

*Valtteri Kujala*

# GUIDELINES FOR BUILDING A COMBINED E-COMMERCE AND ERP PLATFORM IN MICRO-ENTERPRISES

UNIVERSITY OF OULU GRADUATE SCHOOL;  
UNIVERSITY OF OULU,  
FACULTY OF INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING





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**GUIDELINES FOR BUILDING A  
COMBINED E-COMMERCE AND ERP  
PLATFORM IN MICRO-ENTERPRISES**

Academic dissertation to be presented with the assent of the Doctoral Training Committee of Information Technology and Electrical Engineering of the University of Oulu for public defence in the OP auditorium (L10), Linnanmaa, on 23 April 2021, at 12 noon

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### *Abstract*

In recent years, the role of micro-enterprises as drivers of the economy and society has started to gain recognition. However, many of them fade or remain small without taking their growth to the next levels. Digital platforms are increasingly shaping business models in nascent micro-enterprises. The motivation originated from the issue that business growth requires scalable digital platforms in a rapidly digitalising global economy. Moreover, open-source software has opened new opportunities for small firms to develop platforms with little cost, resources or technical skills.

This study utilised a design science research method to build a combined e-commerce and ERP platform as a design artefact in a Finnish software company. The study related research environment, theoretical background, construction of the platform and the performance, usability and utility evaluations were indicated.

The research findings were building guidelines to use them to build the platform in micro-enterprises to support business growth. The conclusions suggested that a scalable platform can be achieved with open source by using the guidelines. However, initiating growth capabilities, such as previously defined business processes and strategies, were essential before starting the platform's technical development.

*Keywords:* e-commerce, ERP, micro-enterprise, open source, platformisation



## **Kujala, Valtteri, Ohjeistus yhdistetyn verkkokaupan ja toiminnanohjausalan rakentamiseen mikroyritykselle.**

Oulun yliopiston tutkijakoulu; Oulun yliopisto, Tieto- ja sähkötekniikan tiedekunta

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### ***Tiivistelmä***

Viime vuosina mikroyritysten rooli talouden ja yhteiskunnan vetureina on alkanut saada tunnustusta. Monet niistä kuitenkin hiipuvat tai pysyvät pieninä kasvamatta seuraaville tasoille. Työn tarkoitus syntyi siitä, että liiketoiminnan kasvu edellyttää skaalautuvia digitaalisia alustoja nopeasti kehittyvässä globaalissa taloudessa. Tämän lisäksi avoimen lähdekoodin ohjelmistot ovat avanneet pienille yrityksille uusia mahdollisuuksia kehittää digitaalisia työkaluja pienillä kustannuksilla, resursseilla ja teknisillä taidoilla.

Tässä tutkimuksessa hyödynnettiin suunnittelututkimusta (design science research) yhdistetyn verkkokaupan ja toiminnanohjausjärjestelmän (ERP) rakentamiseksi suomalaisessa ohjelmistoyrityksessä. Tutkimukseen liittyvä tutkimusympäristö, teoreettinen tausta, alustan rakentaminen sekä suorituskyvyn, käytettävyyden ja hyödyllisyyden arviointi esitettiin.

Tutkimuksen tuloksena raportoitiin ohjeistus mikroyritysten digialustan rakentamiseksi tukemaan liiketoiminnan kasvua. Johtopäätökset viittasivat siihen, että skaalautuva alusta voidaan saavuttaa avoimen lähdekoodin avulla esitettyjä ohjeita hyödyntäen. Kasvumahdollisuuksien ja aiemmin määriteltyjen liiketoimintaprosessien sekä strategioiden yhtenäistäminen oli kuitenkin tärkeää ennen alustan teknisen kehityksen aloittamista.

*Asiasanat:* alustatalous, avoin lähdekoodi, ERP, mikroyritys, verkkokauppa





*There's an entrepreneur in all of us.*



## **Preface**

I want to express sincere acknowledgements to my supervisors, docent Raija Halonen and Ph.D Elina Annanperä, for their guidance throughout the study. Raija and Elina helped me grow as a researcher and writer, offering immense learning opportunities and countless constructive questions. I could not have imagined better supervisors for my work.

The insightful feedback and comments I received from my pre-examiners, professor Arto Ojala and docent Jonna Järveläinen also were valuable. Thank you both for going through the thesis carefully. I am grateful to the M3S research unit for allowing me to carry out this enterprising research with you. I am also thankful to helpful colleagues, customers and partners at Valfi for your time and patience during this long endeavour. Further, I want to thank Alexander Nelson and Cindy Goldenberg from the USA for the help with language and giving precious support.

My heartfelt thanks to my amazing, lovely wife Anna and son Aaron. Your unconditional support and acceptance encouraged me beyond my expectations. Additionally, great inspiration for the work came from my parents and sister Annika who also encouraged me enormously during this journey. Thank you for being in my life. You are all very special and important to me and I will always treasure you.



## Abbreviations and definitions

B2B/B2C	Business-to-Business/Consumer. A business model of selling products to other businesses or consumers.
CDN	Content Delivery Network, a service that helps to deliver web content quickly based on the user's geographical location
CMS	Content Management System, used to manage web content in a visual UI
CRM	Customer Relationship Management
DDoS	Distributed Denial-of-Service, a malicious attack where the attacker interrupts a targeted service with excessive loads of distributed web traffic
DSR	Design Science Research, research methodology
ERP	Enterprise Resource Planning, a system that the company uses to manage essential parts of the business
GA	Google Analytics, a tool to analyse websites and applications
IS	Information System
PHP	Hypertext Pre-Processor, server-based scripting language
SEO	Search Engine Optimisation, a practice to improve the visibility of a website to gain more traffic in search engine results
SME	Small and Medium-sized Enterprise
Valfi	A Finnish software company where this research was conducted
VR	Virtual Reality



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# 1 Introduction

This introduction explains the research background, motivation and research question of this study. First, the purpose of the study and the research motivation is presented. The principal foundations of existing knowledge are explained along with a research problem and question. In the end, the expected contributions of the work are described. Finally, the structure of the study is presented.

## 1.1 Purpose of the study

The purpose of the study was to explore building guidelines for a combined e-commerce and enterprise resource planning (ERP) platform for micro-enterprises. The study also sought a building process for using those guidelines in the right temporal process. By using the guidelines and process, a micro-enterprise could build the platform to help business growth with an open-source platform infrastructure that is scalable to grow with the business.

The research problem emerged from the issue that sophisticated information systems (IS) are essential in various stages of business growth (see Lewis & Churchill, 1983). Growing business brings more complexity in daily operations, and seamless systems are needed to support growth (Kosalge & Ritz, 2015). Along with technology, growing companies need to develop suitable mentalities and capabilities to build competitive advantages (Carneiro, 2007; Cavusgil & Knight, 2015). Small businesses are constituting a significant part of the economy as around 50% are employed by these (Eurostat, 2020). Still, productivity growth has been lagging, especially in the small companies performing manufacturing (OECD, 2017).

The current study was conducted using a design science research (DSR) methodology in a Finnish software company Valfi Oy (Valfi) that provided the organisational environment and problem domain for the study. The study engaged Valfi's customers that were micro-enterprises or grown out from the micro-level. Valfi also was a micro-enterprise itself during the present study. Valfi and its customers wanted to support their business growth through the use of the guidelines and also provide new knowledge for other IS researchers and practitioners.

## 1.2 Motivation

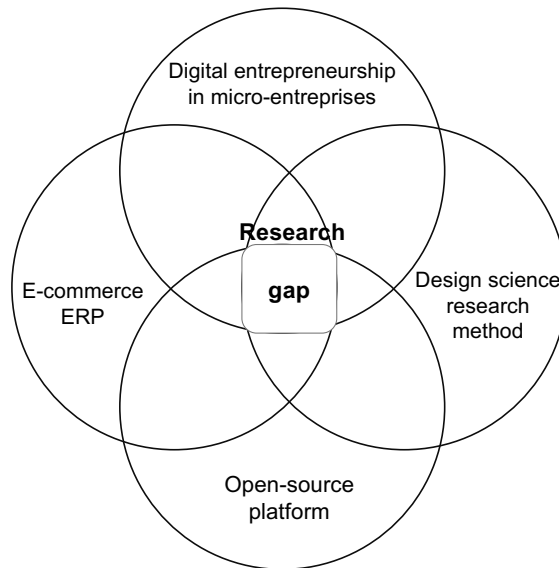
Low economic growth, opportunities and challenging environments may force individuals in entrepreneurship (Serviere, 2010). Economic competitiveness, especially in Finland, has been low or stagnant since 2008 (Eurostat, 2020). High wages that are resulting, for example, from wage-setting with trade unions, can also contribute to the lower chances of finding a job and pushing people to entrepreneurship (Kanniainen & Leppämäki, 2005).

Digital entrepreneurship connects digitalisation and entrepreneurship as the economic landscape is increasingly becoming digitalised. Digitalisation is radically shaping entrepreneurial opportunities. (Nambisan, 2017.) It also provides new global opportunities to small businesses shaping the international trade flows with digital commerce and platforms (Manyika *et al.*, 2016). However, European SMEs especially have had challenges in being competitive in the digital economy, which can result, for example, in non-digital small businesses dropping out from the markets (European Commission, 2020). Digitalisation is changing the society and economy globally, but due to its rapidly evolving nature, entrepreneurship research faces challenges to keep up the pace (Giones & Brem, 2017). However, various fruitful research themes have been created for digital entrepreneurship to guide paths that researchers could follow (Nambisan, 2017).

Entrepreneurs often have low resources when creating digital innovations, and the knowledge to develop software in particular plays a critical role in digital success (Thistoll, Hooper, & Yoong, 2013). According to Nambisan, Siegel and Kenney (2018), platform-driven business is emerging and enabling the rapid development of new digital business models in small firms locally and globally. Still, the entrepreneur must participate actively and guide the vision of software development when creating new digital innovations. The entrepreneur also should flexibly take part in demonstration, validation and improvement of the novel IT solutions. (Thistoll *et al.*, 2013.)

The DSR methodology produces utilisable results by creating and evaluating innovative artefacts built by the DSR researcher (Hevner, March, Park, & Ram, 2004; Gregor & Hevner, 2013). Nambisan (2017) presented that a combination of theoretical concepts and constructs connected with digital platforms can open new entrepreneurial research themes and spur digital entrepreneurship. The research gap of the current study was closely related to that research path. The present study produced new utilisable and theoretical knowledge to fill this gap. It connected the

affordances of digital entrepreneurship in micro-enterprises, open-source platforms, e-commerce, ERP and DSR methodology (Figure 1).



**Fig. 1. The research gap positioning.**

To fill the research gap with new knowledge, it was required to indicate the new building guidelines and process to help micro-enterprises to construct the combined e-commerce and ERP platform for business growth. DSR appeared to be the most suitable method in the current study because of its efficient utility and technology-oriented research framework (see Hevner *et al.*, 2004; Hevner, 2007). The aim was not only to fill the research gap for researchers but also help the growth-oriented digital entrepreneurs to utilise the results. The term ‘combined platform’ in the present study means a web-based platform that included both e-commerce and ERP features in the same seamless platform infrastructure. A different way to implement ERP is to use multiple separate applications, but this may pose increased complexity in the implementation (Lee, Siau, & Hong, 2003).

The motivation for the present study also emerged from the organisational challenges experienced by the researcher while working as an entrepreneur in the Finnish software company Valfi, which offers open-source-based e-commerce and ERP implementation services for its enterprise customers. Valfi also tried to achieve business growth for itself and its customers by utilising the platform. However,

Valfi and some of its customers had faced challenges in earlier e-commerce and ERP implementations: the company and its customers were required to discover the potential obstacles to be more prepared in the future platform implementations through the present study. The earlier findings by the researcher also had led to a study about e-commerce and ERP (Kujala & Halonen, 2018), which motivated the further in-depth research on the same topic.

### **1.3 Prior research**

Digital technologies are increasingly shaping entrepreneurial opportunities across different industries and markets (Nambisan, 2017). A ‘digital platform’ is a broad concept that influences increasingly not only multiple industries but also IS research fields. Platforms can also be viewed with different perspectives, such as technical, socio-technical and organisational viewpoints (De Reuver, Sørensen, & Basole, 2018). Platformisation is a broad concept that connects infrastructures, economic processes and public frameworks using digital platforms (Poell, Nieborg, & van Dijck, 2019). It can help overcoming issues with loosely integrated and inflexible information systems (Bygstad & Hanseth, 2018).

The examination of the prior research found journal articles and other studies related to the micro-enterprises, business growth, IS, platforms, e-commerce, ERP, entrepreneurship and open source. These are all essential topics to present to obtain a sufficient knowledge base around the design artefact, which is essential in DSR methodology (see Hevner *et al.*, 2004). The existing knowledge related to business growth underscores the importance of strategic thinking, defined processes, technology, leadership, innovation and risk-tolerance in a firm’s growth efforts (Miles, Snow, Meyer, & Coleman Jr, 1978; Beaver, 2007; Al Mamun & Fazal, 2018; Weber, Genaste, & Connell, 2015). The firm’s management is responsible for providing the growth orientation and also creating an encouraging environment for organisational culture driving growth (Cavusgil & Knight, 2015; Weber *et al.*, 2015; Mazzarol, Reboud, & Soutar, 2009; Beaver, 2002; Miles *et al.*, 1978). The owner’s motivation for growth also plays a role in micro-enterprises (Perren, 1999).

From the methodological view, DSR is a well-defined and used research method in the IS areas, utilising the construction of technical artefacts (Hevner & Chatterjee, 2010; Hevner, 2007; Hevner *et al.*, 2004; Baskerville *et al.*, 2018). DeLone and McLean (1992) suggested an ‘Information systems success model’ that connects the system and information quality, use and user satisfaction followed by the individual and organisational impact. The updated version of the original IS

success model was also connected to the e-commerce world (DeLone & McLean, 2003).

Small businesses are getting part of global trade flows by utilising the opportunities of digital platforms, e-commerce and connectivity, but they need help, recognition and assistance to survive (Manyika *et al.*, 2016; Blackburn & Jarvis, 2010). Some 'born global' start-ups are aiming for rapid international growth fast after being established (Cavusgil & Knight, 2015; Gabrielsson, Sasi, & Darling, 2004). However, start-ups should build software products that are ready-to-scale to support growth and a growing user-base (Giardino, Paternoster, Unterkalmsteiner, Gorschek, & Abrahamsson, 2015).

The existing studies in e-commerce fields have provided insights into success factors, IS success, usability and trust (Choshin & Ghaffari, 2016; DeLone & McLean, 2003; Lanford & Hübscher, 2004). E-commerce can be framed as a cluster or set of various innovations rather than defined as a single innovation or technology (Daniel, Wilson, & Myers, 2002; Prescott & Conger, 1995; Poong, Zaman & Talha, 2006). Online business also has strategic and organisational implications for the company (Abebe, 2014; Osterwalder, 2004; Fisher, Craig & Bentley, 2007). Still, micro-enterprises may face challenges in technical innovations due to limited resources (Faherty & Stephens, 2016).

Costs and infrastructure play essential roles in e-commerce (Choshin & Ghaffari, 2016). Furthermore, open-source software has been studied in organisational issues (Poba-Nzaou, Raymond, & Fabi, 2014; Hedberg, Iivari, Rajanen & Harjumaa, 2007; Lee, Kim, Choi, & Rhew, 2007). Some previous research was also found on the open-source-based WordPress platform (Patel, Rathod & Parikh, 2011; Douglass, Little, & Smith, 2006; Cabot, 2018), also providing some insights on data security (Kyaw, Sioquim, & Joseph, 2015). The studies related to the WordPress platforms appeared to focus on the comparison of web publishing features, performance and security (Patel, Rathod, & Prajapati, 2011; Kyaw *et al.*, 2015). The WooCommerce e-commerce plugin for WordPress was mentioned indirectly in some application development papers (Dehghani & Kolahdouz-Rahimi, 2019).

Existing research addresses the role of the ERP systems in small business decision-making, new technology adoption, daily operation and competition (Malhotra & Temponi, 2010; Buonanno *et al.*, 2005; Laukkanen, Sarpola & Hallikainen, 2007). However, integrating the ERP systems to the businesses appeared a complex and challenging process. The development of the enterprise systems should originate from clear strategic goals and realistic expectations, and

there should be a commitment from the company's team and management (Umble, Haft & Umble, 2003; Barker & Frolick, 2003; Bernroider, 2008). The existing literature review also provided implications about the differences between the small and large ERP systems, implementation differences and focus points (Bernroider, 2008; Almajali, Masa'deh, & Tarhini, 2016).

Some ERP research has been done about the experiences, objectives and constraints in small business environments (Iskanius, Halonen, & Mottonen, 2009; Laukkanen *et al.*, 2007). The International Organization for Standardization (2018) provides a standard definition for usability in human-computer interaction (HCI), which refers to the performance evaluation. The existing knowledge for usability analysis (Nielsen & Molich, 1990; Nielsen, 1994; Agarwal & Venkatesh, 2002; Lohse & Spiller, 1998), case studies (Eisenhardt, 1989; Runeson & Höst, 2009) and interviews (Schultze & Avital, 2011; Ackermann & Eden, 2011; Ulwick, 2002; Fontana & Frey, 2000) also are presented. Table 1 summarises the existing theoretical concepts with concluding focus points used in the current study.

**Table 1. Essential theoretical concepts of the current study.**

Topic	Focus points	Papers
IS success and construction	Design and success principles of information systems, process	DeLone & McLean (2003); Hevner <i>et al.</i> (2004); Hevner & Chatterjee (2010); Peffers <i>et al.</i> (2006); Levy & Powell (1998); Thistoll <i>et al.</i> (2013)
Micro and small businesses	Entrepreneurs and businesses with international growth potential and ambition	European Commission (2003); OECD (2017); Perren (1999); Blackburn & Jarvis (2010); Di Giovanni <i>et al.</i> (2011); Lanford & Hübscher (2004); Kumar & Kumar Singh (2017); Manyika <i>et al.</i> (2016)
Business growth	Growth capabilities, role of IT in different stages of business growth	Lewis & Churchill (1983); Street & Meister (2004); Carneiro (2007); Fitzgerald <i>et al.</i> (2013); Burns & Harrison (1996); Thong (1999); Nummela <i>et al.</i> (2005); Weber <i>et al.</i> (2015); Beaver (2002); Cantamessa <i>et al.</i> (2018)
E-commerce	Essential factors of building an e-commerce platform, adoption, B2B e-commerce	DeLone & McLean (2003); Poong <i>et al.</i> (2006); Sila (2013); Choshin & Ghaffari (2016); Stockdale & Standing (2006); Boateng <i>et al.</i> (2008); Al-Ismael & Sajeev (2014); Kuan <i>et al.</i> (2005); Osterwalder (2004)

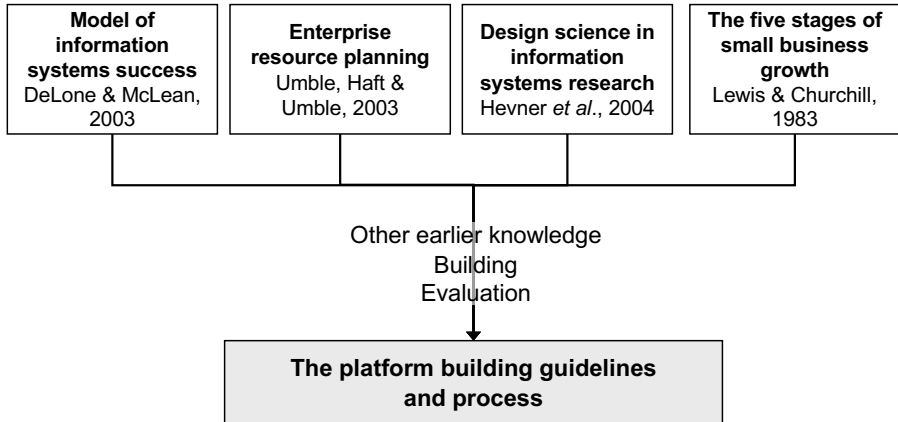
Topic	Focus points	Papers
ERP	ERP with scalability and minimal complexity	Umble <i>et al.</i> (2003); Kosalge & Ritz (2015); Bernroider (2008); Ganesh & Mehta (2010); Malhotra & Temponi (2010); Lee <i>et al.</i> (2003)
Digital business, platforms, open source	Platformisation, open-source software development	Nambisan (2017); Patel <i>et al.</i> (2011); Douglass <i>et al.</i> (2006); Hedberg <i>et al.</i> (2007); Cabot (2018); Baack (2015); Nambisan <i>et al.</i> (2018); Poba-Nzaou <i>et al.</i> (2014); Giardino <i>et al.</i> (2015)
Evaluation	DSR, performance evaluation, usability analysis, interviews, case studies, validity	International Organization for Standardization (2018); Eisenhardt (1989); Runeson & Höst (2009); Iivari (2007); Hevner <i>et al.</i> (2004); Nielsen & Molich, (1990); Schultze & Avital (2011); Hasan <i>et al.</i> (2009)

## 1.4 Research approach

Growth is connected closely to a firm's success and strategic objectives (Beaver, 2007). Still, it is known to challenge the internal communication and sales processes, which can cause issues with growth in small businesses (Street & Meister, 2004). The research problem was influenced by the issue that business growth should be supported with sophisticated information systems in the various stages of a small enterprise's growth (see Lewis & Churchill, 1983). The research problem was approached by presenting the research question:

*How can a combined e-commerce and ERP platform be built in a micro-enterprise?*

To answer to the research question, the study explored the building guidelines for the platform and also the process of using them in the right temporal order. The construction of the guidelines followed the DSR methodology and framework (see Hevner *et al.*, 2004). DSR has been suggested as a suitable methodological perspective to explore digital platforms (Nambisan, 2017). The key elements behind the guidelines were inspired by the IS success model (see DeLone & McLean, 2003) and other existing theoretical concepts as presented in Figure 2:



**Fig. 2. Major existing theoretical concepts behind the present study.**

The foundation for the building guidelines and process in the current research relied essentially on the four existing theories and methods, presented in Figure 2. The guidelines were influenced by the IS success model (see DeLone & McLean, 1992; DeLone & McLean, 2003). The other essential theories influencing the guidelines came from business growth (see Lewis & Churchill, 1983) and ERP implementation (see Umble *et al.*, 2003).

