists in standard formats. However, in cases where the number of transactions grows and their complexity increases, respondents emphasized the need for human intervention. For example, the use of complex financial methods such as inventory accounting or management of intangible assets depends on the context and field the company operates in. Therefore, human intervention is still required for double-checking the results of automated processes and ensuring quality. Accordingly, it is common practice for large companies which implement specialized accounting systems to still assign accountants to carry out support tasks, e.g. dealing with payrolls, depreciation on fixed assets or production.
A more general concern we must take note of is related to over-optimistic expectations for RTE which seem to be prevalent in the current discourse. Respondents highlighted long lists of financial and administrative functions that RTE solutions are expected to transform. However, despite the rapid development of digital technologies over the recent decades, cases where technological solutions fully replace human labor are quite rare. A pragmatic approach in this context would be focusing RTE-related efforts on financial and administrative functions which are repetitive, frequent, and have calculable results. One of the recurring expectations relates to automation of data-entry tasks in the field of accounting. Despite the benefits of turning paper-based data into digital formats, some respondents to interviews questioned the need to use such technical solutions in smaller settings such as Estonia. Limitations also apply to the use of artificial intelligence in this context – as with humans, intelligent systems do not always automatically detect every error in systems or data. Therefore, although administrative burdens and financial costs can certainly be reduced to some extent, the need to check data manually is unlikely to disappear entirely.

4.3. POSSIBLE RISKS OF RTE

The evolution of RTE also raises concerns about the possible risks and uncertainties involved. Since the future of RTE is strongly dependent upon public acceptance, it is important to build a wide understanding of the different risks associated with new RTE solutions. Interview results identified four dominant risks that are associated with RTE solutions:

**Creating a ‘big brother’**. The biggest risk identified throughout the interviews is the threat that RTE solutions will develop a sufficient infrastructure to establish government control or even a so-called ‘Big Brother’ system. As of today, state governments all over the world use ICT tools to enforce their political agenda and regulate different aspects of political, economic and social life. Even though none of the Estonian interview respondents demonstrated such intentions, all digital data is in principle accessible. Therefore, in cases where groups with malicious intents happen to seize control of data-driven technologies, an integrated system can easily be compromised. Respondents also referred to the threat of RTE ecosystems evolving into something comparable to the Social Credit System (SCS) in China. However, at its core, these two initiatives are fundamentally different. While SCS is a social management program set up to provide rewards and punishments as feedback for citizen behavior (Creemers, 2018), RTE initiatives aim to establish an ICT-based infrastructure for accelerating interactions between economic actors. Moreover, the nature of the data sources for the two systems is fundamentally different. Where SCS intends mixing government and socially generated data from online and offline sources (Chen & Cheung, 2017), RTE initiatives only require a limited amount of financial information commonly generated from a limited number of online sources.

**Data security**. A second risk emphasized by Estonian stakeholders refers to cybersecurity and security of data within RTE ecosystems. By its very nature, RTE facilitates the exchange of data and connects different economic partners. Therefore, a potential
breakdown of the RTE network may give rise to crises that could affect the whole Estonian economic ecosystem. As businesses have no motivation to operate in systems where business secrets can be revealed at any moment, establishing a strategy to address such concerns will be a crucial factor for adopting future RTE solutions. One proposition to mitigate the risk is to keep all data in RTE ecosystems in an anonymized form. Therefore, if there is “a big pool of non-relatable data, it is much more difficult to breach it” and “even if that happens, there is not much that saboteurs and attackers can do with the numbers and figures” (interview with Christman Roos, MoEAC). What is more, excessive transparency in business data is seen as damaging overall business competitiveness. Businesses will be able to develop different types of analytics and develop a holistic picture of their position compared to other business partners. Accordingly, firms with greater power may develop additional mechanisms to increase control over smaller partners.

**Over-standardization.** Ranked next in order, interview respondents identified over-standardization as a major threat which can result from RTE initiatives. Although standards are cited as a core component to facilitating implementation of RTE, a well-balanced level of standardization is still needed. This results from the fact that over-standardization poses a threat to overall operational flexibility and may be contrary to companies’ increasing demand for reducing administrative burdens (Helm, 2006). In this context, one of the interviewees also added that rigid standardization risks starting to drive business and giving rise to environments where only ideas which comply with existing standards attract attention. Furthermore, respondents emphasized the importance of determining the correct standards. It is suggested to start by exploring what RTE-related standards other countries employ and see if there is an opportunity for Estonian stakeholders to lead standardization efforts. Another suggestion was to prefer standards with an already established user base.

**Developing digital islands.** Interviews suggested that RTE initiatives run the risk of developing isolated solutions that only work in the Estonian context. The growing number of governments trying to employ a global perspective when developing technical solutions is regarded as helping harmonize public administration practices and facilitate cross-border collaborations (Pardo et al., 2010). Nevertheless, in practice, cross-border interoperability will require additional time and effort. There is still a large gap between countries when it comes to the degree of digital development. The interviewed Estonian public officials claim that other countries often have difficulties understanding the Estonian approach to developing e-government and e-services. In the RTE context, this means that the same solutions that are supposed to create advantages on a national level risk creating barriers at the cross-border level.

### 4.4. KEY OPPORTUNITIES FOR ESTONIA

In the course of this study, a large number of opportunities and risks became evident that the transition to a real-time economy may create for different types of stakeholders. These are summarized in Annex 2. Out of the many opportunities, three broad domains emerge
as areas where RTE could create particular value for Estonia: accounting and reporting, economic forecasting, and supply chain management.

4.4.1. REAL-TIME FINANCIAL ACCOUNTING AND REPORTING

One of the areas in which RTE solutions possess significant potential is real-time financial accounting and reporting. There is an evolving vision and initial practices which involve transmitting accounting data on transactions by automated means between information systems without any human intervention. We are already witnessing a tendency towards decreased input from human labor to accounting and bookkeeping processes. In a full-fledged ‘RTE’ environment, this process would go further, involving both automated accounting and automated financial reporting based on financial accounting.

One of the main questions is to what extent existing International Financial Reporting Standards (IFRS) support this vision. In some areas of accounting, standards already enable paperless processes, while in other areas human intervention is required. The latter category includes financial instruments, valuations or the use of special methods such as inventory accounting or the management of intangible assets. For example, depreciation can easily be calculated by a machine but if a company decides to change the calculation method, period of asset use or the asset’s residual value, then human intervention is required. The findings from our research suggest that typical business transactions such as day-to-day billings, receiving payments, payrolls, banking transactions, etc. can easily be automated. Therefore, the majority of transactions that most companies complete on a daily basis can be replaced by real-time machine-to-machine communication. Our findings also suggest that automated accounting as such would not have an adverse effect on key objectives of financial accounting, i.e. ensuring that information on a company’s financial position, financial performance and cash flows is relevant, timely, objective and comparable.

Several technical barriers must be overcome in order for automated accounting to become a reality. A crucial precondition for automated accounting is using common standards for exchanging financial accounting data. Currently, one of the most promising standards for this seems to be XBRL GL (Extensible Business Reporting Language Global Ledger), which allows us to make every data field relating to an entry machine-readable. In this way, a universal digital entry is generated, which facilitates sending transaction data from one ERP to another, recording it, and automatically using data received in financial statements, reports to government authorities, and for diverse financial accounting, management, production, and reporting purposes.

Automated accounting is likely to have an important impact on the financial reporting supply chain (see Figure 2), which also affects investment activities on a national level.

Figure 2. Financial Reporting supply chain (MacDonald et al., 2006)
In short, automated digital entries for everyday business operations and transactions are fundamentals for automating enterprise’s internal and external reporting. Automated accounting thus also influences the corporate reporting supply chain (Figure 3). Aggregated data from automated reports can serve as inputs into policy-making, which in turn influences investments and other long-term decisions.

Figure 3. Corporate Reporting supply chain (DiPiazza and Eccles, 2002)

The corporate reporting chain begins with company executives who are ultimately responsible for producing financial information, the board of directors approving financial information, auditors who provide an audit opinion, information distributors, third-party analysts, and investors and other stakeholders who use the information and analyses from various sources. These activities and actors depend on the bodies setting standards and market regulators who establish and enforce the rules. Finally, various types of enabling technologies support the entire supply chain (Buys, 2008). In this context, real-time data capture and transfer technologies may increase the speed of interactions and decisions in the corporate reporting supply chain. Furthermore, the availability of real-time data from ERPs may yield benefits beyond the accounting and reporting area, in particular if combined with data from other sources. Table 5 summarizes the possible outputs and benefits of the usage of real-time data from ERPs and other systems, along with the key preconditions where gaps still exist.