## **1.5 Contribution and significance of the thesis**

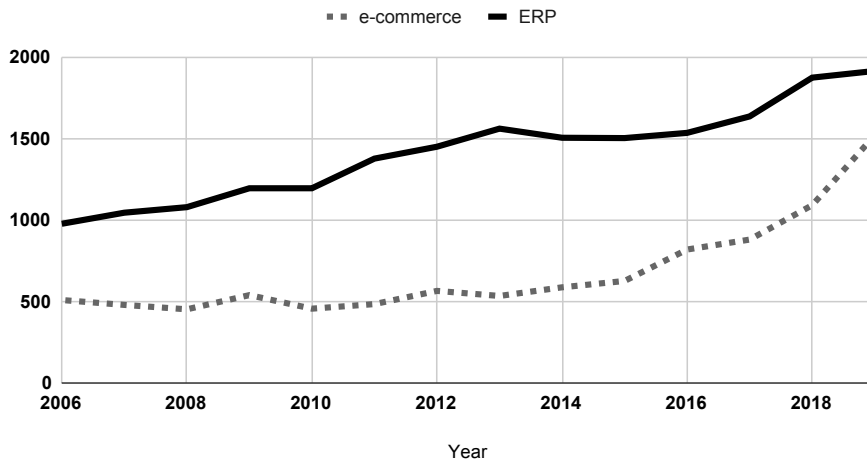
The outcome of the research was targeted for professional and entrepreneurial audiences interested in micro-enterprise business growth, platformisation and DSR methodology.

The construction of the platform was conducted in an active business setup in the Finnish software company Valfi, constructing the e-commerce and ERP platforms for its customers. The construction of the solution and its evaluation was utilised in Valfi's customers base as well as in the developer's existing constructions. Regarding the research significance, the present study filled a research gap in the e-commerce, ERP and micro-enterprise fields.

As indicated in this Chapter, most of the keywords essential for this study have had a growing interest from research audiences, as presented in Figures 3 and 4. The studies of e-commerce and ERP keywords had been increasing according to Figure 3, which shows the results of searching for the words 'e-commerce' and 'ERP' in journal titles, abstracts and keywords on Scopus. However, while the



statistics shown in Figure 3 might include solutions for companies of various sizes and other related research, the topics were found overall fruitful and active among researchers.

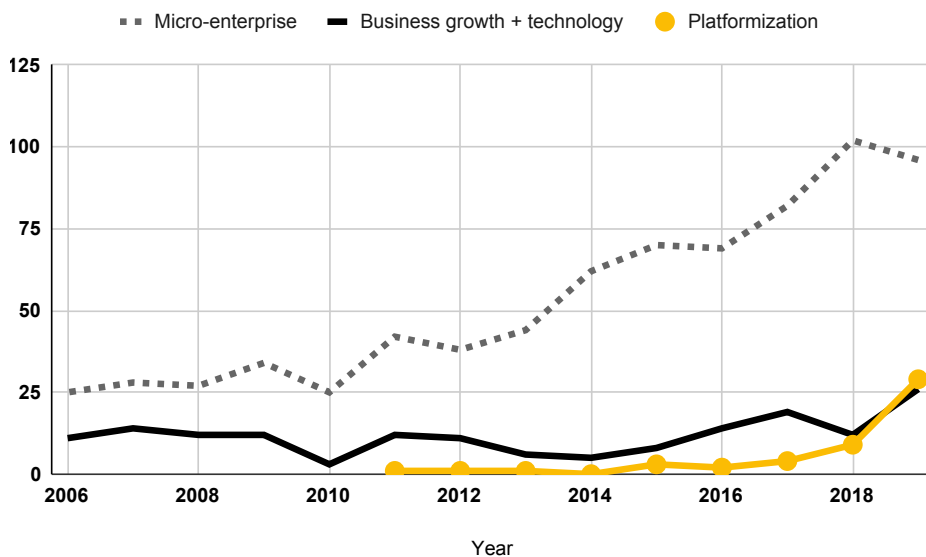


**Fig. 3. E-commerce and ERP mentions<sup>1</sup>.**

Similarly, Figure 4 presents the appearances of keywords ‘micro-enterprise’, ‘business growth + technology’ and ‘platformisation’ in a Scopus search.

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<sup>1</sup> Scopus. Retrieved 25 August, 2020 from: <https://scopus.com> with keywords “e-commerce” and “ERP”



**Fig. 4. Growth in journal mentions on major topics<sup>2</sup>**

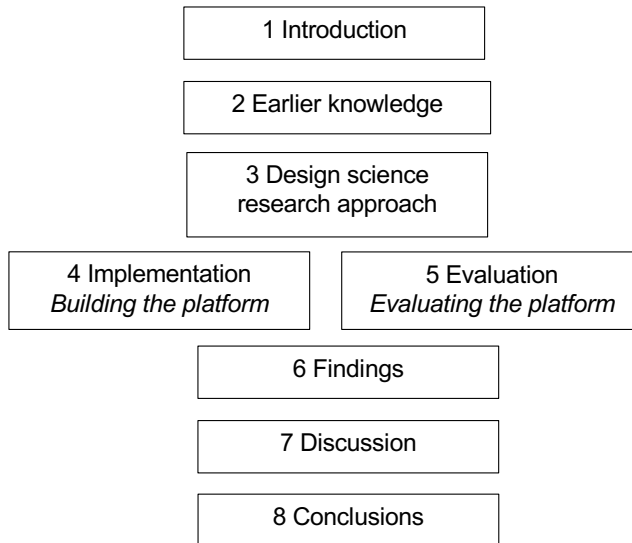
Although the number of the published journals was relatively small, according to Figure 4, the pace accelerated from 2013 onwards (in Figure 4). This possibly indicates that the research interest in the micro-enterprise, business growth, technology and platformisation fields was growing. In particular, the term ‘platformization’ seemed to accelerate from 2018 onwards. However, the insights presented in Figures 3 and 4 are limited to the Scopus search database.

## 1.6 Structure

This study follows a structure that presents the introduction, earlier knowledge, research approach, platform (artefact) construction, evaluation, findings, discussions and conclusions (Figure 5) in that order. Chapter 1 introduces the reader to the motivation and purpose of the study. Moreover, it addresses the essential earlier studies and theories. Chapter 2 points out the relationships between business growth and information systems, e-commerce, ERP and open-source platforms

<sup>2</sup> Scopus. Retrieved 14 October 14, 2020 from Scopus document search: <https://scopus.com> with terms ‘micro-enterprise’, ‘business growth + technology’, and ‘platformization’ (the word ‘platformisation’ did not indicate remarkable results)

through an in-depth literature review. Chapter 3 presents to the reader the use of design science research (DSR) as the research method. Chapter 4 presents the building of the platform. Chapter 5 evaluates the platform using three different evaluation methods. The findings of the study are presented in Chapter 6. Chapter 7 discusses the results of the study and also connects it with the essential existing studies presented in Chapter 2. Finally, Chapter 8 presents the conclusions. Figure 5 presents the structure of the current study.



**Fig. 5. Structure of the present study.**



## 2 Earlier knowledge

This Chapter presents the earlier knowledge relating to the present study. First, micro-enterprises are accounted for, along with digitalisation and information systems. The essential factors behind growth, e-commerce, open-source platforms, ERP and usability are pointed out with information content aspects. Finally, maintenance, security and trust issues are presented.

### 2.1 Micro-enterprises and digitalisation

Small businesses constitute an increasingly influential role in the growth of global economy, innovation, competitiveness and job creation (Thurik & Wennekers, 2004; Wong, Ho, & Autio, 2005; Acs, 1999; Van Stel, Carree, & Thurik, 2005; Acs, 1992). Small firms are also providing job opportunities and they are noteworthy goods suppliers and service providers for large enterprises (Kumar & Kumar Singh, 2017).

Micro-enterprises are defined as businesses having an annual headcount below ten persons and turnover of under 2 million euros (European Commission, 2003). Increasingly, young people see entrepreneurship as an opportunity that provides fruitful work paths outside traditional careers. However, in some cases, start-up culture may be forced because of the lack of other work and career opportunities. (Van Stel, Storey & Thurik, 2007.) Moreover, Thurik and Wennekers (2004) indicated that entrepreneurship could help in personal development issues and resolving social problems. Areas with unemployment and low-income workplaces can force individuals towards entrepreneurship and self-employment (Serviere, 2010). Still, Beaver (2002) underscored that small firms are not an effective response to unemployment challenges unless the firm's strategies are based on healthy competitive advantages and factors.

As small businesses constitute a significant part of private sector enterprises, help and support are needed in order to survive and grow in today's global business environments (Blackburn & Jarvis, 2010). Although start-ups may be able to create innovations and proceed to global business environments directly, time-pressure and lack of resources can be challenging especially, in the software industry (Giardino *et al.*, 2015).

Small businesses are increasingly participating in global markets by leveraging the opportunities of digital platforms and connectivity. Digitalisation is radically shaping global entrepreneurship, with over \$1 trillion in cross-border e-commerce transactions was expected by the year 2020. However, the gap between the

developing and developed countries in global trade flows is closing slowly. Generally, global businesses should recognise the transition to electronic environments. (Manyika *et al.*, 2016.) Still, problems in e-commerce adoption can be related to finding competent and efficient experts and support, leading to uncertainty (Stockdale & Standing, 2006).

Di Giovanni, Levchenko and Ranciere (2011) indicated that the international trade efforts may be characterised by the business and home country sizes. An independent and free way of living have enabled new styles of living and work for individuals who take advantage of digitalisation, enabling them to break away from traditional work culture. These ‘digital nomads’ have emerged from the presence of adequate access to information and information systems without commitment to time and place, allowing work and personal projects to be combined with independent work, freelancing and entrepreneurship. (Müller, 2016.) The development and utilisation of digital services are contributing to the development of the nomad culture, enabling efficient cross-border digital entrepreneurship (Nash, Jarrahi, Sutherland, & Phillips, 2018). Especially in small countries, international business activity can be active compared to larger countries (Di Giovanni *et al.*, 2011).

Start-ups can start with an immediate global focus by selling their products and services globally as their initial strategy. However, attention should be paid to proper financing and planning. (Gabrielsson *et al.*, 2004.) The born-global approach requires the company to focus mainly on innovation, technological edge and engagement of the partner networks with the flexible balancing of risk and opportunity (Cavusgil & Knight, 2015). According to Gabrielsson *et al.* (2004), the born-global companies are flexibly obtaining global management-related capabilities and business experience by utilising partners and venture capital sources. Seizing international opportunities by making new connections and being aware of opportunities seemed practical especially in family-driven small firms (Kontinen & Ojala, 2011). Sound IT systems, entrepreneurial visions, strategic thinking and ability to communicate these to employees and other business networks are essential in small businesses (Mazzarol *et al.*, 2009; Beaver, 2007).

A firm’s capital structure is a crucial element when developing the business strategically, providing flexibility to move towards long-term goals (Beaver, 2007). According to the European Commission (2020), SMEs in Europe face challenges in digital transformation that should happen not only in large enterprises but also in smaller companies. If growth can be managed and strategic thinking applied (Beaver, 2007; Mazzarol *et al.*, 2009), small firms may have improved chances of

being part of global business flows with e-commerce and improved connectivity (Manyika *et al.*, 2016). Growing firms go through stages of mere existence and survival before stabilising or achieving more significant growth. Information systems, growth management and sufficient funds are essential elements to support growth. (Lewis & Churchill, 1983.) Still, innovation efforts in micro-enterprises are often limited to a lack of resources (Faherty & Stephens, 2016).

Possessing enough capital plays an essential role in small businesses and the firm's growth is often related to managing it adequately (Lewis & Churchill, 1983; Jasra, Hunjra, Rehman, Azam, & Khan, 2011). Businesses that have received financing from investors may be cumulatively at lower risk of failure compared to non-investor-financed businesses (Puri & Zarutskie, 2012). Sufficient cash flow plays an important role in business growth and preventing business failure, being an essential part of business development (Lewis & Churchill, 1983; Cantamessa *et al.*, 2018).

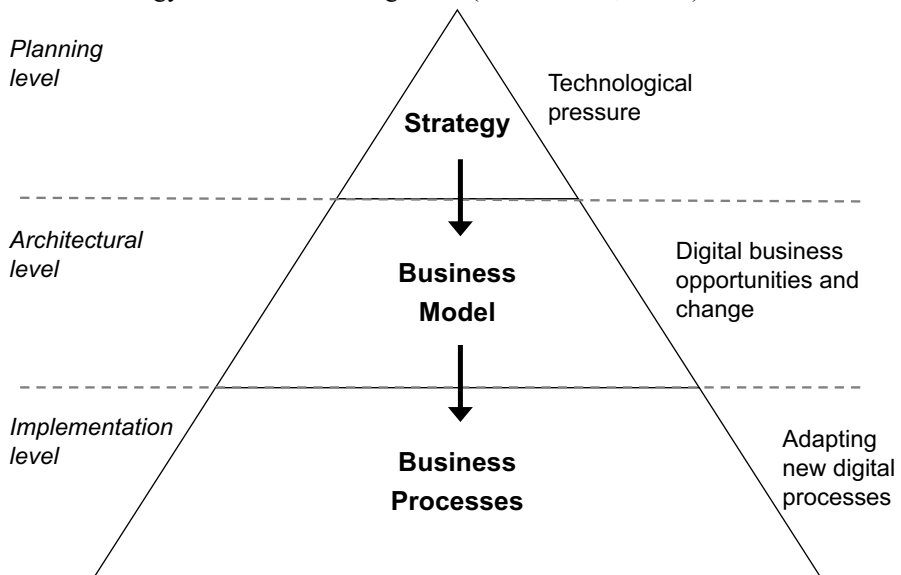
Digital transformation changes the landscape of business as it is becoming more global and interconnected. Tightening competition in international markets requires new products and services providing high value. (Kenney, Rouvinen & Zysman, 2015.) Furthermore, societies and communities could see notable economic and social benefits if they build and foster digitalisation in their environments. The improvement could be seen in increased productivity, new business, increased employment and improved quality of life. (Sabbagh, Friedrich, El-Darwiche, Singh, & Koster, 2013.) For example, in India, the start-up and international software industries are strongly driven by entrepreneurs (Majumdar, Vora, & Nag, 2010). However, countries with developed economies experience lower new employment growth on digitization while emerging economies see job growth brought by new technology and the potentials of digitalisation (Sabbagh *et al.*, 2013).

## **2.2 Information systems in small business**

Wong *et al.* (2005) indicated that only a limited proportion of entrepreneurs may be interested in actual technological innovation. Thistoll *et al.* (2013) underscored that skills related to software development are essential resources for innovative entrepreneurs. Europe is facing challenges with digitalisation and also lagging behind the United States in digital potential. Small and medium-sized enterprises (SMEs) also fail to attract a skilled new IT workforce compared to their bigger counterparts. (European Commission, 2020.)

According to Morris, Schindehutte and Allen (2005), a company's business model can help entrepreneurs and employees to focus, guided by the decisions made in the firm's management. On a company level, Street and Meister (2004) suggested that growth efforts may cause issues for the internal communication and sales processes. Thistoll *et al.* (2013) argued that entrepreneurs should actively gain technological expertise and lead the IT development with other partners, such as software engineers. However, platforms with open architectures can help businesses with limited resources leverage new IT opportunities (Nambisan, 2017).

Stakeholders may bring complexity and challenges to a firm's development work. In an IT-driven vision, the management should first define and design a clear business strategy to respond to the market demands, followed by the architectural-level considerations and business processes implementations. The concept of the e-business strategy is illustrated in Figure 6. (Osterwalder, 2004.)



**Fig. 6. Strategy to processes in e-business according to Osterwalder (2004).**

Attention should be given to the interplay of business models, strategies, processes and IT. Digitalisation can create opportunities to transform existing business models or creating new ones. (Pateli & Giaglis, 2004.) Moreover, the business model plays an essential role in the firm's competitiveness, and it should produce value for different partners and customers in software businesses (Ojala & Tyrväinen, 2011). According to Osterwalder (2004), the organisational e-business

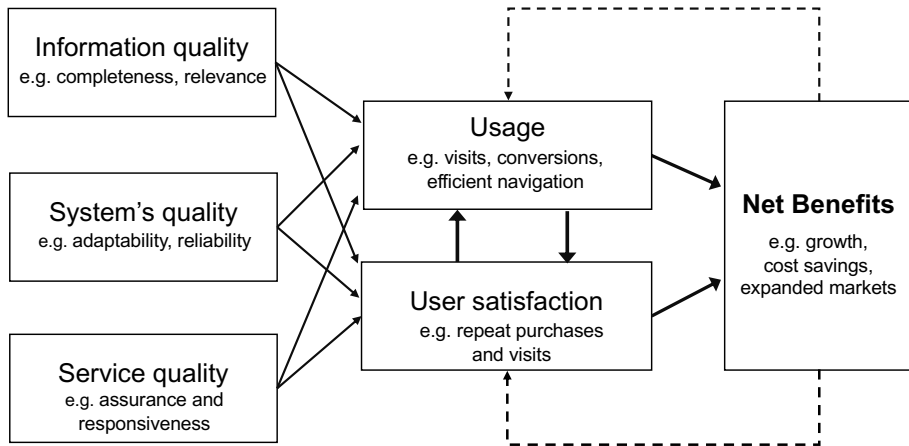


development strategy could start from the planning level and go through the business model level, finally ending with the digital business process adaption (Figure 6).

Beaver (2007) indicated that the strategy could be seen as actions the business needs to take to drive its financial objectives. Mazzarol *et al.* (2009) recommended that it is also essential to communicate the firm's clear strategic vision to the employees and other networks in small businesses. Miles *et al.* (1978) suggested a human relations model, in which the firm's manager should create an environment where the employees can contribute to the extent of their skills and abilities. The process of challenging the old models and bringing new technology could help firms to convey new value to their customers. However, companies might have different challenges and variables contributing to the success of new business models. (Pateli & Giaglis, 2004.) According to Osterwalder (2004), business processes are linked closely to the digital business model, strategy and vision, as presented in Figure 6. As Osterwalder (2004) indicated, business models could be studied together with the digital development stages. For example, in enterprise systems development, various development stages could be identified as technological transitions, pointing out the challenges of the changing scale in companies' operations (Kosalge & Ritz, 2015).

Companies' IS development requires active support from the management. It should not only be driven by the technological aspects and IT professionals, but the managers should also give attention to the value of information systems. Collaborative work between the different groups in the business is recommended. (Järveläinen, 2013.) Commitment and leadership from the top management are essential, especially in the enterprise system implementations, which are often challenging (Umble *et al.*, 2003).

The IS success model refers to an interplay of information, system and service quality leading to usage, the intention of use, user satisfaction and finally to net benefits. The model can be interpreted as a framework that presents the interplay of various IS research elements that are essential to understand when conducting IS management and investment efforts. It can also be interpreted as an arranged process where the system is first created and then measured by involving the users to experience and interact with the system. (DeLone & McLean, 2003.) The IS success model can also be connected to e-commerce, as highlighted in Figure 7.