Table 5. Outputs and benefits of real-time data

<table>
<thead>
<tr>
<th>Input data</th>
<th>Outputs</th>
<th>Benefits</th>
<th>Key preconditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Data from ERPs</strong></td>
<td>• Self-generated reports to authorities (tax, statistics, etc.)</td>
<td>• Saved time and money</td>
<td>• Agreement on common standards (e.g. XBRL GL), taxonomies and classifications (at cross-border level) for accounting and reporting</td>
</tr>
<tr>
<td></td>
<td>• Automated entries into participants’ ERPs</td>
<td>• Administrative burden reduction</td>
<td>• Expanded obligatory use of e-invoices and e-receipts</td>
</tr>
<tr>
<td></td>
<td>• Automated transactions in real-time</td>
<td>• Faster decisions</td>
<td>• High data quality</td>
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<td></td>
<td></td>
<td>• Increased efficiency</td>
<td>• Free open-source RTE</td>
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<tr>
<td></td>
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<td>• Increased completeness</td>
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<td></td>
<td></td>
<td>• Decrease in gray economy and fraud</td>
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<td></td>
<td></td>
<td>• Increase in trust and</td>
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51
4.4.2. REAL-TIME ECONOMIC FORECASTING

As shown above, the availability of real-time business data will likely also trigger changes in economic forecasting. Evaluating the existing economic situation and forecasting future
macroeconomic events is one of the most important tasks of statistical agencies (Monteforte & Raponi, 2019). However, forecasting also becomes increasingly important at lower levels as it equips decision-makers with mechanisms for tackling uncertainties and improving the accuracy of their decision-making.

The transformation of data from analogue to digital formats creates new sources of data for analysis and forecasting. It is likely that as financial data becomes increasingly available in machine-readable formats and with reduced time lags, Estonian public and private agencies will be able to expand their forecasting abilities to different policy domains. Moreover, forecasting models are also expected to change. Firstly, decision-makers can adopt new analytics methods for processing real-time data and visualizing them in modern dashboards to create a ‘live overview’ of the national economy. These same tools can also be used to drill down and explore different details relating to time, date, context, and location of real-time events. One of the main enabling standards in this context is the XBRL GL taxonomy framework. As it enables acceleration and automation of many business-to-business and business-to-government interactions, numerous new sources will be generating accurate and real-time data. Therefore, while high-level statistics can be used to visualize trends, detailed real-time data can be used for making short-term predictions to inform economic operators’ actions. Moreover, forecasting models in RTE environments will no longer be dependent on retrospective data. Instead, real-time data on economic transactions, sensor data, estimates about the future, different contextual data, and the most recent developments in the policy level can be linked. As a result, forecasting models can improve reliability and provide a holistic up-to-date view of the whole economy. The relationship between real-time and improved forecast accuracy is summarized in Figure 4.

![Figure 4. Real-time forecasting](image)

Ever since data-driven technologies gained momentum in the business, state agencies have engaged in developing similar ICT applications for the public sector. The main purpose of these technologies is to support decision-making processes by providing evidence-based estimates and early warnings for public and private sector companies. Recently, the number of financial models developed to predict financial frauds, corporate bankruptcies, identify hazardous situations or estimate potential scenarios is has grown constantly. In this context, data-driven technologies can facilitate the development of
policies and strategies which support economic growth and assist governments in preventing undesirable outcomes.

First pilot initiatives in this area have already been launched in Estonia. For example, the Tax and Customs Board conducted a pilot project in partnership with the Center of IT Impact Studies (CITIS) of the University of Tartu to develop analysis and forecasting models and create dashboards for monitoring certain economic indicators in real time. The project used monthly VAT, social and labor tax declarations data going back 12 years, combined these data with other data sources (e.g. business register, Eurostat data) and developed dashboards visualizing insights from the data with the aim to create a forecasting tool for policy planning and provide input to probability-based decisions.