**Fig. 7. IS success model with e-commerce perspectives according to DeLone and McLean (2003).**

System quality, usability and user satisfaction are also essential in the IS success model (DeLone & McLean, 2003). For example, in the e-commerce context, an initial positive experience can create a bridge of trust between the buyer and seller, encouraging future purchases (Järveläinen, 2007).

Business processes could be seen as an essential resource for companies. The processes indicate how the company achieves its goals. Often, the companies search for technological expertise to support and automate these processes. (Leymann & Altenhuber, 1994.) The different perspectives about business processes have been studied earlier, suggesting that business processes could be seen as activity systems operating inside a specific business environment and having possible constraints (Melão & Pidd, 2000). March and Storey (2008) indicated that executives, who monitor the firm's performance, play a central role in long-term economic success, creating an essential research field in the IS discipline. Business processes can also be supported by flexible information systems integrated into key business drivers and actions (Gebauer & Schober, 2006).

The enterprise system should be selected and planned wisely to achieve possible utilisation for the purpose for which it has been developed (Umble *et al.*, 2003). Continuously developing technologies and innovations helps the growth of the business in several ways, such as enabling the new features for customers, better communication and added value (Carneiro, 2007). According to Poba-Nzaou *et al.*

(2014), especially in global environments, small and medium-sized enterprises are faced with challenges in competitiveness, innovation skills and flexibility along with quality and information processing capabilities. Kosalge and Ritz (2015) proposed that a small scale in technological operations can pose issues in a growing number of users, data security, scalability and hierarchies.

In the software industry, cloud and software as a service (SaaS) businesses are changing the way software solutions are developed and distributed, meaning innovative, effective business models are needed for these companies (Giessmann & Stanoevska-Slabeva, 2012). Digital technologies are helping businesses in several ways, such as applying social media, mobile technologies, analytics or embedded devices to improve customer experience and business operations and create new business models (Fitzgerald, Kruschwitz, Bonnet, & Welch, 2013).

### **2.3 Growth capabilities**

Raposo and Do Paço (2011) saw entrepreneurship as a mechanism to turn visions into reality through action, where entrepreneurship education can provide tools to discover people's entrepreneurial potential. Growth, when approached strategically, can be used as a firm's performance and success measure (Beaver, 2007). Lewis and Churchill (1983) indicated that the growth of the small business could be taking place in the five different stages, where initially the company needs to be able to gather customers and offer them the right kind of products.

Beaver (2002) suggested that a sound competitive edge should be present in the strategy to support the company's sustainable and balanced success. Moreover, in the desirable 'defender-type' organisational strategy, having a limited set of premium products aimed at a narrow part of the total market is a central concept (Miles *et al.*, 1978). Lewis and Churchill (1983) proposed that in the further growth stages, companies' operations must be sufficiently profitable in terms of cash flow to maintain growing operations.

Profitability, capitalisation and employees appeared to be a robust measure of growth as well (Mazzarol *et al.*, 2009). In the later stages of growth, business owners need to be able to manage the growth and delegate tasks while also keeping the firm's operations and financials stable. Further, at this stage the company has achieved its growth goals and has significantly more market power, resources and a larger functioning organisation. (Lewis & Churchill, 1983.)

Expansion of economic activities can also mean evolvement in a network of self-employed using new technologies (Stam, 2010). It is possible to strategise and

plan the key business processes, such as the company's ability to innovate and internationalise (Onetti, Zucchella, Jones, & McDougall-Covin, 2012). According to Rockart (1982), communication skills are also crucial for business managers along with the human resource, management and reposition skills requiring thinking, planning and coordination in the IS implementations.

Small and medium-sized enterprises have a high probability of failure, especially during their first years of (Franco & Haase, 2010). For example, Baldwin, Bian, Dupuy and Gellatly (2000) indicated that about one quarter of companies crashed within the first years of their formation and only 42% reached the age of four years in a Canadian study. Cantamessa, Gatteschi, Perboli and Rosano (2018) pointed out that typical failing businesses have issues with business development, including running out of funds.

Nummela, Puumalainen and Saarenketo (2005) discovered that in small firms, survival in the market is enough; only a tiny portion of firms have a growth orientation, and an even smaller portion have international growth capabilities. Burns and Harrison (1996) indicated that many of the small firms are 'lifestyle' businesses, providing the owner with a satisfactory living, but without the company growing further. Cantamessa *et al.* (2018) also indicated that businesses may become too focused with their product and sales, missing essential business development stages.

Small businesses, in particular, have a high risk of collapse compared to medium-sized and large companies (Baldwin *et al.*, 2000). Arasti, Zandi and Talebi (2012) suggested that personal factors are leading to the failures in small businesses and the problems are often originating from the lack of crisis management capabilities and poor skills in marketing, finance and HR. Beaver (2002) sees a connection between business challenges and inability to manage the firm's growth or strategic processes.

Even though entrepreneurship is seen as an opportunity for economic prosperity and freedom, only a few companies can grow their business and many lack willingness to do so (Weber *et al.*, 2015). Burns and Harrison (1996) indicated that the owners may feel they are not controlling the business any more; when the problems in the communications and daily tasks pile up, it demands time for leadership and delegation.

The chances of survival may depend on the companies' abilities to get through the start-up stages into more active player in the markets (Reynolds & Miller, 1992). Many small business owners use most of their time on the day-to-day operations, having problems building solid strategies, processes, skills and trust (Beaver, 2007).

The advisors and strategic management engagers might need to know first if the firm they are guiding has desires to grow before taking assistive action on small business growth issues. The policymakers also should target their growth-seeking efforts into the strategy-driven firms, having the best chances and ambitions to grow, employ and contribute further to the society and economy. (Weber *et al.*, 2015.)

The owner's negative motivation for growth seems to prevail in micro-enterprises that are not growing (Perren, 1999). Growing businesses need to leverage the opportunities of technology with a supportive organisation, the right mentalities and committed management (Carneiro, 2007). Essential entrepreneurial competences in micro-enterprises are related to innovation and creativity along with proactiveness and autonomy (Al Mamun & Fazal, 2018).

Mahdikhani and Yazdani (2020) found that leadership plays a role in improving service quality and team performance, also having an effect on interpersonal and team performance trust in e-commerce businesses. Moreover, owner-managers in small businesses especially should be prepared to grow the business through strategic thinking followed by appropriate action (Beaver, 2007; Mazzarol *et al.*, 2009). Al Mamun and Fazal (2018) suggested that even though innovativeness and creativity are essential, they are not statistically significant actors in the micro-enterprise's performance in entrepreneurial competences.

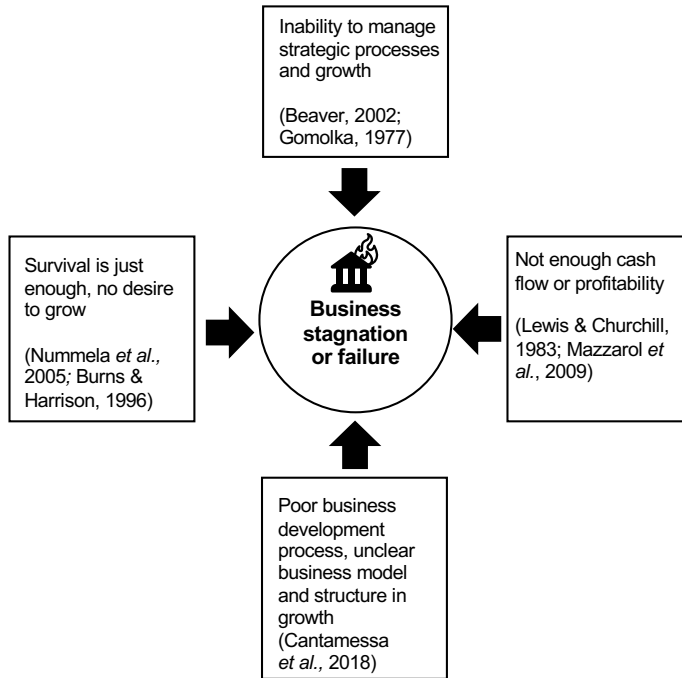
Bandera and Passerini (2020) indicated that digital entrepreneurs are optimistic about the future and using anxiety as their power to drive up their firm's performance when compared to traditional entrepreneurs. Thong (1999) found that companies whose CEOs see information systems as useful, appropriate and easy to use are more likely to start leveraging them. A CEO of a small business should have a proper risk-taking capacity to take new information system projects forward: a small business can experience significant damage if a project fails. Innovativeness and knowledge combined with proper risk-taking could be a recipe for success when implementing information systems in small firms. (Thong, 1999.)

Entrepreneurs' personal factors have an impact on a company's chances of success in addition to resources and strategic choices. Leadership skills, decision-making ability and technological adaptability are essential in business development. (Jasra *et al.*, 2011.) Thong (1999) presented an integrated model for information systems adoption in small businesses, especially highlighting required characteristics from the company's CEO.

Effective market opportunity recognition could be seen as part of essential entrepreneur skills especially in emerging technology firms. When a company can show profitable growth and efficiency in its early-stage operations, it sends a clear

message to investors, customers and other stakeholders of a reliable and robust expert, potentially also offering long-term success. (Gruber, MacMillan, & Thompson, 2008.) Seeking achievement, being independent and desire to be an effective leader might lead to successful entrepreneurs. Further, experiencing challenges earlier in previous jobs might lead people to start their own businesses. (Brockhaus, 1982.)

Awareness of one's own knowledge and skills could develop the identification of opportunities in business through metacognition. As rapidly changing technologies and marketplaces evolve, metacognitive skills are needed in entrepreneurs to run a business successfully. This could increase the likelihood of achieving the set goals and strategies. (Haynie, Shepherd, Mosakowski, & Earley, 2010.) Successful entrepreneurs operating in challenging and fast-growing business environments, such as John Chambers of Cisco Corporation or billionaire Richard Branson of Virgin Group, have been seen to use various cognitive strategies in their work (Morris, Munoz, & Neering, 2002). Figure 8 illustrates insights about entrepreneurial characteristics, pointing out factors that can lead to potential stagnation and interfere with business growth.



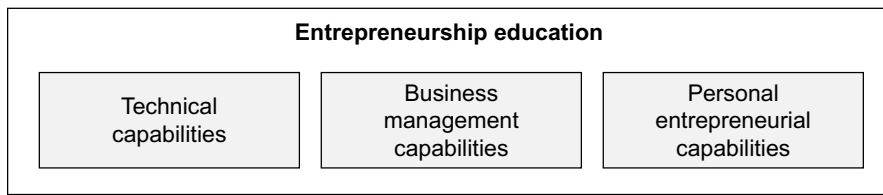
**Fig. 8. Essential indications of why firms stagnate or fail.**

As seen in Figure 8, the essential elements related to firms' growth issues and failure are related to desires to grow the business model, development, strategic management, processes and cash.

The public sector could support entrepreneurs in their entrepreneurial skills by providing, for example, training in entrepreneurial skills and flexibility in terms of bureaucracy (Jasra et al., 2011). Almahry, Sarea and Hamdan (2018) indicated that entrepreneurship education can help businesses to face possible obstacles in running the business, while asking for action from educational and public institutions. However, the educational efforts should begin from the early levels throughout the educational path, being more than just a single course or curriculum at the educational institutions (Raposo & Do Paço, 2011). For policymakers, it can be hard to recognise international potential in companies (Nummela et al., 2005).

According to Almahry et al. (2018), entrepreneurship education can provide essential skills that help business owners in their day-to-day requirements: it can include relationships between technical, business management and personal

entrepreneurial capabilities. The entrepreneurship education concept is presented in Figure 9.



**Fig. 9. Essential entrepreneurship education elements (see Almahry *et al.*, 2018).**

However, Galloway and Brown (2002) proposed that entrepreneurship education might have more long-term than short-term effects, while industry experience, maturity and networks have had immediate results. If growth-related help is provided to small businesses by advisors, it should be investigated first whether the businesses are willing to grow (Weber *et al.*, 2015).

Teaching entrepreneurs technical skills, business management skills and personal entrepreneurial skills can help businesses in their operations and in handling challenging situations. Governments should support these efforts, raising awareness of the role of entrepreneurship education. (Almahry *et al.*, 2018.) Government agencies also should provide more open data policies to allow businesses to create new digital solutions (Nambisan, 2017). Substantial funds are flowing to entrepreneurship education, but more evidence should be presented on its effectiveness. In general, governments investing in the topic should be paying more attention to evidence and results rather than just injecting the money into it. (Pittaway & Cope, 2007.) According to Räsänen and Tuovinen (2020), particularly in remote areas, opportunities to take advantage of digitalisation are improving, for example, through free workshops in which it is easy for companies to participate. Almahry *et al.* (2018) found that entrepreneurship education provided by higher education institutions especially is essential.

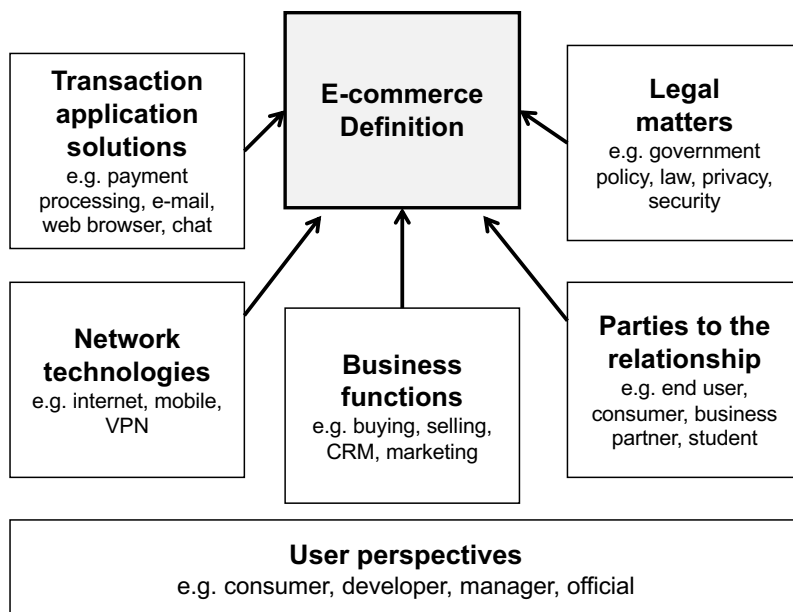
## **2.4 E-commerce**

E-commerce can be seen as transactions made with electronic tools, and generally, this is a wide definition reshaping customer and supplier communications (Daniel *et al.*, 2002; Prescott & Conger, 1995). Implementing e-commerce solutions in



business can improve internal processes and performance, also streamlining the operations (Abebe, 2014).

According to Poong *et al.* (2006), there are different perspectives on e-commerce, indicating various instances and components to consider. Multiple views can arise, for example, from technologies, applications, business functions, relationships and legal matters. For example, a user could have different standpoints when using the platform in interacting with a client, IT manager, lawyer or executive. The business models also contribute to the definition; for example, the purchase process of buying a book online can be significantly different compared to the process of buying a car online. When defining e-commerce, the user perspective should be aligned, relevant components selected and instances addressed, which finally creates the targeted e-commerce definition, as presented in Figure 10. (see Poong, *et al.*, 2006.)



**Fig. 10. Defining e-commerce (see Poong *et al.*, 2006).**

Choshin and Ghaffari (2016) indicated that e-commerce has shaped buying and selling practices with improved and faster communication, improving the relationship between consumers and suppliers and bringing competitive advantages.

However, even though the Internet is providing entrepreneurs global trade opportunities through e-commerce, the technological gap between the developing and developed countries is worsening due to the unequal access to information, payment mechanisms and infrastructure (Alyoubi, 2015). According to Stockdale and Standing (2006), entrepreneurs should be supervised, receiving assistance and training, also from the public sector, in e-commerce related issues. Fisher *et al.* (2007) pointed out that a firm's decision to utilise e-commerce technologies should arise initially from the firm's web strategy before the investments and business model changes towards digital commerce.

E-commerce has a significant influence on global business and sales, reshaping the companies and organisations that are ready to become more connected. The Internet ecosystem is advancing both technologically and socially, but new practical research approaches are needed to unleash the potential of e-commerce, particularly in developing countries. (Boateng, Hinson, Heeks, & Molla, 2008.)

Lanford and Hübscher (2004) indicated that many e-commerce sites need to solve issues of usability and trustworthiness to succeed. Implementing e-commerce technologies in business is a strategic choice for selling, marketing and combining online services that enable opportunities for reaching and retaining customers around the world. E-commerce adaptability could be increased if the cost of developing e-commerce and other critical factors was accommodated. (Choshin & Ghaffari, 2016.) Improving the quality of the system is an essential factor, especially when trying to increase e-commerce purchases (Kuan, Bock, & Vathanophas, 2005). The crucial e-commerce and web success measures are defined, among others, as download speed, customisability, ease of navigation, privacy and security (Palmer, 2002; Molla & Licker, 2001). Customised service for customers can be achieved, for example, with a customer relationship management (CRM) system (Phan & Vogel, 2010).

Small and medium-sized enterprises should move to electronic environments. However, rather than categorising all businesses as one homogenous group needing e-commerce, various e-commerce adoption levels should be identified. (Stockdale & Standing, 2006.) Still, the specific characteristics such as the innovativeness and the level of IS knowledge are contributing to IS adoption (Thong, 1999). Small businesses require personalised help, especially in the development of digital sales tools, in order to encourage firms to be active in e-commerce. This development could contribute to the training and mentoring offered by local business networks and public sector communities. Business owners and managers, likewise, have a

responsibility to find the willingness to adopt and develop the firm's e-commerce strategies. (Stockdale & Standing, 2006.)

The organisational and environmental requirements to adopt to IT differ (Neirotti & Paolucci, 2013). However, the business processes should be supported by flexible information systems that could be combined into the essential business drivers and actions (Gebauer & Schober, 2006). The e-commerce adoption levels, inventory management, ordering processes and labour costs are some of the essential drivers in business efficiency (Baršauskas, Šarapovas, & Cvilikas, 2008).

One of the most significant success factors in e-commerce development is cost. Cost is determined to include the technological costs, such as the infrastructure and platform set-up, and the expenses arising from the support services and organisational costs, such as employee training and time used to operate the system. The firm's technological awareness and the cost-efficient adaptability of e-commerce technologies are also essential factors. (Wymer & Regan, 2005; Choshin & Ghaffari, 2016.)

According to Dai and Kauffman (2002), companies' industry and market plays a significant role in the development of B2B e-commerce operating models. In B2B e-commerce adoption, management commitment and trust play a significant role (Sila, 2013). The B2B companies that take advantage of e-commerce opportunities could be more efficient in their operations by providing useful information and knowledge to their customers. By providing common platforms based on data and process standardisation, the B2B market could flourish due to the networking between the different companies. (Dai & Kauffman, 2002.)

Smaller companies also might face more security challenges than larger companies. Security and complexity are significant drivers for companies that have acquired e-commerce systems. Those drivers may depend on the size of the company. Smaller companies have more problems than larger companies in development. (Sila, 2013.)

## **2.5 Open-source platforms**

Nascent entrepreneurs are utilising digital platforms and continuously developing technical infrastructures to explore new digital models for their business (Kraus, Palmer, Kailer, Kallinger, & Spitzer, 2018). Nambisan, Siegel and Kenney (2018) indicated that platformisation is shaping the digital commerce field, as firms are becoming more dependent upon digital platforms as the essential vehicles for delivering and creating value. A technical viewpoint to digital platforms defines

platform as a technical codebase that integrates with third-party modules. Platform can include a collection of different applications that works with the core platform. (De Reuver *et al.*, 2018.)

Platformisation can be seen as a process where separate systems, or ‘IT silos’, become an integrated architecture using a common digital layer that connects the different applications through a unified platform with one owner. It helps to reduce complexity and provides a harmonised ecosystem for organisations, developers and third parties to flexibly develop new applications and integrations with the platform. (Bygstad & Hanseth, 2018.)

Open architectures on the platforms can help entrepreneurs to create new opportunities with limited skills (Nambisan, 2017). According to Poba-Nzaou *et al.* (2014), the adoption of open-source software will continue to rise in small- and medium-sized firms, having optimistic growth predictions. Baack (2015) indicated that open source and openly available data could help the utilisation of software in new ways. Open innovation and shared knowledge can reduce costs and bring efficiency to the commercialisation of innovations (Nambisan *et al.*, 2018).

Kraus *et al.* (2018) found that technological platforms are characterising digital entrepreneurship as a new path to conduct business. However, success in development is much determined by the user requirements and carrying out the open-source software selection process properly (Lee *et al.*, 2007). In web development, open source has been a potent force, and it is helping to prevent excessive power of commercial software groups and companies. Trends towards the utilisation of open-source platforms and data is supporting more democratic and borderless solutions. (Baack, 2015.)

Start-ups especially can leverage the opportunities of open-source software among the other third-party technologies to help in tackling the complexity of product development (Giardino *et al.*, 2015). Using web-based applications and e-commerce can enhance the access to global economy and business (Ingram & Lunsford, 2001).

However, open-source applications may not guarantee technical continuity in the future (Heron, Hanson, & Ricketts, 2013). There might be many challenges associated with choosing open-source software for companies’ IT needs. When multiple options are available, applications might not provide detailed information about their content or functionality in the intended uses. Selecting open-source applications may require investigation of the source code. Open-source software is often not ready for the intended use, requiring necessary modifications and customisations to make it operational. (Lee *et al.*, 2007.)

According to Hedberg *et al.* (2007), increasing commercial interest and popularity may lead more developers, with a broad range of technical capabilities, to participate in open-source development. However, Poba-Nzaou *et al.* (2014) indicated that shared development within communities and organisations is desirable and should be further endorsed. More developers and users in the open-source world may pose challenges, especially to the usability of open-source software. In many cases, large user communities can provide feedback to open-source developers. Nevertheless, quality monitoring should be done before the software is delivered to the end-users, who may also pay for the use of the application. (Hedberg *et al.*, 2007.) According to DeLone and McLean (2003), usability is one of the key elements in an e-commerce system's quality. Moreover, Hedberg *et al.* (2007) argued that attention should be allocated to assuring quality and usability in an open-source software development.

West and Gallagher (2006) indicated that open-source software may be supported by commercial organisations. Attention should be paid to the usability and quality process in open-source development as the commercial interest and popularity is increasing (Hedberg *et al.*, 2007). When commercial organisations do not reach success with open-source projects, they might wither away, leaving future projects without active interest. Open external innovation also could bring costs and risks related to the increased need for coordination in the development of open-source applications. (West & Gallagher, 2006.) Still, using open-source software in small firms may be achievable and supported further by open-source communities (Poba-Nzaou *et al.*, 2014).

## **2.6 Enterprise resource planning (ERP)**

According to Oracle, enterprise resource planning (ERP) software can be generally defined as 'software that organisations are using to manage their daily business activities'<sup>3</sup>. ERP can be seen as a heart of the business, containing the features that are running and automating the company's essential functions. The developer is required to understand the processes and strategies of the business in which the ERP is planned to be implemented. The ERP system should become part of the DNA of the firm's business model and should support, automatise and enhance business processes further. (Umble *et al.*, 2003.)

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<sup>3</sup> Oracle. Retrieved 17 October, 2020 from <https://www.oracle.com/applications/erp/what-is-erp.html>

ERP systems integrate the management of the company's critical resources to a centralised system. The ERP system might include, for example, sales, production, personnel management and distribution functions. It can provide real-time access to the business-critical data that is entered into the system. (Minahan, 1998.) According to Iskanius *et al.* (2009), small enterprises appreciate product development in the ERP systems more than larger companies utilising ERP software. Almajali *et al.* (2016) indicated that utilising ERP systems may have a central role in the company's data management and staff development. Bernroider (2008) discovered that companies with strategic IT governance perform better in ERP development; however, larger organisations require more top-management commitment and support to perform in ERP deployments.

According to Huang and Palvia (2001), low IT level development, small company size, lack of management systems and lack of managed business processes can cause problems in ERP development. Moreover, Kosalge and Ritz (2015) indicated that small-scale systems can cause issues when trying to manage a growing user base, data security, scalability and hierarchies. Defining the existing processes and pointing out the transparent management practices are essential elements in ERP implementations. If a company does not have pre-defined managed processes, the ERP system may not bring the desired benefits to the development of the company. (Huang & Palvia, 2001.)

Kosalge and Ritz (2015) also argued that increasing complexity in business growth requires the systems and integrations to support the firm's growing operations. Moreover, in small firms, attention should be allocated to the careful planning of the ERP system and understanding the business processes behind it (Malhotra & Temponi, 2010). According to Laukkanen *et al.* (2007), the small businesses pursuing ERP systems should not be considered as a homogenous group of entrepreneurs; the specific needs of their varying business models should be understood.

Lack of sufficient evaluation, support from management and unrealistic expectations are contributing to the failures in the ERP implementations. Many ERP projects do not deliver expected benefits. (Ganesh & Mehta, 2010.) Technical challenges are common when implementing the new ERP solutions. The businesses developing ERP systems should recognise the essential business functions in which they expect the system to be used to tackle the implementation challenges. (Umble *et al.*, 2003.) A similar approach was also suggested by Kosalge and Ritz (2015) who argue the ERP system should be considered as a well-planned strategic move by the company. In certain business functions, implementing ERP tools may not be

practical, potentially creating complexity for other information systems. Attention and significant care should be applied to factors influencing the various phases of the ERP development efforts. (Umble *et al.*, 2003.)

Kosalge and Ritz (2015) indicated that the extensive ERP construction efforts pose significant risks and costs, although they may originate from the strategic decisions of the company. The companies and integrators developing the ERP solutions are often failing to recognise the technical, commercial and organisational impacts of the ERP implementations (Ganesh & Mehta, 2010). The essential success factors in the ERP implementations are connected to the cultural change, use of consultants and management support, along with the other dependent and basic-classified factors in the organisation (Ahmad & Cuenca, 2013). Selecting the ERP system should originate from a committed strategic decision that helps in the specific business functions, followed by the in-depth measurement of the desired objectives. Although ERP implementations are often failing, the ERP project could start with failure but lead to a positive outcome in future development. A successful evaluation-build cycle in ERP planning could lead the system to success by studying the ERP project's early-stage failures. (Ganesh & Mehta, 2010.)

Expenses and risks are associated with all businesses conducting ERP implementations. These implementations are challenging especially for small businesses. (Malhotra & Temponi, 2010.) As Iskanius *et al.* (2009) indicated, a newly acquired ERP system is often perceived as a rigid system, frequently causing information mismatches and duplication between the separate systems and modules.

Traditional ERP system integrations have been slow to adapt to the needs of rapidly changing markets. The functions of ERP systems may be static and not support the individual business models of the companies using them. (Lee *et al.*, 2003.) Organisations tend to move from the existing systems to the new ERP implementations, often driving the system transitions up when the operations and businesses grow and become more complex (Kosalge & Ritz, 2015). Lee *et al.* (2003) indicated that ERP implementations include several pieces of software, legacy applications and other components, bringing duplicated integration work and complex integrability.

Firms can utilise web-based ERP systems to solve business problems and develop efficiency in business processes, automation and management. A web-based ERP system may function on various platforms, bring flexibility and reduce expenses. (Tarantilis, Kiranoudis, & Theodorakopoulos, 2008.)

According to Iskanius *et al.* (2009), IT skills and strong communication skills are essential when choosing an ERP provider. Almajali *et al.* (2016) suggested that

supportive leadership and ease of use plays an important role in ERP implementations. Large enterprises have been utilising ERP solutions widely. However, as ERP technologies evolve and development costs become lower, smaller businesses may consider ERP implementations. The company should understand creating the connections between the ERP system, people and business operations at the early stages of the implementation. Organisational cultural change should also be considered in ERP implementations. (Ahmad & Cuenca, 2013.)

According to Kumar and Kumar Singh (2017), the issues related to coordination and responsiveness in small businesses and their relation to the IT applications have been essential drivers coordinating supply chains. Furthermore, Ahmad and Cuenca (2013) claim that understanding the critical ERP success factors and their interrelationships is essential when integrating supply chain systems.

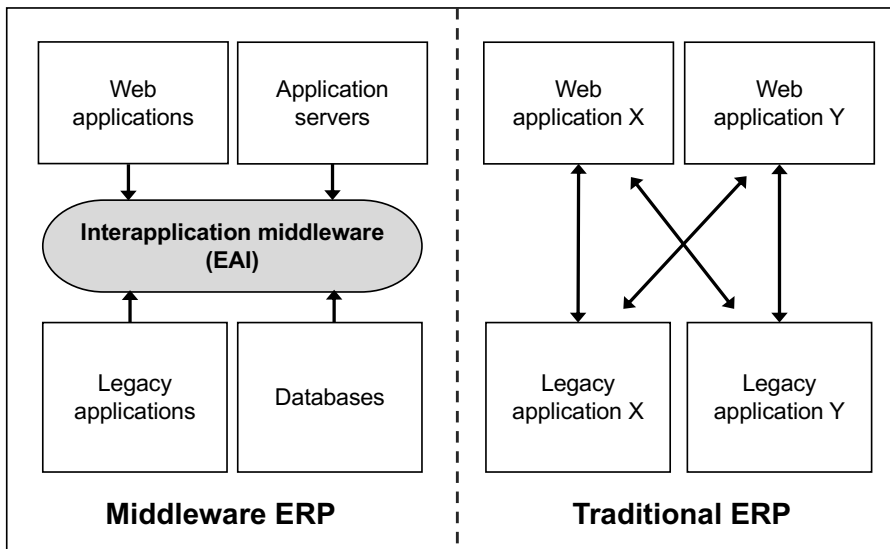
Having a single ‘interapplication middleware’ rather than multiple separate applications could improve the efficiency of the enterprise systems (Lee *et al.*, 2003). According to Microsoft Azure and RedHat<sup>4, 5</sup>, middleware is referred to as software that is in the ‘middle’ of the operating system and applications, providing functions such as data management, authentication and directories. A potentially less complicated approach to implement an ERP system can be an Enterprise Application Integration (EAI) model. In the EAI model, the ‘interapplication middleware’ is used instead of implementing multiple separate integrations between the systems in the traditional ERP implementations. The EAI approach talks to the different systems, combining the features, databases and software using a central middleware infrastructure. The use of the EAI approach can improve the performance of the ERP implementations as the integrability is improved. In the EAI approach, there is no need to re-write the integrations into the different parts and functions separately. (Lee *et al.*, 2003.)

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<sup>4</sup> Microsoft. Retrieved 4 October, 2020 from <https://azure.microsoft.com/en-us/overview/what-is-middleware/>

<sup>5</sup> RedHat. Retrieved 4 October, 2020 from <https://www.redhat.com/en/topics/middleware/what-is-middleware>





**Fig. 11. EAI approach for designing ERP systems according to Lee *et al.* (2003).**

As indicated in Figure 11, the EAI approach can bring efficiency in ERP implementations by reducing the need to integrate the various ERP functions between the different parts. In that approach, a central ‘middleware’ handles the inbound and outbound requests from the various applications and data sources (Lee *et al.*, 2003).

## **2.7 Content and user experience**

Olsina, Covella and Rossi (2006) indicated that web application development can be approached in various ways, and developing them requires understanding of diverse topics, such as information systems, software engineering and knowledge management. Businesses may engage customers to purchase items and services online if trustworthiness and usability are perceived (Lanford & Hübscher, 2004).

Cestyakara and Surendro (2013) underscored that start-ups are required to have agility and smart engagement skills to face rapidly changing global business environments and markets. As a web application can be seen as a mixture of relevant information content, functionality and services, the attention should be paid to each element to achieve success (Olsina *et al.*, 2006). Marketing in social media is one manifestation of ICT development. Mere knowledge of the existence

of social media does not help the entrepreneur to succeed. An appropriate strategic approach to social media is required in the businesses using it for their digital marketing efforts. A four-step model that helps a company build visibility on social media and measure its impact is proposed. The model consists of analysis, adoption, implementation and evaluation as the crucial stages of social media adoption in enterprises. (Cestyakara & Surendro, 2013.)

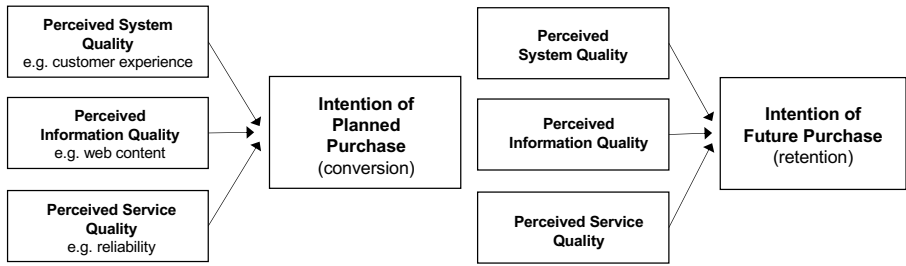
Being active on social media can help companies to grow and evolve. Social media is mainly used to acquire new customers and market products worldwide. It can also support the emergence of new business networks and partnerships. Being active on social media can also improve the company's ability to innovate. (Olanrewaju, Hossain, Whiteside & Mercieca, 2020.)

Alamäki, Pesonen and Dirin (2019) underscored the effect of videos supporting companies' marketing efforts. The study showed that marketing videos are influencing behaviour changes. However, the test subject's preference and interest in the content of the videos had more significant impacts. The more a person liked the video, the more likely it affected the person's behaviour. (Alamäki *et al.*, 2019.) Lanford and Hübscher (2004) also underscored that the customer's expectations should be met with a good reputation. Alamäki *et al.* (2019) found that the videos designed for instructional purposes correlated better with positive emotions and with a stronger intention to participate.

Engaging and narrative storytelling can help the business to sell experiences by communicating the firm's unique and personal stories about their products with the rest of the world (Lee & Jeong, 2017). Moreover, video marketers should reach the right audiences through appropriate storytelling rather than just focusing on making high-quality 'general level' video content (Alamäki *et al.*, 2019).

The use of narrative video marketing can transform consumer behaviour with collective storytelling approaches (Gordon, Waitt, Cooper, & Butler, 2018). However, technology has to overcome challenges such as production quality, content and training that are critical in determining whether the videos help in e-commerce success (López-Nores, Blanco-Fernández, & Pazos-Arias, 2013).

Kuan *et al.* (2005) indicated that the customer conversion and retention in e-commerce is linked to perceived system quality along with the information and service quality, having influences from the IS success model (DeLone & McLean, 2003). This approach with examples is presented in Figure 12.



**Fig. 12. Research model for customer conversion and retention (see Kuan *et al.*, 2005).**

Successful and trustworthy e-commerce business might have a connection with customer’s expectations of the user experience and usability of the system (Lanford & Hübscher, 2004).

The International Organization for Standardization (ISO) presents usability as part of the system that can be used effectively by the user that achieves the intended goals with efficiency and satisfaction<sup>6</sup>. DeLone and McLean (2003) pointed out that attention should be paid to the personalised and complete content that spurs the e-commerce conversions and retention.

If the mobile usability aspects are not respected in web application design, the result can be issues with the mobile users, leading to frustration and poor customer experiences. The essential dimensions in mobile web testing have been related to effectiveness, efficiency and satisfaction. (Al-Ismail & Sajeev, 2014.) The existing studies also underscore that suitable interface features may contribute to sales in online stores (Lohse & Spiller, 1998).

Heuristic evaluation can be one cost-effective method for collecting a high proportion of usability insights and design problems with a few evaluators (Sutcliffe & Gault, 2004). Heuristic methods are conducted as human experiences (Simon, 1996). Just 3–5 usability evaluators may be enough to recognise most of the problems in the system being tested in heuristic analysis. More than five evaluators do not provide significant value in finding new usability issues. (Nielsen & Molich, 1990.) Tan, Liu and Bishu (2009) found that evaluators’ experience can be considered in heuristic analysis when deciding the right number of evaluators, meaning fewer evaluators in the case they are experienced. Heuristic analysis could

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<sup>6</sup> International Organization for Standardization. (2018). Ergonomics of human-system interaction— Part 11: Usability: Definitions and concepts (ISO Standard No. 9241-11:2018). <https://www.iso.org/obp/ui/#iso:std:iso:9241:-11:en>

help in early phases of development, pointing potential out usability issues with reasonable cost-efficiency in software development (see Tan *et al.*, 2009).

The earlier studies in heuristic evaluation pointed out that essential drivers of a firm's web presence are related to the quality of content, promotion and advertising (Agarwal & Venkatesh, 2002). General rules of thumb for a good user interface design (Nielsen, 1994; Nielsen & Molich, 1990) are pointed out as:

1. Visibility of the system status
2. Match between system and the real world
3. User control and freedom
4. Consistency and standards
5. Error prevention
6. Recognition rather than recall
7. Flexibility and efficiency of use
8. Aesthetic and minimalist design
9. Help users recognise, diagnose and recover from errors
10. Help and documentation

In the web-based systems the users may experience the good/bad usability first and do the respective transactions afterwards, pointing to the importance of conducting a good heuristic analysis in e-commerce development. Moreover, minimal load-time among other factors plays the role of improving usability on the web. (Nielsen, 1999.)

## **2.8 Maintenance and trust**

Infrastructures, costs, customer satisfaction, and awareness are crucial factors in running a successful e-commerce business. E-commerce businesses should be capable of gaining new customers but also keeping them satisfied. (Choshin & Ghaffari, 2016.) Cloud services enable the delivery of content over the Internet efficiently without the need for investing in hardware and infrastructure. By utilising cloud services, businesses can pay flexibly for the used resources, have IT continuity and streamline web operations. (Buyya, Yeo, Venugopal, Broberg, & Brandic, 2009.) Kosalge and Ritz (2015) indicated that cloud services in ERP context may allow for businesses to access their information everywhere, but the running cost can be high in a long run.

Cloud services can be based on a robust and scalable virtual machine technology, where the same hardware provides a differentiated virtual environment

for each user. High security and privacy can be organised by the cloud service provider. Server level agreements (SLAs) can be helpful in ensuring quality, depending on the service providers. In the event of a potential problem, such as a failover, the cloud service provider would ensure the continuation of the services' operation. (Buyya *et al.*, 2009.)

According to Armbrust *et al.* (2009), cloud services refer to the combination of hardware and software offered by a web service provider on a pay-as-you-go basis. Citrix defines the term 'cloud service' as an on-demand service where the user does not have to build a data centre or acquire their own server equipment as the cloud service provider manages and charges for it according to use<sup>7</sup>. Businesses are leveraging cloud services to improve scalability for their services, as well as preparing for the possible sudden spikes in their service demands. Cloud service providers can offer packages and prices based on utility and usage, offering flexible pricing models for scalability. Utilising cloud services may bring flexibility and cost savings to maintain web services that are changing resources and essential parts of the business. (Buyya *et al.*, 2009.)

Building trust is an essential element in e-commerce. It should be built over a long period to achieve sustainable consumer confidence. (Martins, Martins, & Oliver, 2001.) Trust can be improved in e-commerce sites by moving certain risky actions, such as payment gateways, to third parties. Security on the e-commerce site, along with usability, should be a top priority to enhance the opportunities to succeed. (Lanford & Hübscher, 2004.)

The WordPress open-source platform has a long history of security issues, being one of the most hacked systems on the web<sup>8</sup>. A combination of manual and static analysis of vulnerabilities is essential for security in the WordPress system. Relying on the automated tools alone is not enough, as they only weakly identify potential vulnerabilities in the first place. The platform administrator needs to be familiar with the system and its related components to achieve adequate security. (Trunde & Weippl, 2015.) The active tracking of log data could be used to monitor the integrity of a web application. However, the security professional should have in-depth understanding about the functionality of the system and the underlying web server to point out the potential security risks in the application. (Kyaw *et al.*, 2015.) Moreover, an attacker also can access and abuse the underlying WordPress

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<sup>7</sup> Citrix. Retrieved 16 October, 2020 from <https://www.citrix.com/glossary/what-is-a-cloud-service.html>

<sup>8</sup> Zdnet. Retrieved 18 October, 2020 from <https://www.zdnet.com/article/wordpress-accounted-for-90-percent-of-all-hacked-cms-sites-in-2018/>

database by exploiting bugs or vulnerabilities in the system (Trunde & Weippl, 2015).

One solution to decrease risks in e-commerce could be to move some critical features, such as payment features, to third parties such as PayPal (Lanford & Hübscher, 2004). The WordPress system is vulnerable to password guessing attacks in which hackers access the system using administrator rights by quickly exploring the possible passwords with automated tools. Passwords of less than seven characters, written in small print, can be easily cracked by taking advantage of ready-made lists found online. The password guessing attacks may be protected against, for example, by taking advantage of the WordPress plugins that block malicious users after several invalid login attempts. (Kyaw *et al.*, 2015.)