We can expect the future development of such predictive and prescriptive models to benefit highly from the emergence of advanced Artificial Intelligence (AI) solutions. However, similarly to other technologies, AI will not solve all issues on its own. The interviewed experts highlighted the fact that even the most advanced AI (including machine-learning) technologies make mistakes and give false results. As this is an inherited feature of AI, even real-time data cannot completely eradicate the need for human checks and validation.

In conclusion, RTE solutions could improve forecasting in several ways. First, RTE solutions enhance the overall quality of data circulating within RTE ecosystems. Secondly, RTE facilitates the free flow of data and provides network participants real-time access to data. Depending on their level of access, RTE participants will be provided with a real-time overview of various activities. As real-time data will be generated from new sources, decision-makers will be provided with an enhanced overview of economic activities from various sources. The compatibility and quality of data resulting from standardization provides better foundations for forecasting models and provides decision-makers with more accurate and reliable suggestions.

4.4.3. STIMULATING RTE IN BUSINESS AND INDUSTRY

Whilst the benefits of RTE solutions in business reporting and forecasting mainly relate to efficiency and the quality of decision-making, the application of RTE in business – in particular industry – also has the potential to create new economic value and boost innovation. In essence, RTE may be perceived as the emerging face or the expected next step for digital transformation in business as it goes beyond mere digitization of paper-based processes and also drives new models of production and consumption. RTE is closely related to the concept of Industry 4.0, which refers to the introduction of cutting-edge technologies to optimize industrial manufacturing (Schmidt et al., 2015). Industry 4.0 aims to transform three aspects of industry (Roblek et al., 2016):

- Production: the integration of different information systems for managing production.
- Process automation: incorporating cutting-edge technologies to automate processes and capture data in different production stages.
• Communication: connecting different manufacturing sites and facilitating rapid and free movement of data relevant for production and consumption.

The same domains also have relevance for RTE – integration, machine-to-machine communication and adoption of digital technologies are key components of both. Whereas RTE encompasses different kinds of technologies and systems enabling the collection, sharing and use of data in real time for various purposes, Industry 4.0 is frequently associated with the implementation of self-controlling cyber-physical systems capable of acquiring and processing data and interacting with humans via interfaces to allow for end-to-end engineering and personalized production (Brettel et al., 2014). Hence, in the context of digitalization in industry, the concepts of RTE and Industry 4.0 intertwine and overlap to a large extent.

Studies emphasize the need for modern organizations to manage production and distribution processes in their supply chains in order to maintain competitiveness (Lapinskaitė & Kuckailytė, 2014). As the scope of benefits from implementing an RTE infrastructure goes beyond individual companies, RTE solutions can play a role in enhancing cross-organizational information flows and fostering collaboration and data-sharing practices among business partners. Information flows across supply chains are associated with outcomes which improve performance (Patnayakuni et al., 2010) as well as process efficiencies, productivity and business relations with customers.

In addition to improving the speed and volume of data flows, real-time data solutions increase the quality of information exchanged between partners in value chains. Apart from allowing businesses to improve operational efficiency, enhancing the quality of data also supports new forecasting practices, optimization of management expenditures, efficient monitoring of inventory, and the provision of reliable evidence for decision-making. For example, studies in the field of digitalization associate technological developments and access to accurate data with improved employee productivity (Aral et al., 2007). Productivity improvements allow managers to reallocate human resources to more complex cognitive tasks – for example, instead of dealing with data entry and keeping track of products, workers could be transferred to supervising and training intelligent systems.