## **2.9 Summary**

This Chapter concludes Chapters 2.1–2.8 by summarising the essential earlier knowledge and indicating its relation to the research gap (see Chapter 1.2). Chapter 2.1 presents small businesses' recognisable and unrecognisable players in the global economy (see Thurik & Wennekers, 2004) that are rapidly digitalising and utilising platforms (Manyika *et al.*, 2016). This brings validity to the research gap in the current study as it recognises the rapid change towards the more digitalised entrepreneurial landscape. The sub-class of small businesses are micro-enterprises that have small resources in terms of financial resources and employees (European Commission, 2003). Proper IT systems, managed growth and sufficient cash flow are high priorities for survival (Mazzarol *et al.*, 2009; Lewis & Churchill, 1983). Small businesses require help and training to succeed (Blackburn & Jarvis, 2010).

Chapter 2.2 pointed out how small businesses face challenges in digitalisation. It also explains why the entrepreneur should have an active approach and interest in creating new digital solutions (see Wong *et al.* 2005; Thistoll *et al.*, 2013). Before starting the technical implementation of new digital business solutions, the company should have a clear strategy and vision leading to more precise business processes that implement the latest technologies, as presented in Figure 6 (see Osterwalder, 2004). The owner plays an essential role to encourage employees to get the best out of their abilities (Miles *et al.*, 1978). DeLone and McLean (2003) presented an IS success model that describes the critical elements in successful IS implementation, also considering e-commerce viewpoints (see Figure 7). These insights are important for the present study as they especially point out technological requirements that are necessary to create a successful digital business.

The growth capabilities were presented in Chapter 2.3 to show how business growth results from various elements and their relation to information systems that companies use. According to Beaver (2007), a firm's growth usually provides useful insights about firms' performance and success measures. Business growth happens in multiple stages, as Lewis and Churchill (1983) indicated. Small businesses have a tendency to fail (Franco & Haase, 2010; Cantamessa *et al.*, 2018).

Managed growth requires various skills and resources to succeed and motivation to go further (Weber *et al.*, 2015; Beaver, 2002). Entrepreneurs' personal (Raposo & Do Paço, 2011), leadership, market identification and decision-making skills also contribute to success (Jasra *et al.*, 2011; Gruber *et al.*, 2008). Entrepreneurship education and the need to train business owners also was highlighted in Chapter 2.3 to show that technical skills can be acquired, and that it is essential for entrepreneurs (see Almahry *et al.*, 2018; Thistoll *et al.*, 2013). These insights illustrate that technical skills are becoming essential for entrepreneurs and should be addressed in entrepreneurship education. Moreover, growth capabilities were important to outline as this research aimed to help micro-enterprises with growth ambitions to grow with the digital platform.

Chapter 2.4 defined the e-commerce concept and presented various ways to view the concept (see Figure 10). It is essential to show the e-commerce-related research to harness the e-commerce definitions and concepts of ERP to help businesses tackle the digitalisation challenges presented in Chapter 2.2. E-commerce success factors were also presented, and they were related, for example, to costs, infrastructure, technological awareness and usability (Choshin & Ghaffari, 2016; Abebe, 2014).

Platformisation and open-source platforms are presented in Chapter 2.5 to explain earlier knowledge related to the constructed and evaluated solution in the present study. Chapter 2.5 presents how important platformisation is in an increasingly digitalising businesses landscape (see Kraus *et al.*, 2018; Nambisan *et al.*, 2018) and how open platforms can help with this phenomenon (Nambisan, 2017). However, challenges were presented relating to technical continuity and usability in open-source solutions (Heron *et al.*, 2013; Hedberg *et al.*, 2007).

The research gap of the current study is also positioned through e-commerce and ERP research topics. The ERP system plays an essential part in a company's 'DNA' and helps digitalise the company's processes and information flows (Umble *et al.*, 2003; Minahan, 1998). It is essential to explain the background of the critical success factors and elements of an ERP system in the current study to form the background theory to construct a viable solution utilising it. As an addition

to the technical success factors, other elements such as the need for proper IT governance and manageability (Bernroider, 2008; Kosalge & Ritz, 2015) are also presented (see Chapter 2.6.).

Chapter 2.7 presents the earlier knowledge related to content and user experience, as these were essential elements, especially in e-commerce (Chapter 2.4) and web application development. Solely technical knowledge is not enough as developing web applications may require understanding of various topics (Olsina *et al.*, 2006). For example, companies are required to be active on social media (Cestyakara & Surendro, 2013), among other growth capabilities (see Chapter 2.3). Video marketing features and narrative storytelling were also found essential to improve marketing (Alamäki *et al.*, 2019; Gordon *et al.*, 2018). These elements were contributing to the research gap as the platform had to take account not only of technical aspects but also the information content that the solution was going to hold. Information content was also an essential part of the IS success model (see Chapter 2.2) as well as user experience, as described in Chapter 2.7.

Finally, Chapter 2.8 highlights the existing knowledge about maintenance and trust, which are crucial elements in information systems (see Chapter 2.2) and e-commerce (see Chapter 2.4). Cloud services can help optimise the costs of running web applications and improve their continuity (Buyya *et al.*, 2009). Consideration should be paid to moving specific risky actions, such as payment gateways, to third parties (Lanford & Hübscher, 2004). Further, the WordPress platform is one of the most hacked website platforms on the web (Trunde & Weippl, 2015). These existing theoretical insights are essential to present and take into account before starting work with the requirements and construction in Chapter 4.



### 3 Research approach

The present study was carried out by using the design science research approach. First, this Chapter indicates DSR as a research paradigm and presents a three-cycle model with relevance, rigour and design cycles to the reader. Then, the DSR artefact and research environments are pointed out. Finally, it presents how the DSR method was applied to the present study.

#### 3.1 Design science research

Hevner *et al.* (2004) presented DSR in information systems as being pragmatic and actionable by its nature, as it is expected to create innovative IT artefacts, such as constructs, models, software and prototypes to grow organisational and human capabilities. March and Storey (2008) also indicated that the IT artefacts are aligned to improve the business performance in organisations. According to Baskerville, Baiyere, Gregor, Hevner and Rossi (2018), DSR is balanced between technological artefacts and theories; therefore, the research should produce both contributions. DSR can be referred to as design and evaluation of innovative products and processes solving real-world problems, especially in information systems (De Villiers, 2012).

DSR is suitable for business environments solving efficiency issues (Hevner *et al.*, 2004). It also provides a practical framework to explore digital entrepreneurship and potential solutions related to digital platforms (Nambisan, 2017). Baskerville *et al.* (2018) also underscored that creating both technological artefacts and design theories should be produced in DSR. The scientific evaluation methods, practical for the problem environment, should show the feasibility of the construction. Attention should be paid to how well the artefact can be utilised and how it solves the defined problems. It is not as essential to theorise and prove why the artefact works. (Hevner *et al.*, 2004.) New goals may also emerge from the design's research activity itself (Simon, 1996).

According to De Villiers (2012), DSR can have philosophical aspects in interpretivism that is rooted in acquiring new knowledge through making new things and changing the world with new artefacts. DSR can employ various methods of conducting the study, such as qualitative, quantitative and case study methods (Hevner *et al.*, 2004). For example, the analysis process itself reveals the definitions and essential measurements in case study research (Eisenhardt, 1989). Similar to action research, DSR has observations and interventions. However, DSR

provides a problem-solving approach that requires designing innovative technical artefacts, such as prototypes, which become solutions mainly in business environments and complex domains. Designers can rely on various existing knowledge sources to gain research rigour. DSR can also utilise creative methods such as intuition and experience to achieve results. (De Villiers, 2012.)

When developing systems using a constructive research method, creativity should be supported to spur innovation. Building IT artefacts should not only be the sole responsibility of the academic research communities. Information system practitioners also should have the opportunity to create new inventions. It is essential to consider the scientific evaluation of the artefacts related to information systems as a design science. (Iivari, 2007.) For example, according to Gartner<sup>9</sup>, a system integrator can put together multidisciplinary computing operations such as planning, deployment, testing and maintenance.

In DSR, the design artefacts, such as software products, can show their state-of-the-art impact in the world as they become popular and widely downloaded (Baskerville *et al.*, 2018). According to Hevner *et al.* (2004), design science research should follow the seven guidelines presented in Table 2.

**Table 2. Seven guidelines of DSR (see Hevner *et al.*, 2004).**

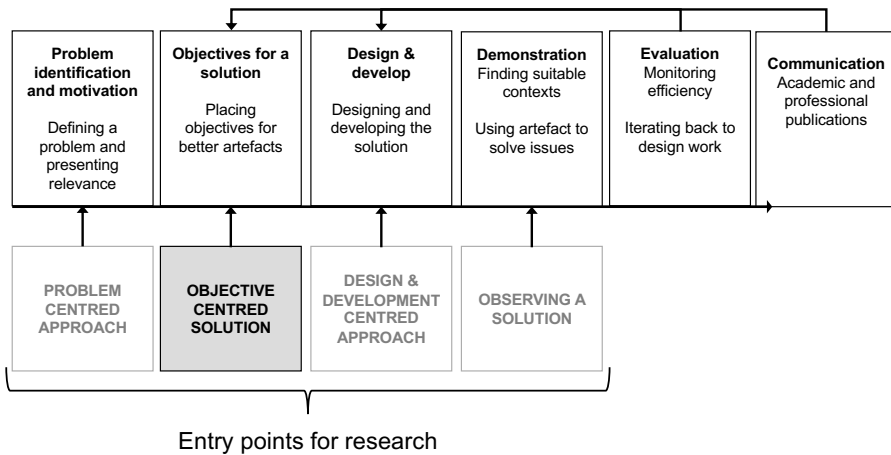
Guideline	Description
1. Design as an artefact	A viable artefact should be produced. The artefact can be, for example, a construct, method, model or instantiation that is useful for an organisational issue. The artefact should be purposefully explained: it should show its development and purpose in the relevant business needs and organisational environment.
2. Problem relevance	The research should keep as its main objective creating technology-based solutions to relevant and unsolved business problems. Business problems, such as increasing revenue and reducing costs, can be efficiently solved by designing efficient business processes using technology. Strategic development of IS plays an essential role in solving these problems.

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<sup>9</sup> Gartner. Retrieved 14 October, 2020 from <https://www.gartner.com/en/information-technology/glossary/si-system-integrator>

Guideline	Description
3. Design evaluation	The design artefact needs to be evaluated with rigorous methods to address utility and feasibility. The business environment determines the requirements for the implementation of the evaluation. IT artefacts can be evaluated, for example, through functionality, efficiency, reliability and usability so that they are compatible with the context of the problem environment.
4. Research contributions	The design artefact as the outcome of the research needs to be clear, evaluated and contribute to DSR. The artefact should solve a problem that is relevant and previously unresolved, contributing to different areas such as design construction knowledge, foundations and methodologies. The artefact should be capable of presenting the business and technology-relevant environments used in the research.
5. Research rigour	Construction and evaluation of the design artefact are the base of the research rigour in DSR. The researcher should base the study appropriately on efficient use of the knowledge base, such as theoretical foundations and research methodologies. The focus should be on utilising the artefact efficiently in the defined problem environment.
6. Design as a search process	Designing the artefact requires continuous building and evaluation by respecting the requirements of the problem environment. Design science is iterative in nature. Design should be an ongoing process of finding solutions to a defined problem.
7. Communication for research	The study results should be communicated effectively to the academic technology and management-oriented communities, researchers and practitioners. Effective communication of DSR enables its utilisation in further research and expands the knowledge base. Attention should be paid to the relevance of the problem, design process and new solution offered by the artefact.

As DSR is harnessed to design and develop things to solve real problems in the intersections of IT and organisations, the DSR process model (DSRP) proposes different entry points addressing the problems in a nominally sequential order. For example, a problem-centred approach could be selected for the early-level problem identification and motivation stage. The design and development approach could be selected for artefact construction. When the entry point is selected, the research starts moving towards the evaluation and communication steps. (Pefferers *et al.*, 2006.) The DSRP is presented in Figure 13, where the objective-centred solution is pointed out, being the approach used in the current study.

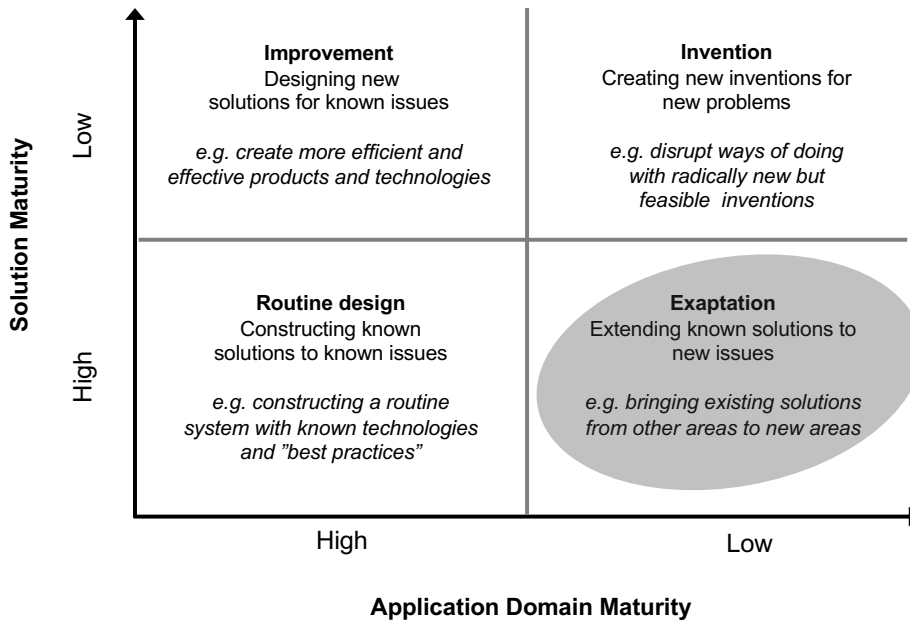


**Fig. 13. DSRP approach (see Peffers et al., 2006).**

The present study developed a set of guidelines to help develop a combined e-commerce and ERP platform for business growth. As the research problem emerged from the micro-enterprises and their growth undertakings, a set of building guidelines was created to build such a solution. The present research originated from the ‘objective-centred’ DSRP approach (Figure 13) that improved the existing well-known open-source platform.

In the objective-centred approach, the results emerge, for example, as by-products of the system development activities. The objectives could seek to find better solutions compared to the currently existing ones. (Peffers et al., 2006.) In the earlier studies, for example, a study was conducted to develop a better IS planning method. The participative methods, such as interviews, were used to make the participants focus on the valuable ideas in the IS development. (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007; Peffers & Tuunanen, 2005.)

It can be challenging to cope with ‘newness’ in new inventions. For example, the problem can be that the plan is not sufficiently based on previous theories or that the constructed thing is incomplete. A lack of rigorous evaluations could also lead to problems. However, the creation of innovations must begin somewhere. Less mature research results should also be able to be used for the knowledge base. The framework for the DSR knowledge contributions is presented in Figure 14. (see Gregor & Hevner, 2013.)



**Fig. 14. Design science research contribution framework (see Gregor & Hevner, 2013).**

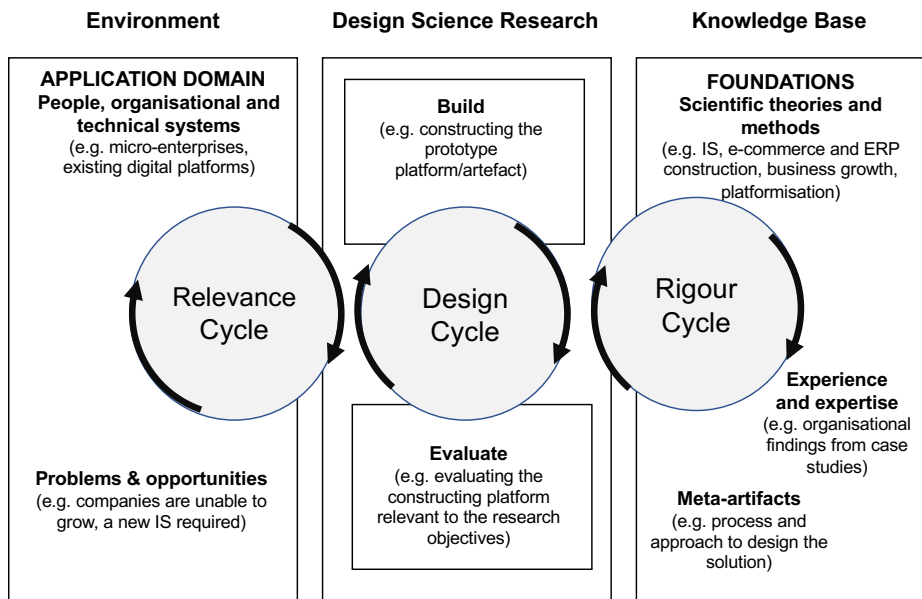
As Figure 14 indicates, *routine design* is producing known solutions to pre-known problems. In routine designs the context of the problem seems well identified and existing solutions are utilised for it. This kind of contribution usually does not produce the new knowledge contributions in DSR. The difference between the high-quality routine designs and DSR contributions could be seen, for example, in the way the contributions are identified and communicated to different communities and how they are backed with prior knowledge and evaluation. (Gregor & Hevner, 2013.)

Iivari (2007) underscored the importance of evaluation to distinguish between the traditional designs and the more disciplined, transparent and rigorous design science outcomes. Gregor and Hevner (2013) indicated that a DSR *invention* can be indicated as a significant breakthrough challenging traditional ways of working. Inventions are generally new in application domain maturity and solution maturity, but they could be considered as DSR in the case that the artefact and evaluation can be conducted in a real-world context and new knowledge has been contributed sufficiently. If a study aims to *improve* an existing solution, it should be able to determine why there were no suitable solutions in the past.

When DSR aims to deliver improvements, the capabilities of the new solution should be compared to the previous solutions. *Exaptation* can be another manifestation of DSR that produces known solutions to new problems. Functional artefacts from one area could be found useful in other areas that had not yet been exploited with the existing artefacts. (Gregor & Hevner, 2013.) The exaptation approach (see Figure 14) was chosen for the current study’s DSR approach. In that approach, a known open-source software application, the WordPress platform with WooCommerce plugin, was utilised for the DSR study.

### 3.2 Design science research cycles

DSR can take place using three research cycles interacting with each other. These cycles are the research relevance, design and rigour cycles. (Hevner, 2007.)



**Fig. 15. Three cycles of design science research (see Hevner, 2007).**

Figure 15 presents the cycles of DSR with example indications related to the present study. The design artefact is the essential part of the design cycle. In the present study, the design artefact was the combined e-commerce and ERP platform that was constructed and evaluated.

### **3.2.1 Research relevance cycle**

The relevance cycle initiates the study with an application background offering the requirements to execute design science research. New and innovative artefacts should be introduced in the research to solve real-world problems and opportunities through artefacts. (Hevner, 2007.) According to Baskerville *et al.* (2018), an influential position should be considered in the selected application domain when working in the DSR projects, creating technological evolution.

DSR should bring new and relevant information to the existing knowledge. The relevance cycle connects the study with the contextual environment. The research relevance cycle also establishes the acceptance conditions for the ultimate assessment of the study results. It answers, for example, how the artefact is improving the environment as expected and how to test and evaluate that improvement. (Hevner, 2007.) Iivari (2007) indicated that meta-artefacts, originating from IS as a design science, can contribute to improving the design process and product knowledge. For example, according to Eisenhardt (1989), case studies could use different data points to gather validity for the construct.

Hevner *et al.* (2004) indicated that evaluation is one of the essential elements in the research process of DSR and that the organisational environment determines the requirements for it. Scientific evaluation methods should be used in the evaluation to address the validity in the IS as design science (Iivari, 2007). Eisenhardt (1989) suggested that constant evaluation and review of the data and method take place until they make a sense together in the case study research. Hevner (2007) underscored that evaluation could be a continuous loop with construction, allowing feedback from evaluation to return the artefact to product development and continuously improve product design through it.

In the evaluation stage, the artefact should face the organisational context and solve real-life problems in the business environment. The evaluation gear provides essential feedback in the development of the solution during its building phase. An element of the completion of a solution could be considered when it corresponds to the goals set for it and the environment in which it is built. However, the evaluation could give freedom to the solution designer in an aesthetic sense, as long as it satisfies the user and the designer of the solution. (Hevner *et al.*, 2004.)

### **3.2.2 Research design cycle**

The research design cycle is the central part of DSR. It focuses on building the artefact and evaluating it while providing constant feedback to improve the design further. (Hevner, 2007.) Extracting valid insights from the design artefacts can be hard to achieve, but proper documentation in the design process can help (Gregor & Hevner, 2013). A balance should be maintained in the building and evaluation of the artefact, with appropriate time delegated for the scope and duration of the design cycle (Hevner, 2007). Simon (1996) indicated that the designs create different alternatives to the design and tests these alternatives to specifications before a suitable design is achieved. Design should happen as a continuous search process improving the effective artefact further through build-evaluate loops, iterating the solution towards the defined research goals (Hevner *et al.*, 2004).

In DSR, the research should address the knowledge base of existing studies, theories and experiences (Hevner, 2007). Small pieces of design can be put together to form a larger design process (Simon, 1996). The design cycle in DSR should advance between the research environment and knowledge base (Hevner, 2007). Accordingly, the environment in the current study was determined to be based on growth-oriented micro-enterprise organisations where the research design cycle was conducted by constructing the platform.

### **3.2.3 Research rigour cycle**

Efficient use of prior research (knowledge base) and evaluation methods satisfies the rigour cycle in the DSR study. DSR should systematically connect the existing state-of-the-art theories, design methods, construction and practices with the problem domain of the research. The research rigour should make clear distinctions between DSR contributions and conventional routine designs. (Hevner *et al.*, 2004.) Moreover, valid methods and grounding theories should be connected to artefact building activities (Hevner, 2007).

Iivari (2007) indicated that using a combination of various idea sources such as existing artefacts, analogies, theories, problems and opportunities can contribute to transparency in design science origins. Gregor and Hevner (2013) pointed out that DSR can contribute to new knowledge by designing new solutions, applying new solutions to existing problems or designing known solutions to new problems (see Figure 14). Iivari (2007) also highlighted that the appropriate evaluation is essential to distinguish IS as a design science from the routine construction of



information systems. Finally, the new inventions and research contributions should be contributed back to the knowledge base to be utilised by the other researchers and practitioners (Hevner, 2007).

### **3.3 Background for the artefact**

In this Chapter, the background of the platform and evaluation methods, used in the present study, are presented.

#### **3.3.1 Platform as a DSR artefact**

This Chapter indicates a technical background of the platform as the DSR artefact in the present study. WordPress is an open-source web publishing platform and software built initially as a management engine for blogs and websites, providing a visual interface for web content management. It contains, for example, a login page, user account management, product and page editing and theme with navigation control in a graphical web-based interface. WordPress is implemented primarily using the PHP programming language, and it works across the wide range of web browsers. The WordPress platform stores content in a web server's MySQL database. To work, WordPress requires a web server that supports PHP and MySQL databases. (<https://wordpress.org>.)

WordPress was not a new invention. However, Gregor and Hevner (2013) indicated that DSR methodology can be conducted as an *exaptation* study by extending known inventions to new issues (see Figure 14). In 2020, the open-source web platform WordPress was used about in a third of the world's top 1 million content management system (CMS) based websites<sup>10</sup>. The WordPress use cases range from business websites to e-commerce and large portal-type news sites, such as UNICEF, Angry Birds, Rolling Stone, Vogue and more.

The WordPress platform provides basic web publishing functions, such as blog and page editor, user management and authentication, templating system, REST API integrations, automatised WP-cron functions and mobile-friendly interfaces. WordPress functionality can be extended with additional open-source and privately developed plugins, such as WooCommerce, which brings e-commerce features to WordPress. In the WordPress platform, the information in the system originates from the web content, such as pages, blog posts, user-related information,

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<sup>10</sup> BuiltWith. Retrieved 26 September, 2020 from <https://trends.builtwith.com/cms>

comments, media and other content that the administrator produces or uploads onto the platform. WordPress provides an active documentation site, plugin and theme repository and support forums for the developers. (<https://wordpress.org>.)

WooCommerce is an open-source WordPress plugin that extends the WordPress platform with e-commerce features. The WooCommerce plugin is a flexible tool for e-commerce that can be used to develop various e-commerce interfaces utilising the WordPress platform core. The plugin also provides the REST API features for various integrations, and it has an active open-source community providing additional help and support for the sellers using it in their business. (<https://woocommerce.com>.) Moreover, WooCommerce is one of the most popular e-commerce platforms and it is used on over millions of sites around the world as of 2020, challenging other popular e-commerce platforms such as Shopify, Magento and OpenCart.<sup>11</sup>

The WordPress platform provides comprehensive guidance and framework for developing custom plugins and custom themes. To help the developers to design new plugins and features, a digital ‘Plugin Handbook’ is available on an official WordPress website. The purpose of WordPress plugins is adding new features to the platform, as an addition to the basic functionality of WordPress. The WordPress plugin system works on a PHP-driven infrastructure, and it supports various built-in PHP functions, actions and hooks when developing new features for the platform. The extensive and active developer community behind WordPress identifies potential security vulnerabilities and other issues. The community has also been providing updates to the platform several times a year with an automated WordPress update service on the cloud. (<https://wordpress.org>.)

WordPress and WooCommerce development can be assisted with external help provided by the various freelancers and contractors that are experienced with the technologies. For example, the site Stackoverflow.com delivered excessive search results to help with the well-described problems, such as developing and customising plugins in WordPress<sup>12</sup>. To gain external help for technical development, the WordPress developers seemed to be easy to find, for example, PHP experts with WordPress and WooCommerce skills were found on multiple

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<sup>11</sup> BuiltWith. Retrieved 18 September, 2020 from <https://trends.builtwith.com/shop> and <https://trends.builtwith.com/shop/WooCommerce-Checkout>

<sup>12</sup> Stack Overflow. Retrieved 18 October, 2020 from <https://stackoverflow.com/questions/tagged/wordpress>

different freelancer platforms such as the ‘WooExperts’ platform suggested by WooCommerce<sup>13</sup>.

WordPress REST API offers an efficient flow of data on a secure and protected channel, offering customisable endpoints to query, modify and create content between external systems. The basic idea of REST API is to work inside the WordPress platform, making extensive use of the JSON format used in the various integrations, which are also supported by the several different programming languages. The comprehensive documentation for activating the REST API can be found in the REST API handbook. (<https://developer.wordpress.org/rest-api/>.)

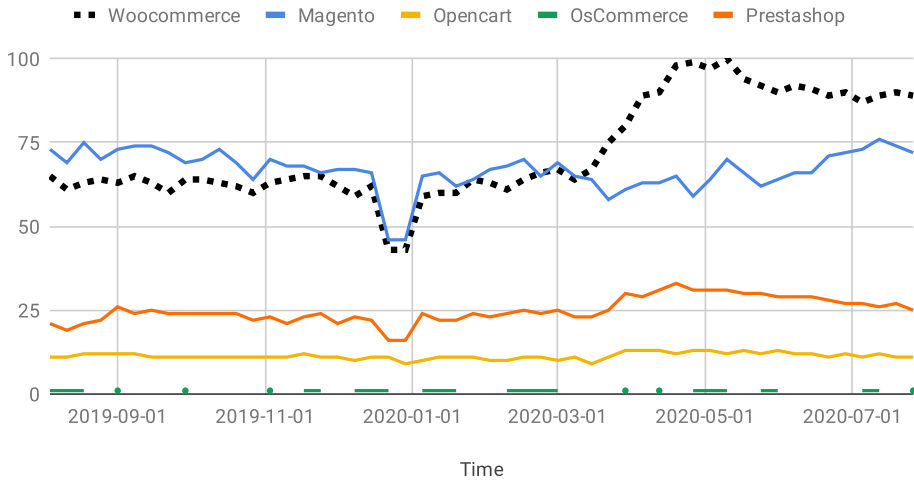
The rise of the commercial e-commerce platforms can indicate the growth of the sector as the share prices of the publicly traded e-commerce companies, such as Amazon and Shopify, also benefitted from the increase in e-commerce in 2020, rising between 1 January and 25 August +81.10% and +160.88% respectively<sup>14</sup>. Downloadable and free versions of WordPress and WooCommerce are both released under the open-source principles, which allows for anyone to access, edit and use source code<sup>15</sup>. According to Google Trends (2020), WooCommerce had the largest interest among the open-source e-commerce platforms in 2019–2020. After that, the next most popular platforms were Magento and Prestashop. WordPress seemed to be the most active platform compared to its private and open competitors. The market shares of the various open-source-driven e-commerce platforms are illustrated in Figure 16.

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<sup>13</sup> WooCommerce. Retrieved 18 October, 2020 from <https://woocommerce.com/experts/>

<sup>14</sup> Investing.com. Historic Amazon and Shopify stock prices. Retrieved 18 February, 2021 from <https://investing.com>

<sup>15</sup> Free Software Foundation. Retrieved 21 September, 2020 from <http://www.gnu.org>



**Fig. 16. Market interest of open-source e-commerce platforms (see Google Trends, 2020).**

Even though the popular WordPress platform and its WooCommerce plugin are based on open source, there are also several other open-source-based e-commerce platforms, as indicated in Figure 16.

### **3.3.2 Platform performance and usability evaluation**

Matera, Rizzo and Carughi (2006) suggested that automated tools can effectively measure repetitive evaluations without the need for significant time and expertise resources from personnel experts. In web application development, evaluation should be focused and oriented to the purpose it is measuring (Olsina *et al.*, 2006).

Automated tools cannot justify the nature of the problem or provide concrete solutions to them. However, automated tools may provide relevant information to support decision-making, which could later be used by the experts, for example, in research and development. As web applications are becoming more complex, measuring users in terms of usability plays a significant role in the success of the web-based system. Automatic usability measurement tools are easy to deploy for repetitive and time-consuming evaluation tasks. (Matera *et al.*, 2006.) Still, web application quality can be easy to recognise but difficult to evaluate or describe (Olsina *et al.*, 2006). Automated tools cannot draw conclusions or suggestions that

require expert reasoning, for example, regarding design options (Matera *et al.*, 2006).

According to Hasan, Morris and Proberts (2009), Google Analytics (GA) can provide the evaluation and metrics that provide information about the performance and usability problems in web-based e-commerce systems. Olsina *et al.* (2006) indicated that evaluation could be conducted by respecting the different stages of a web project and understanding its focus and purpose. GA is an affordable tool that can help to measure web traffic. Other evaluation methods, such as heuristic analysis, can support its efficiency. Using GA in evaluation is automatic by its nature, also pointing out usability insights about the purchasing process in e-commerce. (Hasan *et al.*, 2009.)

GA provides efficient and free tools to measure website and web application traffic for performance and engagement<sup>16</sup>. Usability is a key element in e-commerce success along with trust, costs, infrastructure, user satisfaction and knowledge (Lanford & Hübscher, 2004; DeLone & McLean, 2003; Choshin & Ghaffari, 2016). GA also can help to provide a comprehensive view of the site usability and point out potential usability issues (Hasan *et al.*, 2009).

The user testing determining the website and e-commerce system effectiveness could be called and observed efficiently using the GA web metrics tools (Plaza, 2009). GA offers many benefits to site owners and helps them create user-friendly content. However, the website owners often face challenges in tracking the GA data. Much of the available data remains untapped and the site owners tend to use it out of context. For the data provided by GA, the site owners have difficulties in finding the concrete use cases. The owners of small websites could benefit from additional training and assistance provided by technical experts familiar with GA. (Petersen & Martin, 2015.)

According to Hevner *et al.* (2004), heuristics can provide search approaches that can be used in the business environment to find valid designs as an iterative search process. Simon (1996) also underscored that heuristics can provide sensible results that are satisfactory enough for the objectives of the research. According to the International Organization for Standardization (2018), users should be able to achieve their goals effectively and efficiently when using the system, addressing both the frequent and infrequent users with wide ranges of capabilities. The speed, how a computer as artefact works, may provide insights about its performance and indicate poorly performing components (Simon, 1996).

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<sup>16</sup>Google. Retrieved 6 October, 2020 from <https://marketingplatform.google.com/about/analytics/>

The well-known search engine optimisation site Backlinko<sup>17</sup> found in their study that the average loading speed in a web pages was about 10.3 seconds on desktop browsers and 27.3 seconds on mobile browsers. (Dean, 2019.) Moreover, according to Wolfgang Digital's studies, average conversion rates in the retail sector stood at around 1.9%, avg. pages/session 5, avg. session duration of 2m 57s and bounce rates of 41%<sup>18</sup>. According to Google, the location of the network and the quality of the end-user browsers seems to contribute to the page loading speed.<sup>19</sup>

In search engine optimisation, *Bounce rate* means a sudden exit from a page: this percentage indicates how many visitors leave the page as soon as it is opened. *Pages/session* reading indicates how many pages a visitor used during their visit to the site. *Avg. session duration* indicates the average duration of one visit in minutes. ([https://support.google.com/analytics/.](https://support.google.com/analytics/)) Google prefers sites with a low bounce rate in general<sup>20</sup>.

GA also seemed a practical tool to combat website hacking and suspicious traffic. It appeared to provide detailed information about the addresses of the pages that were logged, along with the browser types of users. By comparing the different sources of web traffic, GA seemed to be able to distinguish between malicious traffic and potential data sniffing attempts. (Qin, Riehle, & Zhao, 2017.) Even though automated testing can help to find vulnerabilities in WordPress, it cannot fully replace manual work to detect potential threats (Trunde & Weippl, 2015).

The creators of e-commerce websites can use GA tools to get the most out of their visitors and the visitors' behaviour. The users and customers can be satisfied with the relevant products and services presented on the sites. It is recommended to pay particular attention to the unique visitors and page loads. Another essential metric is the number of new visitors, which also has an impact on unique visits to the site. A visitor's web browser also plays a role in driving the behaviour on the site. (Awichanirost & Phumchusri, 2020.) The concluding remarks on e-commerce evaluation using GA and other automated tools are shown in Figure 17.

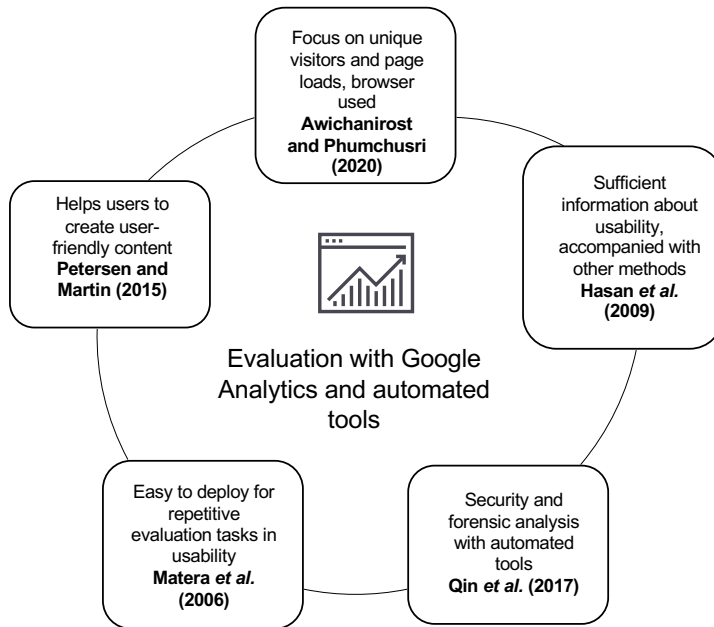
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<sup>17</sup> Backlinko. Retrieved 4 October, 2020 from <https://backlinko.com/page-speed-stats>

<sup>18</sup> Wolfgang Digital. Retrieved 26 November, 2020 from <https://www.wolfgangdigital.com/kpi-2020/>

<sup>19</sup> Google. Retrieved 26 October, 2020 from <https://support.google.com/analytics/answer/2383341?hl=en>

<sup>20</sup> Google. Retrieved 14 October, 2020 from <https://support.google.com/analytics/answer/1009409?hl=en>



**Fig. 17. Remarks on web application performance evaluation.**

As Figure 17 presents, GA evaluation is related closely to users, content, page loading performance and information. The background for heuristics-driven usability analysis as the second evaluation method in the study is presented in Chapter 2.7.

### **3.3.3 Interviews and case studies**

Conducting customer interviews can be an effective method for innovation and product development (Ulwick, 2002). Interviews are also effective methods to collect information in empirical software engineering research, which is often qualitative by its nature. Interviews can provide new insights compared to quantitative results. (Hove & Anda, 2005.) Eisenhardt (1989) pointed out that using various information sources can be effective in case study research; also essential is the data collection process itself. Interviews can gather information using various approaches. Fontana and Frey (2000) indicated that there are different paths of choosing the interview approaches based on various situations. An unstructured type of interview is open, and it gives freedom to the interviewer. The interviewer

might have done some preparation in advance, but it is possible to use more creativity and freedom. (Fontana & Frey, 2000.)

Semi-structured interviews can be utilised often in software research as they give freedom to the interviewer and allow some structure and questions to be planned before the interview. The questions can be shown to the interviewees beforehand. Nevertheless, the interviewer can keep asking follow-up questions and sustain open discussion during the interview. (Hove & Anda, 2005.)

The interview approach in IS research can be aligned in three various ways, offering slightly different angles from which to approach the interviews. For example, in an appreciative interview, a sense of equality and trust between the interviewer and interviewee is desirable. The different interview methods are described more precisely in Table 3. (Schultze & Avital, 2011.)

**Table 3. Interview approaches on IS research (see Schultze & Avital, 2011).**

Interview approach	Appreciative interview	Laddering interview	Photo-diary interview
Study objective	Core capabilities, design and success factors, requirements	Personal construct systems, structure and hierarchical relationships	Meaningful incidents and explanation of events, emotions and behaviours in that context
Interview questions	Positively deviant, action-oriented	Looking for structure and patterns	Re-constructive, critical
Data generation logic	Reframing lived experience with a positive lens to see opportunities in the future	Compare contrast through triads and means-ends analysis	Reflecting through annotated snapshot, capturing informant's situated emotions in particular moment
Interviewer role	Helps the interviewee with positive reframing	To offer examples and inquiry	Facilitate the interpretation of diary entries containing photos

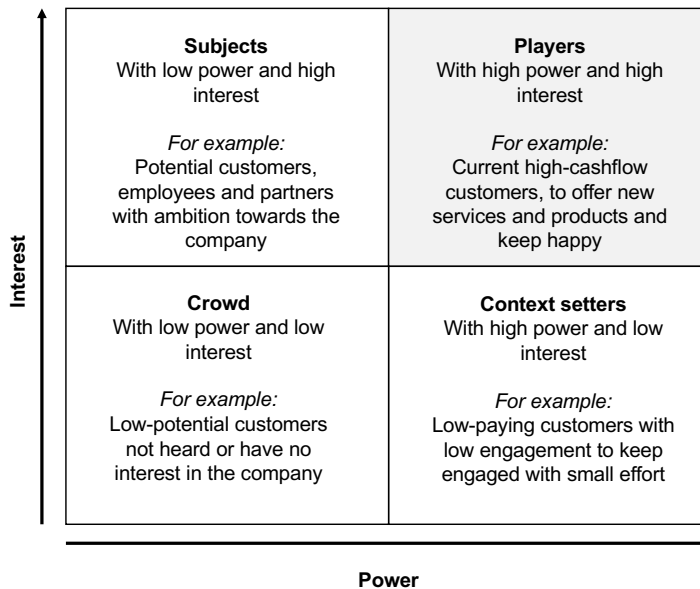
As seen in Table 3, the different interviewing methods, the appreciative, laddering and photo-diary approach, are presented. Schultze and Avital (2011) indicated that these interview methods provide a different approach to produce data. According to Ulwick (2002), the customer interviewees should talk about how they would use the new features in the system and what desirable outcomes would arise when using it, instead of just expressing what new features they would like to see in the system.



Eisenhardt (1989) indicated that observing the different data points and re-considering the important factors can vary in case studies.

In the appreciative interview method, the purpose of the interview should focus on the core strengths, design requirements, success factors and motivations. The interviewer questions should be positively and functionally oriented. The role of the interviewer would be to help and build a holistic view about the subject together with the interviewee. Although the appreciative interview method focuses on creating a positive and solution-focused space between the interviewer and the interviewee, it may drift towards strict analysis or the problems to be solved. (Schultze & Avital, 2011.) In software engineering research, a relaxed and open atmosphere can help with interviews. The interviewer should be respectful and avoid making the interviewee feel uncomfortable. (Hove & Anda, 2005.)

By following the stakeholder responses in organisational strategies, the necessary action can be taken. This may allow companies to add value or eliminate negative responses. The stakeholders in an organisation may be less likely to be managed strategically as a single entity, but smaller parts are more easily managed. A grid can be formed (Figure 18) that can be used to classify the stakeholders so that the essential and relevant stakeholders can be identified. This may allow focusing on the essential focus points in the organisation's operations. (Ackermann & Eden, 2011.)



**Fig. 18. Power-interest table (see Ackermann & Eden, 2011).**

Moreover, customer interviews should represent a wide range of different users and not merely focus on ‘lead-users’ that are already very familiar with the product (Ulwick, 2002).