Collecting and using real-time data throughout the supply chain not only helps automate and optimize production and decision-making but also drives the development of new business models and innovation. Along with innovations in products and services, modern firms can gain competitive advantages by developing new business models and by finding new niche markets. As a result, companies increasingly invest in integrating different sources of data in their value creation processes to satisfy customer needs (Toivola, 2018). Real-time supply chain data also enables the creation of customer value and trust by facilitating rapid response to customer demand. Real-time response to customer demand is largely motivated by evolving customer expectations and the need to provide high-quality services and products. It is common for companies which fail to fulfil these demands to struggle to maintain market competitiveness and to keep customers satisfied. As a response, practitioners and researchers in the field suggest applying real-time data to reduce response latencies for fostering relationships with customers by building long-term trust (Chuang, 2019).
Apart from that, RTE technologies allow customers to keep track of the source and origin of products in the market. Traceability is increasingly gaining momentum in the food sector, for example as a way of reducing fraud in the wine industry. With the help of blockchain and automatic data capturing technologies, e.g. QR or RFID, all the events on a product’s path to the customer can be recorded digitally, allowing customers to trace the provenance of any individual product back along the supply chain. Similar solutions have also begun to emerge in the area of tracking the climate impacts of consumer choices. For example, S-Group and K-Group, the two major Finnish retailers, use digital data on customers’ purchases to produce personalized reports of their estimated carbon footprint. In principle, similar capabilities can be developed for almost every industry.

The principles and priorities outlined in the Estonian government’s Green Paper of Industrial Policy provide a useful framework for stimulating the adoption of RTE solutions in industry. The Green Paper acknowledges the need for a holistic approach to digitalizing all parts of the value chains in order to produce substantial productivity gains and improve companies’ competitiveness. The government’s ICT development program lists several specific proposals for supporting the achievement of the Green Paper’s goal of increasing the added value of Estonian industry to 80 percent of the EU average by 2030. The planned activities mainly focus on conducting analyses, awareness-raising efforts and piloting to test and demonstrate digitalization solutions in industrial companies. In this context, real-life pilots and showcases can be considered as a key tool for improving the understanding and communication of the benefits of creating real-time data ecosystems. The first positive results of the piloting activities led by the Estonian IT cluster in the field of supply chain digitalization (see an overview of the Industry 4.0 pilot in Section 2.1) could serve as a basis for further pilots in the field.

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39 Accessible at: https://www.mkm.ee/sites/default/files/toostuspoliitika_roheline_raamat_.pdf
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CONCLUSIONS AND RECOMMENDATIONS

This study set out to ask how RTE is understood in the world today, what visions of RTE exist among Estonian stakeholders and how Estonian companies and public authorities could best harness the benefits of real-time technologies. The following research questions were addressed in the study:

1. **How is RTE defined according to academic literature and how is it seen by Estonian stakeholders and international experts?**

In short, the findings from literature and stakeholder interviews suggest RTE could be defined as a digital ecosystem where transactions between diverse economic actors take place in or near real-time by way of an increasingly automated exchange of digital, structured and machine-readable data in standardized formats.

2. **What are the enablers, drivers and barriers to RTE? Which risks are involved in developing RTE? What are the potential effects of RTE on companies’ competitiveness and savings?**

The results suggest that RTE solutions are expected to enable the automation of most of accounting and a large part of business reporting processes as well as the transformation of a number of business processes in the private and public sector. The main benefits of RTE are seen in increased efficiency, resource savings and productivity. However, the combination of real-time data with other technologies such as machine-learning, blockchain or IoT may also lead to better planning and economic forecasts, help optimize supply chains and stimulate product and service innovation. Given this variety of benefits, a broad approach to RTE may make the most sense for Estonia. This means that RTE could be regarded as an overriding concept accommodating various kinds of initiatives which utilize digital, structured and standardized data for creating economic and public value.

Many of the key enablers of RTE are already in place or are emerging in Estonia: a fully functional e-government ecosystem along with unique identifiers, eID, a national interoperability framework and experience providing secure data exchange infrastructures, public sector leadership of RTE, existing inter-sectoral collaboration platforms (most notably the PACINNO RTE working group), pilot projects such as Reporting 3.0, a statutory requirement for B2G e-invoicing, and an emerging consensus around the adoption of the XBRL GL taxonomy as a common standard for exchanging financial data. Therefore, Estonia is in a strong position to take further action towards installing RTE at a national level. At the same time, several important RTE building blocks are still missing, in particular a widely accessible technical infrastructure and applications that would facilitate the secure storage and exchange of machine-readable data between different parties.