Case studies may combine multiple sources of data collection methods, where interviews can be engaged together with archives, questionnaires and other observations (Eisenhard, 1989). Case studies can be utilised in software engineering research where data can be collected multiple ways, for example, interviewing, observing and accessing archival data from older projects. Still, the data collection methods should support the objectives of the study. (Runeson & Höst, 2009.) In case study research, data collection procedures, analysis and information about samples should be provided. The research questions and planned constructions should be pointed out in the early stages of the research. (Eisenhardt, 1989.)

The interview setting of the present study is described in Chapter 5.4.1. That Chapter explains how the interviewees were selected, their characteristics and features, along with the interview results.

### 3.4 Research environment

The research environment in the current study was in the Finnish software company Valfi. Founded in 2016, the company offered e-commerce and ERP platform implementation services to its corporate customers, the majority of which were micro-sized, between 2016–2020. The implementation services often utilised the open-source platform WordPress. Some of Valfi's corporate customers were able to grow their business during or after the collaboration. Nevertheless, some implementation projects did not produce the desired results, and the causes of these problems were not clearly identified.

By offering its organisational environment to the present study, Valfi and its customers gained new knowledge by discovering unified build goals and processes to be utilised for future implementation projects. In the current study, it was essential to find not only solutions for Valfi's customers but also Valfi's business that had issues with growth. In Valfi, for example, new customer acquisition or invoicing was not handled efficiently enough with the existing tools. A suitable ERP platform was also missing even though WordPress and WooCommerce were in use in Valfi's business model. However, the analysis and evaluation unit varied from Valfi's customer viewpoint to Valfi's perspectives. As Valfi was itself also at the micro-entrepreneur level, it seemed appropriate, having growth ambitions similar to its customers. Valfi was also utilising the WordPress platform to digitalise its business. Still, most of the present study focused on Valfi's customers, as construction and most evaluations were conducted primarily at the customer level.

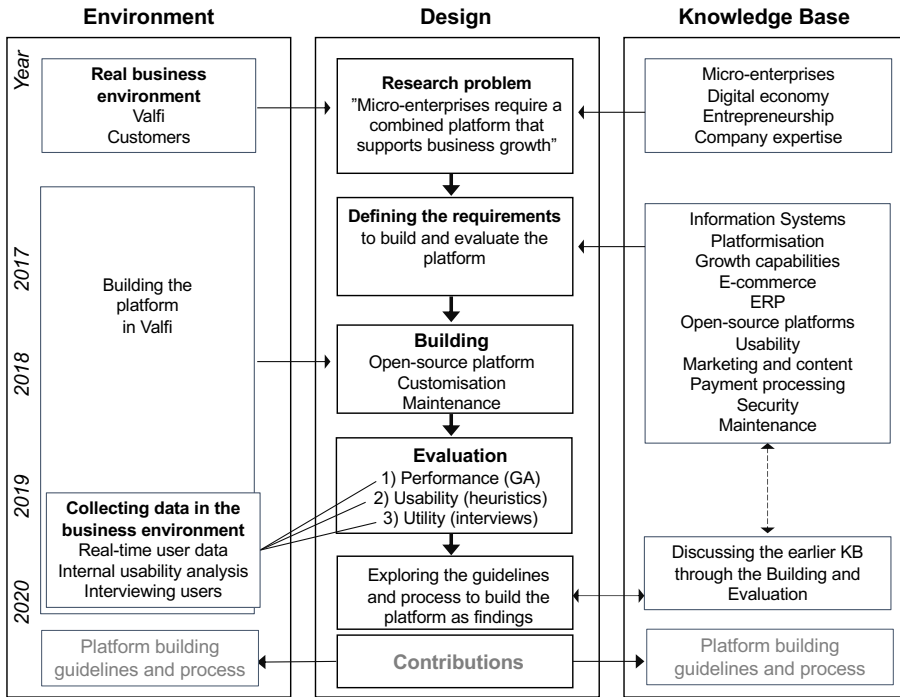
The researcher of the current study was an entrepreneur at Valfi, working mainly as a system integrator in the company. As the company Valfi was a micro-level enterprise, the external experts were mainly outsourced and used according to projects with remote connections. Valfi had not considered or defined its own strategies and process in IT, product development and management. The challenges that small businesses face (see Chapters 2.1–2.3) also was present and recognisable in Valfi's own business.

By acknowledging these starting points, Valfi and its customers leveraged their business environment for the study according to DSR principles. This research environment was relevant to build (Chapter 4) and evaluate (Chapter 5) the platform and finally present the findings (Chapter 6) to be used by future researchers and practitioners.

### **3.5 DSR in the current study**

The starting points for the study appeared to be appropriate for the DSR framework as it connects business environment and technological innovation (see Hevner *et al.*, 2004), the technological artefact (see Chapter 3.3.1) and efficiency in conducting design-driven research that could be evaluated in multiple ways (see Chapter 3.3.2). IT artefacts aim to improve business performance in organisations (March & Storey, 2008). Connection to business growth could be established as performance is also one of the measures of a firm's growth (see Chapter 2.3).

The present study's requirements originated from the earlier knowledge and organisational environment, which both called for improving the performance with a new digital innovation leading to business growth. The purpose of that digital innovation and similarly this study was to discover the guidelines and process of constructing the combined e-commerce and ERP platform for micro-enterprises to help with business growth. The seven DSR guidelines (see Table 2) were also followed in the present study as 'design principles' gathering a suitable knowledge base (Chapter 2) followed by design process and evaluation. The DSR approach used in the current study is illustrated in Figure 19.



**Fig. 19. DSR research approach of the present study.**

Figure 19 shows how the DSR research approach and cycles (see Chapter 3.2) were implemented for the current study. It also indicates how the study developed over the years and various phases took place. Chapter 1 indicated that micro-enterprises require a suitable platform to support their business growth. The literature review in Chapter 2 explored the prior knowledge, theories and best practices related to IS, business growth, platformisation, E-commerce, ERP and more.

In the building component (Chapter 4), the building guidelines for the suitable platform were explored by presenting the platform construction employing Valfi’s organisational environment and its case customers. The evaluation of the platform (Chapter 5) was carried out using the various evaluation methods, also employing Valfi and its customers. A rigorous approach for the current study came from the efficient use of the previous research and knowledge presented in Chapter 2. The research contributions were reported back to the environment and knowledge base as the utilisable building guidelines and process (Chapters 6 & 7).

Table 4 presents the overview of the main research subjects and methods in the current study in DSR approach.

**Table 4. Main research subjects and methods in DSR approach.**

Research subject	Main methods employed	Purpose in the study
Platform requirements and building process <i>Chapter 4</i>	Making requirements and building the platform (building the artefact)	Identify guidelines and process to build the platform
Platform performance <i>Chapter 5.2</i>	Google Analytics analysis (characterising the platform's end-users)	Compare the platform performance to industry averages and definitions
Platform usability <i>Chapter 5.3</i>	Usability analysis (heuristics)	Acquire usability insights conducted by the usability specialists
Platform utility <i>Chapter 5.4</i>	User interviews (companies using the platform)	Gather insights from companies using and developing the platform

As presented in Table 4, the current study conducted the research first by forming the requirements and building the platform accordingly (Chapter 4). After that the platform performance, usability and utility were evaluated (Chapter 5). The research environment and artefact validity that supported the building and evaluation Chapters were explored in this Chapter.

The present study employed the exaptation approach (see Figure 14) to produce new knowledge through the DSR method. According to Gregor and Hevner (2013), exaptation aims to connect known inventions with new problems to produce new innovations. As explained in Chapter 3.3.1, the WordPress artefact utilised in this study was not a new invention. For years, it had been used as a popular open-source web publishing platform powering millions of websites on the Internet. However, the present study introduced and customised this platform for an emerging issue related to micro-enterprises that required a suitable platform to connect e-commerce and ERP to grow their business in a single application. This was the new issue that followed the exaptation approach in the DSR method.

The objective-centred approach was also followed in the current study (see Figure 13). The system development activities play an essential role in the objective-centred approach as development activities produce new results. This approach aims to create better results over other alternatives. (Peffer *et al.*, 2006.)

In the present study, the objective-centred approach could be seen similarly to the exaptation approach. The well-known WordPress platform (see Chapter 3.3.1) was utilised for a new purpose to help micro-enterprises grow their business by connecting e-commerce and ERP features into the same platform. An alternative approach could have been, for example, to have these in separate WordPress installations and integrate them with REST API gateways or third-party service providers. The decision to use a single installation came from the EAI approach (see Chapter 2.6), need for low costs due to limited resources (see Chapter 2.1–2.2) and platform background (see Chapter 3.3).





## 4 Building the platform

This Chapter describes the building, implementation and maintenance of the combined e-commerce and ERP platform. The parts presented in this Chapter were brought together by reverse-engineering the various parts Valfi had constructed for itself and for its customers by utilising the WordPress platform between the years 2016–2020, as also presented in Figure 19.

First, a selection and a set-up of the combined e-commerce and ERP open-source infrastructure is presented. Then, a construction of the platform ERP functionalities, such as extended content types, invoicing and CRM, are described. In the end, the requirements to continuously develop and maintain the platform are indicated. The technical processes indicated in this Chapter are simplified from the original building processes in view of the study's focus and readability.

### 4.1 Requirements and infrastructure

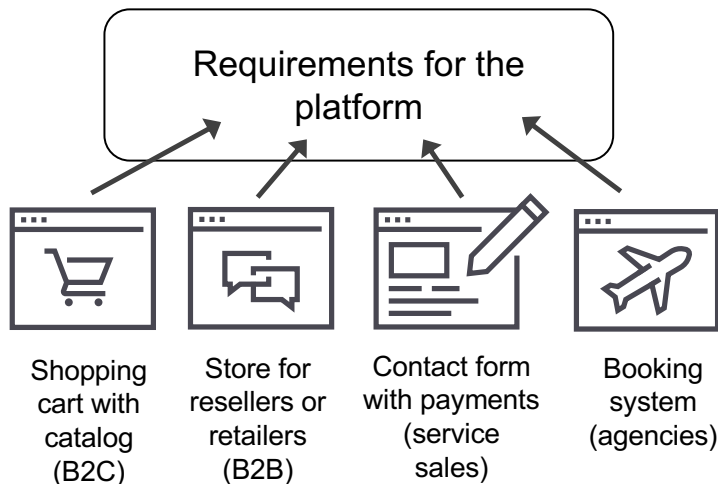
The requirements for the platform arose from the research environment (see Chapter 3.4), which was supported by the knowledge base. These requirements were framed according to DSR principles (see Chapter 3.1) that also could be seen as 'design principles' for the construction and evaluation process in the present study. The problem was meaningfully defined to create a specific solution to the problem domain.

Considering the research environment and problem domain, the platform had to be open source, which is free to use by its nature. A cost-efficient solution addressing micro-enterprises (see Chapter 2.1) was one of the most critical factors framing the requirements. However, cost-efficiency, among other concepts, could be seen as a theoretical requirement that had to be combined with a real-world, DSR-specific business problem. This business problem was the digitalisation and growth challenges that Valfi and its customers faced, similar to the other businesses (see Chapter 2.1). Table 5 presents the essential requirements for the platform.

**Table 5. Requirements for the platform.**

Requirement	Description
Platform core infrastructure	Scalable open-source infrastructure, well-performing website, user accounts, content management, MySQL database structure, API connections, usable visual user interface, active support, well-documented manual, active updates, security
E-commerce features	Managing and listing products and orders online, shopping cart, controlling payment gateways, shop backend and frontend, product images and experimental videos, multiple payment gateways
ERP features	New content types, automated invoicing, document creation, CRM (see Table 6)

Open-source software was used in multiple parts of the platform. First, the platform was built using the open-source platform WordPress where the WooCommerce e-commerce plugin was installed and customised to achieve the combined e-commerce and ERP features for the platform. Before starting to develop the platform, it was essential to understand the requirements that micro-micro-enterprises and users would expect from the system, especially as their business models differed. Figure 20 indicates various use cases where the platform could have been utilised. These use cases also could mean potential industries benefiting by using the platform exclusively. Despite these categories, the solution could be used through various B2B or B2C industries by following the process and customising the features of the platform to specific business needs.



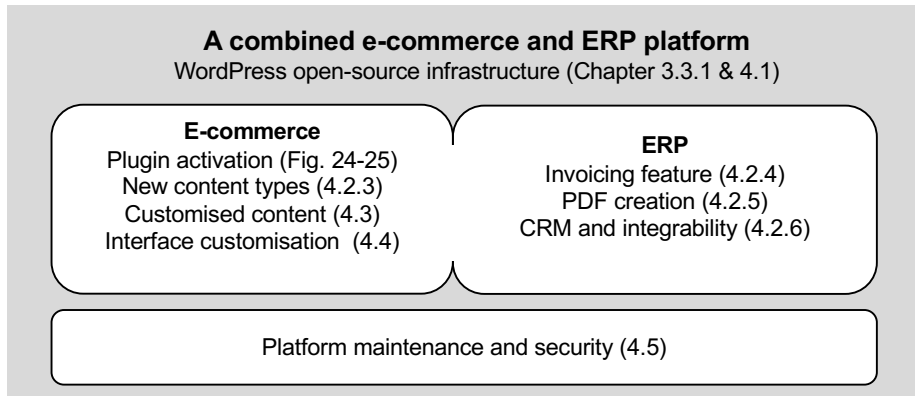
**Fig. 20. Requirements for the platform from an e-commerce viewpoint.**

The needs regarding the platform requirements partly depended on the business models of micro-enterprises: for example, it would have been challenging for the platform to handle all the diverse functions of various e-commerce business models. As indicated in Figure 20, the constructed platform focused mainly on micro-enterprises that offered products for consumers (B2C) and other businesses (B2B). Moreover, the platform was targeted to service sales, such as agencies.

As the platform was operating fully on the web, it had to be fast, usable and secure. Performance evaluation was conducted and compared to fresh industry average loading speeds to measure performance. Usability referred especially to mobile usability, as organisational environment and real-time user statistics from organisations' analytics called for a good user experience, particularly on mobile. As the platform was working openly over the Internet, it had to be capable of mitigating possible web attacks and malicious visitors.

The WordPress-based open-source platform enabled different ways of doing e-commerce based on a firm's business model. It was possible to achieve, for example, a shopping cart model, in which products were collected from the site and dropped into a cart, or an order form page, a booking system, or automated contact forms. Moreover, it was possible to integrate the platform with simpler websites, for example, by enabling placing the orders through contact forms. The micro-enterprise Valfi (see Chapter 3.4), providing the research environment, especially fell into the B2B scope as it had to sell its software development services through the platform. However, the customers of Valfi represented other requirement scopes, from retail B2C sales to agencies, as described in more detail in Chapter 5.4.

The constructions indicated in this Chapter were collected from the several implementations that Valfi developed for its own business and its customers as a system integrator. The deployments indicated in this Chapter were chosen to be practical for various businesses, leaving space for creativity to use each feature across multiple business models. This Chapter continues in a temporal order that frames a building process, starting from the platform infrastructure selection and moving towards more advanced features for growing businesses. Figure 21 shows the more detailed requirements for the e-commerce and ERP features and maintenance in the platform and how they are presented in this Chapter. Figure 21 also indicates the scope of the combined platform that integrates both e-commerce and ERP features into the same WordPress infrastructure.



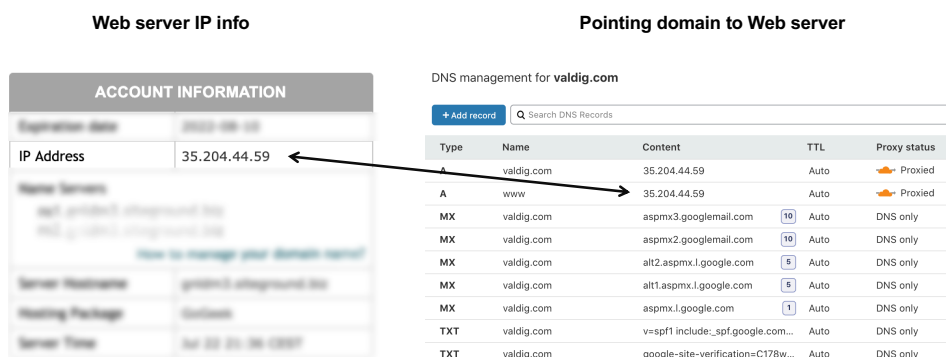
**Fig. 21. Structure for the e-commerce and ERP features in the platform.**

Before starting to develop the platform, Valfi had begun a new strategy for business growth, where the combined e-commerce and ERP platform was the primary driver. The essential source to learn about suitable strategies was to utilise existing research and examine it through its organisational environment and constructions it had made previously. It was also clear which processes had to become more efficient and automatised in the platform. Those processes replaced the manual work tasks, such as sending invoices manually and keeping a separate customer registry from e-commerce. Valfi's customers that were participating in the study had similar prerequisites considered before starting the technical deployments.

Although the WordPress open-source installation package was free, it required a reliable web server, in the cloud, to maintain the site publicly on the Internet, requiring at least a PHP and MySQL database engine support from the web server. Both of these could have been installed locally on a Windows, Linux or Mac environment, in addition to obtaining a static IP address to maintain the site. In practice, however, this would have been an uncertain way to manage site maintenance, as the server software and site installed on the machine was required to be online all the time. The solution to that problem was found in a separate cloud service that rented out 24/7 hosted and pre-optimised web servers to maintain the platform for a monthly fee or resource-based pricing. From several different options, an administrator had to choose the most suitable package for its use within the cloud service providers.

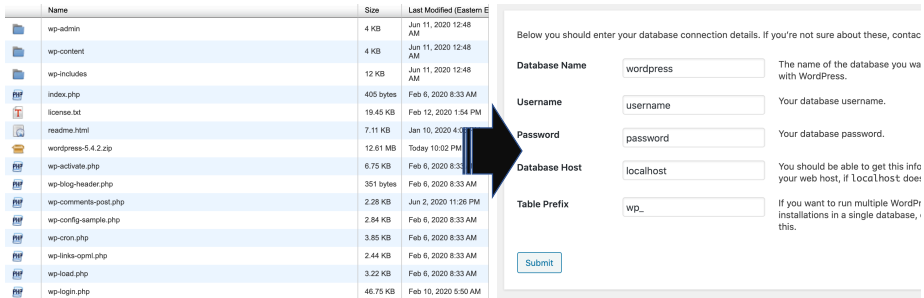
Along with the web server, it was necessary to reserve a domain name or IP address for the site. Some web hosting services offered the ability to register a domain in the same location. That step was recommended especially for the end-

user, because there was no need to configure or manage the domain name server settings in a separate location. To show the domain pointing to WordPress, the domain was initially registered through Cloudflare while security was also provided through their firewall and HTTPS security service. When the domain was set up in Cloudflare, it was pointed to the cloud-based web server with IP-addresses as shown in Figure 22.



**Fig. 22. Pointing the domain to a web server securely.**

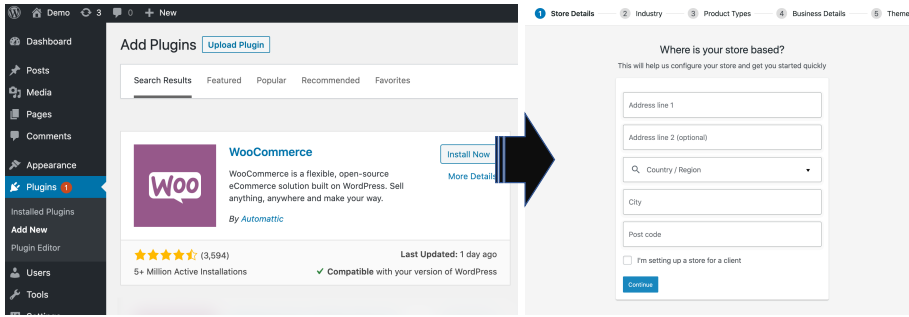
The requirements for the web maintenance package originated from the requirements and various business demands of the companies. First, a web server space was acquired from the cloud service provider. With a service provider’s web server space, the platform was given credentials for the server’s file management area and database. On the official WordPress website, documentation and a developer portal provided comprehensive instructions for installing and deploying the platform. The latest WordPress platform installation package, downloaded from WordPress.org, was uploaded to the web server space and unpacked there. A new MySQL database was created in the web server. When the WordPress installation package containing .PHP, .HTML, .CSS, .JS and other files to run the system was placed into the web server’s public folder, it was possible to access the platform through a web browser, as shown in Figure 23.