The study also revealed some risks and limitations to the concept of RTE. These mostly have to do with concerns about exposing sensitive data to third parties and the security of the systems used for data exchange. Moreover, experts suggested that despite a generally favorable national context for RTE, Estonia should refrain from building a national RTE ecosystem that only functions within its own borders. Due to the cross-border and global nature of business and trade, Estonia should prioritize cross-border interoperability.
at least at the European level if not more widely. The stakeholders and experts interviewed for this study believe that Estonia together with other Baltic and Nordic partners could serve as a testing ground for various RTE solutions and the rules and standards for governing them. If successes can be demonstrated on a regional level, the Nordic-Baltic region could also take the lead in fostering RTE at the EU level.

3. Which business processes could be automated based on real-time data?

This study identified three key areas where the development of RTE solutions and automated processes looks particularly promising: real-time accounting and reporting, real-time economic forecasting and real-time supply chains.

4. How could AI-enabled data-driven forecasting affect the efficiency of industrial companies’ supply chains and risk monitoring?

Artificial Intelligence (AI) solutions can support the development of predictive and prescriptive models to help both public sector decision-makers and managers in the business sector. AI-enabled forecasting clearly has the potential to generate benefits in terms of efficiency, productivity, better planning, adjustment and risk monitoring. However, at the moment, even the most advanced AI technologies still produce errors and their reliability is highly dependent on the rigor of the analytical models used. Therefore, for now, human participation in interpreting and validating the outputs of analytics and forecasting models is still required.

5. What could be Estonia’s vision for RTE and which steps could be undertaken to achieve this?

In light of stakeholders’ views and the emerging RTE pilots, Estonia would benefit from a broad definition of RTE encompassing various kinds of initiatives which utilize real-time data for creating economic and public value. The following measures could be taken to unleash the potential value of RTE:

**Recommendation 1: Developing a roadmap for RTE**

The adoption of a roadmap stating the key activities and milestones towards a ‘full-scale’ RTE environment would help guide a systematic approach for developing RTE in Estonia. Given MoEAC’s current leading role in advancing the thinking around RTE in Estonia, the ministry could steer the development of such a roadmap. Furthermore, MoEAC could consider hiring a project manager with sufficient resources and time to coordinate the development and implementation of the roadmap. The findings of the study suggest that the development of a national RTE ecosystem should be planned as a long step-by-step process comprising various modules that are guided by a common vision. The RTE roadmap could contain plans and timelines for the following types of activity:

- Standardization activities, incl. collaboration with European and international stakeholders (e.g. OpenPEPPOL, XBRL);
- Technical prototyping and pilots;
- Legislative and regulatory changes required to facilitate the adoption of RTE solutions. Although Estonian companies do not seem to be ready for a legal obligation to provide B2B e-invoices and e-receipts in the near future, such legislative changes could still be part of the long-term vision. Other areas where regulatory changes may be required are enforcing common standards for data exchange and setting up a legal basis and conditions on which public authorities could access business data for automated reporting and analysis;

- Research and analysis activities, including but not limited to economic impact assessment of real-time solutions, cost-benefit analyses of particular RTE solutions such as real-time taxation or real-time supply chain monitoring solutions, study of existing best practices of value chain digitalization and real-time supply chain management (e.g. the use of real-time data in the German automotive industry), and study of the ethical and security aspects of real-time data exchange between various parties, especially at the cross-border level).

- Engaging businesses in working groups concerning the development of standards, technical infrastructure and governance models for real-time data exchange.

Experience in other countries shows that where governments lead efforts towards RTE, most initiatives tend to gravitate towards B2G data exchange. B2G e-invoicing and reporting can be important drivers of RTE but in order to create a vibrant RTE environment where innovative business models can emerge, the focus needs to shift from B2G to B2B communication and from financial reporting to production, logistics and sales.

Therefore, it is advisable to focus on building stakeholder communities around RTE and engage business actors in working groups dedicated to specific RTE issues, such as standardization, technical solutions and governance models. Existing national XBRL working groups (such as the one operating in Finland) that collaborate with the international XBRL working group could serve as a possible role model.

**Recommendation 2: Piloting a technical platform for secure data exchange**

One of the key building blocks for real-time data exchange is a technical platform which provides a secure environment for online data exchange in standardized formats. Interviews revealed that at the moment enterprises need to invest huge amounts of money to develop individual solutions for secure communication with their peers. It is therefore advisable for the government to take an active role in developing such an infrastructure and provide it free of charge at least for small volumes of transactions to ensure its accessibility and affordability for different stakeholders, in particular SMEs. The existing distributed model of the X-tee infrastructure in Estonia could serve as an example but instead of government-to-government communication it would be aimed at business-to-business and business-to-government data exchange. Such an infrastructure should not replace but complement the existing data exchange layer.

**Recommendation 3: Early adoption of business-relevant SDGR services**

Estonia can avoid becoming a digital island by actively contributing to European standardization in the area of cross-border e-services. The Single Digital Gateway (SDGR) will provide key cross-border services for companies such as registering as a taxpayer in
a foreign EU member state or registering employment of an employee abroad by mid-2023. By proactively incorporating cross-border services in Estonian e-government solutions, Estonian companies can be provided faster access to the European Digital Single Market, which would strengthen their RTE competitiveness.

**Recommendation 4: Supporting the digitalization of Estonian business and industry**

An important factor for RTE is the ability to connect a company’s information resources and data to suppliers’ and buyers’ digital solutions. In order to strengthen these undertakings, MoEAC should investigate and research opportunities on how digital capabilities in Estonian industry can be strengthened, including through financial incentives (a ‘Marshall Plan for Digitalization’), training programs, networking and other means. Estonia will only be able to avoid developing a digital island if Estonian businesses are capable of exchanging data by digital means not only with the Estonian state agencies but also with its suppliers and buyers.

**Recommendation 5: Focusing on reaching a critical mass of adopters**

Capabilities and incentives must be built in order to render Estonian businesses fully RTE-compliant. The success of Estonian e-government initiatives such as the eID may serve as a good example of the value of thinking in feedback loops. Rapid adoption of RTE can be fostered by prioritizing the development of services and applications that 1) are interesting enough to invest in the technology (such as e-voting has been in the past), 2) have medium to high usefulness and 3) first and foremost have high usage frequency of use for citizens and businesses.

**Recommendation 6: Investing in new technologies that add value to real-time data**

The usage areas of real-time data can be expanded if possibilities are created for encoding human decisions by machine-readable means. Estonia should therefore investigate the opportunities offered by blockchain-based smart contracts, which allow encoding different contractual alternatives which can be automatically executed if pre-defined conditions emerge. This should cut down on latency and delays considerably through avoiding the need for human intervention in ongoing machine-to-machine communication.
BIBLIOGRAPHY


ANNEX 1. LIST OF INTERVIEWEES

**Estonian experts and stakeholders:**
Lehte Alver, Tallinn University of Technology
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Külli Kraner, Ministry of Economic Affairs and Communications
Taavi Köhler, Ministry of Finance
Rain-Alari Külm, Omniva
Andres Lilleste, Fitek
Heiti Mering, Tieto
Mart Mägi, Statistics Estonia
Mait Palts, Chamber of Commerce and Industry
Reet Reismaa, Ministry of Economic Affairs and Communications
Rivo Reitmann, Tax and Customs Board
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Janek Rozov, Ministry of Economic Affairs and Communications
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Esko Penttinen, Aalto University (Finland)
Christian Vindinge Rasmussen, e-Boks (Denmark)
# Annex 2. Expected Opportunities and Impacts of RTE

<table>
<thead>
<tr>
<th>Actors</th>
<th>Expected opportunities and positive impacts</th>
<th>Potential costs and negative impacts</th>
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<tbody>
<tr>
<td><strong>Government</strong></td>
<td>• Access to business data in real-time&lt;br&gt; • Access to new data sources&lt;br&gt; • Automation of financial reporting&lt;br&gt; • Enhanced forecasting capabilities&lt;br&gt; • Increased cooperation at EU level&lt;br&gt; • Evidence-based decision-making&lt;br&gt; • Integration of e-services and technical systems&lt;br&gt; • Operational efficiency for public agencies&lt;br&gt; • New and innovative real-time services&lt;br&gt; • Quicker reaction to economic and market changes&lt;br&gt; • Prediction of economic crises&lt;br&gt; • Reduction of latencies in administrative processes&lt;br&gt; • Automation of tax collection&lt;br&gt; • Large and positive impact on VAT collection&lt;br&gt; • Paperless administration&lt;br&gt; • Real-time overview of the economic situation on national and EU level&lt;br&gt; • RTE solutions reactivate underutilized e-services and ICT infrastructure&lt;br&gt; • Infrastructure for real-time analytics in public sector&lt;br&gt; • Reduced carbon footprint&lt;br&gt;</td>
<td>• Need to cover the initial cost to establish the RTE infrastructure&lt;br&gt; • A potential malfunction of RTE system threatens economic stability&lt;br&gt; • RTE solutions make Estonian business environment highly dependent on technology&lt;br&gt; • RTE initiative requires further supporting regulations but creates a risk of overregulation&lt;br&gt; • Risk to develop ‘island’ solutions that function only in the Estonian context&lt;br&gt; • Over-standardization can hinder innovation&lt;br&gt;</td>
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<td><strong>Large Enterprises</strong></td>
<td>• Higher prediction accuracy for business cycles&lt;br&gt; • Opportunities for creating new real-time services/products&lt;br&gt; • Opportunities for business process re-engineering&lt;br&gt; • New business opportunities on national and international level&lt;br&gt; • New management approaches, incl. evidence-based decision-making and management&lt;br&gt; • RTE solutions facilitate centralization of enterprise management&lt;br&gt; • Opportunities for reusing business data to create new business value&lt;br&gt; • Improved coordination in supply chain&lt;br&gt; • Paperless management&lt;br&gt; • Productivity improvements&lt;br&gt; • Real-time response to demand and market changes&lt;br&gt; • Automated financial management&lt;br&gt; • Reduction of administrative burden&lt;br&gt; • Improved data quality&lt;br&gt; • RTE solutions provide additional communication channels&lt;br&gt;</td>
<td>• Potential data breaches and exposure of business secrets&lt;br&gt; • Standardization of data and business processes can harm business flexibility&lt;br&gt; • Over-dependence on technology&lt;br&gt; • The implementation of many RTE solutions (i.e. e-receipts, automated accounting, automated tax reporting etc.) requires state agencies’ access to business data. This can have negative implications on privacy and competitiveness&lt;br&gt;</td>
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<td>REAL-TIME ECONOMY: DEFINITIONS AND IMPLEMENTATION OPPORTUNITIES</td>
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<td><strong>Small and Medium Enterprises (SME)</strong></td>
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<td>• Reduced need to develop internal complex and expensive technical systems</td>
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<td>• Reduced carbon footprint of production</td>
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<td>• Automation of financial management</td>
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<td>• Cheaper and quicker transactions</td>
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<td>• RTE solutions provide additional communications channels</td>
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<td>• SMEs can access advanced technical systems that they usually cannot afford (ERP, EDI, CRM, etc.)</td>
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<td>• Evidence based decision-making</td>
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<td>• New business models and business opportunities</td>
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<td>• New national and global market opportunities</td>
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<td>• Real-time response to demand and market changes</td>
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<td>• Reduction of administrative burden</td>
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<td>• Reduction of costs</td>
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<td>• Opportunities for reusing digital business data to create new business value</td>
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<td>• Improved competitiveness</td>
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<td>• Improved coordination in supply chain</td>
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<td>• Reduced carbon footprint</td>
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<td>• Small businesses lack resources and may lack full access to RTE solutions</td>
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<td>• RTE solutions can amplify the digital divide between businesses</td>
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<td>• The majority of SMEs in Estonia lack the basic IT infrastructure and require considerable ICT investments to catch up</td>
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<td>• SMEs tend to lack knowledge and human resources to exploit the available real-time data</td>
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<td>• SMEs lack ICT experts who can use RTE solutions to create competitive advantages</td>
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<tr>
<td>• Cyber security and data privacy are major concerns for SMEs</td>
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<tr>
<td><strong>Citizens</strong></td>
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<td>• Access to real-time services</td>
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<td>• Reduced bureaucracy for managing a business</td>
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<td>• Real-time product tracking</td>
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<td>• Real-time information about value chain</td>
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<td>• Carbon footprint tracking</td>
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<td>• RTE creates many new sources for government and businesses to collect citizen data</td>
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<tr>
<td>• Citizens with less knowledge and access to ICT infrastructure may be excluded from RTE solutions</td>
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