**Fig. 23. Uploading the installation files and accessing the installation wizard.**

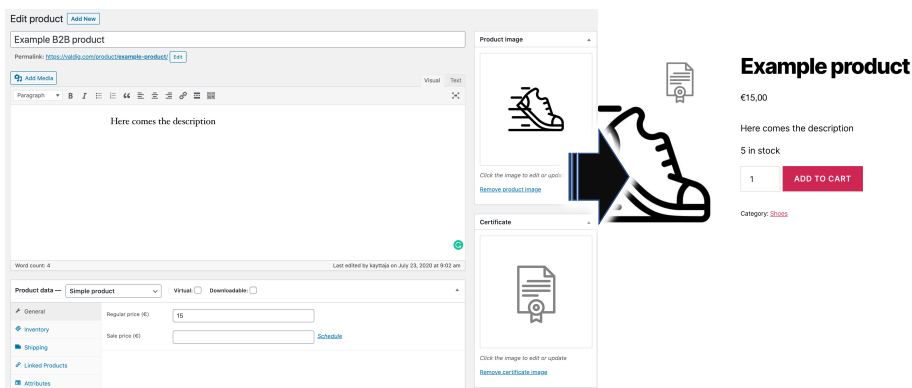
Once the WordPress platform was installed, it was time to install the WooCommerce e-commerce plugin. WordPress provided a transparent plugin management interface for the platform’s administrator. In a plugin management interface, the administrator can install open-source and commercial plugins without having to download plugin packages to the machine and upload them to the web server separately. In the plugin management interface, updating the plugins also seemed easy to use and logical. Several plugin developers appeared to offer free, trial or paid versions of their plugins. However, the basic version of the e-commerce plugin WooCommerce was completely free and open-source based. The WooCommerce plugin was easy to install into the WordPress platform. This was accomplished entirely through a graphical user interface in the WordPress administrator interface, with a search function looking for the plugin.

WooCommerce was successfully installed through an installation wizard (Figure 24), which performed the essential e-commerce functions and settings in the platform. In the installation wizard, for example, the currency of the store, a default location, payment methods and possible delivery settings were defined. In total, the installation of the WooCommerce add-on on the WordPress platform took about 10 minutes. Once the plugin was installed in the platform, a listing of products for sale in the platform could begin. The products were listed in the platform through a simple graphical user interface, in which the products were given a title, a description, categories, a product image and, finally, stock and price information. The listing of products in WooCommerce was a process similar to that of other media types, such as pages and blog posts in WordPress.



**Fig. 24. Activating the WooCommerce plugin in the WordPress platform.**

The products were created in a WooCommerce interface on the WordPress platform. Listing a product was a similar process to creating a page or blog article in WordPress, including the layout and logic of the familiar WordPress interface. Immediately after a release of the product, the product appeared on the public side of the platform. It was also possible to modify the product afterwards from the same interface where the product was initially created. The creation and editing of the products were also effortless via a mobile device, as the layout of the administrator interface was scaled according to the screen resolution using responsive design technology. The process of creating and showing the product in WooCommerce is shown in Figure 25.



**Fig. 25. Creation of the product in WordPress plugin WooCommerce.**

All the necessary steps—from linking the domain and server space to installing WordPress, activating WooCommerce and listing the first products—took place

mostly through the graphical user interface without the need to familiarise the administrator with the platform's source code or other excessive coding requirements.

WooCommerce's setup options initially defined bank transfer and PayPal as the default payment methods. More support and instructions for other payment gateways was found in the WooCommerce support documentation. To enable PayPal payments on the platform, the administrator needed a pre-created PayPal account to receive payments. However, the WordPress plugin library and WooCommerce online documentation presented several plugins and tutorials, from third party payment processing to product content and sales reporting tools to enhance the platform.

## **4.2 Creating combined e-commerce and ERP features with custom WordPress plugin**

This Chapter presents how the ERP features were built for the platform using a WordPress plugin structure and its out-of-the-box functions. First, a technical infrastructure to construct the ERP features in the platform is indicated. Then, creation of new content is shown, followed by other extended features.

In this Chapter, a 'seller' is indicated as a micro-enterprise using the platform. In contrast, a 'customer' is indicated as an 'end-customer' of the seller, buying goods from micro-enterprises' e-commerce or utilising the seller's platform in other ways. The term 'platform' is indicated as the combined e-commerce and ERP platform that integrates both e-commerce and ERP features into the same platform.

### ***4.2.1 Defining the features to build***

During the construction phase, it was decided to build the following features into the combined e-commerce and ERP platform, extending the core WordPress and WooCommerce functionalities (Table 6).



**Table 6. Constructed custom features of the combined e-commerce and ERP platform.**

Feature	Function
Effortless content production (Chapter 4.2.3)	Show and manage new types of content as addition to e-commerce content, such as bulletins (e-commerce)
Automated invoicing and payment tracking (Chapter 4.2.4)	Generating and tracking paid invoices by the customer, generating and reading reference numbers to mark orders as paid (ERP)
PDF invoice and document creation (Chapter 4.2.5)	Ability to send invoices instead of direct payment, generate PDF files and send them automatically via STMP mail (ERP)
CRM (Chapter 4.2.6)	Extended information and segmentation of customers, additional information on customers (both e-commerce and ERP)
User management (Chapter 4.2.6)	Users are able to see the states of their orders and related invoice payments (ERP)
Video features (Chapter 4.3)	Adding video, such as 360° VR product tours and additional media to product pages (e-commerce)
Service customisation (Chapter 4.4)	Reducing information load for the administrator to make usability better (e-commerce)

As Table 6 shows, the quantity of the combined e-commerce and ERP features on the platform was limited to certain features. Some of these features were more related to the e-commerce side and others to the ERP side. The scope of the construction was mainly to show the process of constructing the customisations in the WordPress infrastructure, utilising the built-in functions and plugins of the platform. These features appeared to be suitable for the presented organisational environment in micro-enterprises.

#### **4.2.2 WordPress plugin structure**

The extended ERP features on the platform were developed by utilising the WordPress plugin functionality and customised further using the default PHP functions provided by the platform. The WordPress plugin functionality allowed the installation or development of ready-made plugins within the WordPress

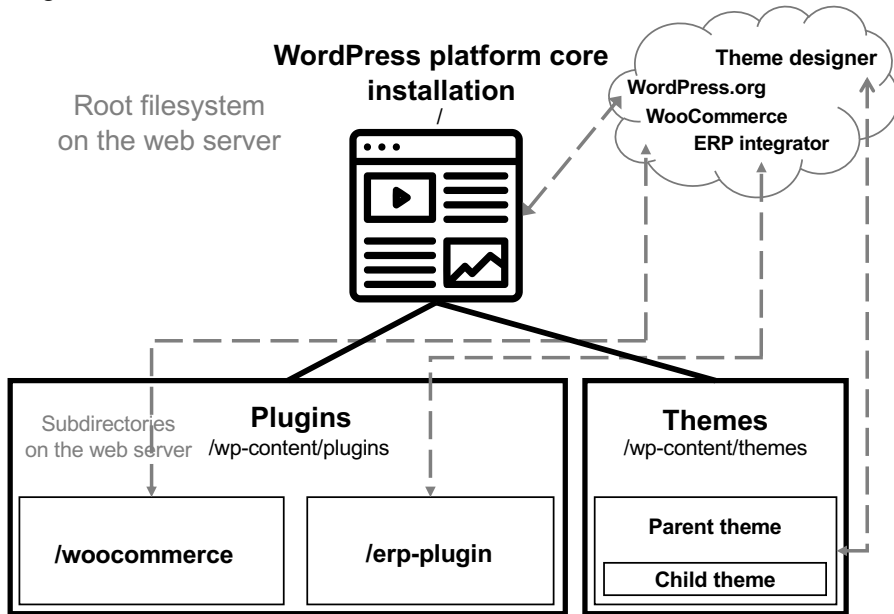
infrastructure, as presented in Chapter 4.1. Moreover, Figure 24 showed the installation of the WooCommerce e-commerce plugin. The ERP feature development started on the platform by creating a new plugin for WordPress.

An invoicing system for payment tracking, a versatile customer register and additional content features were developed with UI customisations on the platform. A goal of the invoicing system was to monitor the payments of corporate customers who paid by the invoice using a payment reference number. For example, when a B2B customer purchased products from the seller's online store, an invoice could be chosen as the payment method. When the B2B customers paid for their purchases using the invoicing method with the reference number given to them, the account statement was to be picked up electronically from the seller's bank and imported into the platform. The platform then automatically marked the invoices as paid based on the reference number payments. If the payments did not appear, the payment reminders were sent automatically to the customers via email.

The WooCommerce e-commerce feature in WordPress was also based on a WordPress plugin (see Chapter 4.1). The plugins in the WordPress system were programmed in a `/wp-content/plugins` folder that was separated from the WordPress core infrastructure source files. This allowed the WordPress platform to be updated and monitored securely as a separate entity from the custom plugins. Similarly, plugin and theme developers were able to implement the update services for the functionality they implemented separately from WordPress installation. For example, if a security vulnerability was found in the WooCommerce plugin, a community specialising in WooCommerce improvements would update it and upload the update quickly to the automated update server (Figure 26). In this process, the administrator would not need to touch files in the WordPress platform or other plugins. Also, the integrity of WordPress backend installation could be monitored for viruses and other problems with specific monitoring tools. The plugins developed for WordPress were mainly made using the PHP programming language but might also contain other technologies such as CSS and JS files, images, icons and other web assets. Although WordPress plugins often included multiple files, the added functionality they produced in the platform could be achieved with a single or just a few files containing some PHP code using its ready-made PHP functions.

First, a plugin handbook from the official WordPress documentation was studied. The documentation comprehensively described the built-in functions required for the development of the plugin using the PHP programming language in WordPress. In the current study, the customised ERP functionalities were

achieved by creating a new plugin in the WordPress platform’s /wp-content/plugins folder. The development of the new plugin began by creating a new folder, /erp-plugin, inside the /wp-content/plugins folder. In that folder, a new PHP file plugin.php was created to include the basic functionality and information of the plugin. The flowchart of the WordPress custom plugin and theme structure is shown in Figure 26.



**Fig. 26. File structure for plugins and themes with automated updates.**

When the plugins and themes were detached from the source files in the WordPress backend (Figure 26), it was also possible to implement the updates separately in different parts of the platform. It was possible to implement a function that would automatically check a theme designer’s or plugin developer’s automated update service for updates when a new version was released. In the automatic update function, the updated files of the plugin were uploaded to the web server, replacing the old files as well as adding the new files.

The same technique was also used to update the WordPress themes, providing a graphical frontend interface for the users and customers. Building custom themes worked in a similar way to building plugins, but themes required separate files in multiple folders, including separate definitions for pages, blog posts, headers and footers. The styles also had to be defined in the theme using CSS files.

The WordPress theme engine, presenting the user interfaces, also supported hierarchical themes on a parent-child basis. The top-level parent theme could be, for example, a pre-built theme package optimised for e-commerce for WooCommerce. If the user wanted to customise the theme more to their own needs, a different theme could be made on a child basis, creating a theme folder that contained only the changed information about the parent theme. In this way, it would not have been necessary to start making a whole new theme from scratch, but for example, using a suitable open-source theme to achieve the desired user interface.

Figure 27 shows the file structure for the various functionalities in the ERP plugin. For clarity, the plugin’s PHP classes were placed into their classes folder and linked together with the PHP’s *include* statement. The CSS style files were placed into their own folder, and JavaScript functionality was also in its folder.

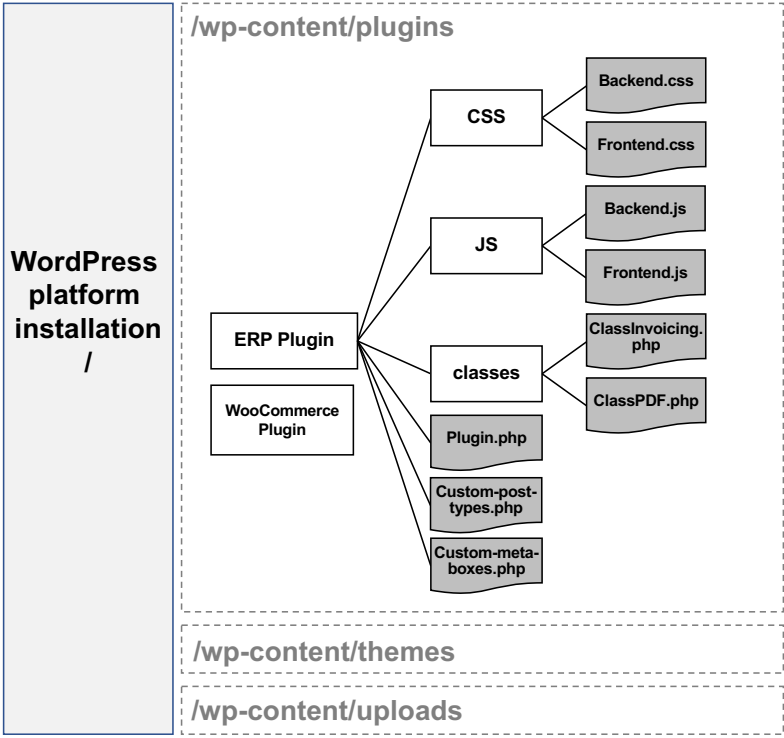


Fig. 27. Structure of the ERP plugin on the platform.

As seen in Figure 27, the implementation of the ERP functionality in WordPress was achieved with an organised file structure, utilising the WordPress filesystem to provide a base infrastructure to build the additional functionalities separated from the platform's core infrastructure. WordPress' ready-made update system (see Figure 26) also provided support for plug-in upgrades and security continuity with the WordPress platform updates and other updates.

The development of the plugin was able to focus on creating completely new ERP functionalities while WordPress provided a good ready-made base infrastructure for the essential web application features. The general built-in functions in the WordPress plugin system, such as *register\_post\_type* and *add\_meta\_box*, significantly reduced the time required for development and made it technically easier, as there was no need to create such functions with PHP from scratch. Further, WordPress managed all the data insertions safely into the MySQL database with reliable authentications.

Programming the advanced ERP features to the WordPress platform was easily accomplished by leveraging the WordPress platform's built-in functions with comprehensive help and examples found in the online documentation and other open-source support forums on the web. Although the creation of the plugin required some programming, due to the versatile examples and the help of the available help sites, it was possible to achieve the ERP features with relatively basic web competencies and skills.

### **4.2.3 Creating new content types**

After establishing the base structure for the ERP features with the custom plugin (Chapter 4.2.2), the plugin development continued with an additional feature to create new content types for WordPress. An example of a new content type was 'Bulletins' that made producing new content for the platform effortless. The purpose of this content type was to enable the sending of customer bulletins, similar to email newsletters and releases, via mass email. Through the new content type, the seller's key stakeholders, profitable customers, would remain in touch with the company's communications and new products without a separate newsletter system, such as MailChimp. This feature was achieved as follows.

In order to develop the new functionality, a custom post type functionality provided by WordPress was utilised, enabling the creation of a completely new content type in addition to pages, blog posts, products and users on the platform. A

PHP code delivering that functionality was included in the file Custom-post-types.php shown in Figure 28.

The Bulletins content type used the same customer register database as WooCommerce customers and other WordPress related content. The feature to add the new custom post type required only a few lines of code in the Custom-post-types.php file, leading to the user-friendly graphical creation of such content.

The bulletins feature was possible to develop with light editing, utilising the built-in PHP function *register\_post\_type* in WordPress. The custom post type creation is illustrated in Figure 28. The file Plugin.php included the base information of the new plugin so that WordPress could interpret the new file in the folder as a plugin. For example, the name of the plugin, description and version were marked at the beginning of the file between lines 2–6, as seen in Figure 28.

```
1 <?php
2 /**
3  * Plugin Name: ERP Plugin
4  * Description: Basic ERP functionality to WordPress-Woocommerce
5  * Version: 1.0
6  **/
7
8 //Defining a new function
9 function create_posttype() {
10
11     register_post_type( 'bulletins',
12 //Setting the options
13     array(
14         'labels' => array(
15             'name' => __( 'Bulletins' ),
16             'singular_name' => __( 'Bulletin' )
17         ),
18         'public' => true,
19         'has_archive' => true,
20         'rewrite' => array('slug' => 'bulletins'),
21         'show_in_rest' => true,
22     )
23 );
24 }
25
26 //Connecting the function to WordPress action
27 add_action( 'init', 'create_posttype' );
```

**Fig. 28. Creation of custom post type Bulletins.**

Similarly, it was possible to create other functionalities in WordPress. As the custom post type was a simple and effective way to create the new content types

on the platform, another versatile way was to extend them or existing ones with added features.

Another example of the extended content features in the platform's e-commerce functions was a separate place for viewing a certificate or badge to present additional product information. These certificates or badges could indicate, for example, the received certificates, such as quality control logos, original manufacturer brands or insurance policies as an addition to the product images. This feature was achieved by using a ready-made PHP function *add\_meta\_box*. The *add\_meta\_box* function was also used to create a new input field for embedding video in the e-commerce products, enabling the administrator to utilise mp4 videos and third-party video services to show product videos, video presentations and other video material in the platform's product pages in various formats. This is explained in more detail in Chapter 4.3.

#### ***4.2.4 Invoicing and receivables monitoring system***

The platform, based on the open-source WordPress infrastructure with WooCommerce's e-commerce plugin, provided the basic e-commerce features to the seller (micro-enterprise). It connected the several different payment methods, such as PayPal and payment cards, to the platform. The WooCommerce plugin in WordPress supported multiple payment methods by default. One of the default payment methods was a bank transfer method that allowed the customers to place their orders using the bank transfer. However, the default bank transfer method in WooCommerce did not include a payment tracking or a bank connection, requiring the seller to manually track the arriving payments from the e-commerce sales. This was perceived as a very cumbersome and time-consuming process for sellers (micro-enterprises). The feature to automatically monitor arriving payments on the platform required custom development of the ERP plugin. This feature was important especially for B2B (business-to-business) customers of the micro-enterprise as it helped to improve the sales process, supporting continuous cash flow.

On the platform, it also was found practical for purchases to be paid for in advance. If the purchases were not satisfactory, consumer customers could return

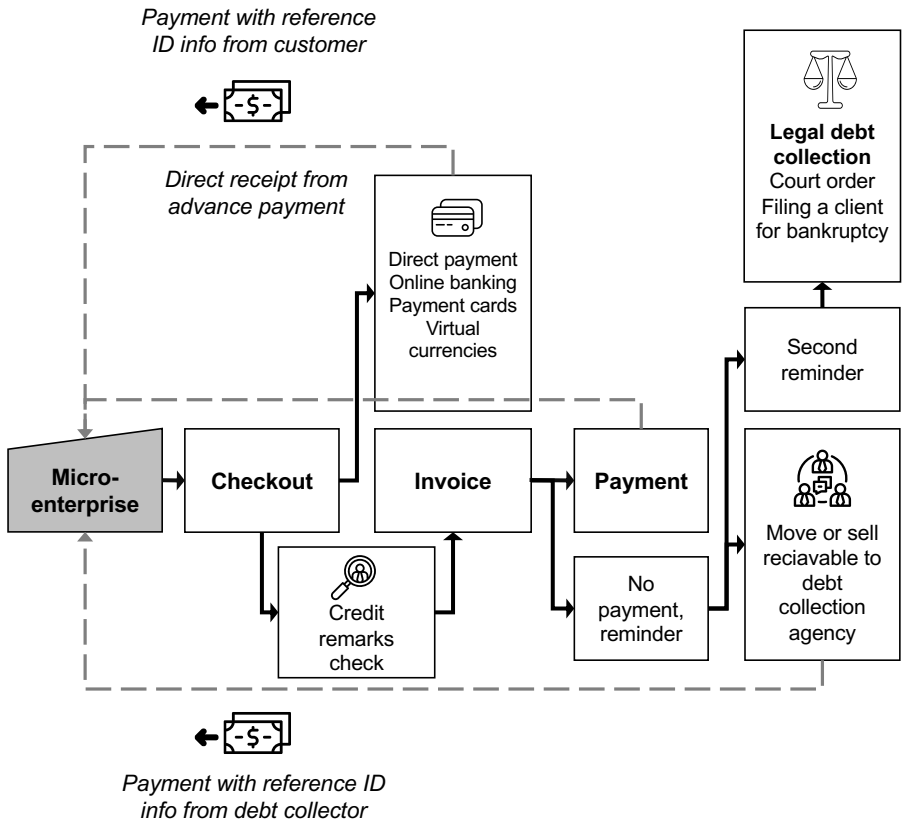
them, citing consumer protection laws<sup>21</sup>. Further, when paying by credit card without receiving the goods, the customer would later have the opportunity to complain to the credit card company, such as Visa or MasterCard, about the non-arriving products and services, possibly avoiding the credit card charge. However, B2B sales were not subject to consumer protection laws in the same way. One-time purchases could be, in some cases, much larger and could involve complex entities for different products and services. Some sellers could want, for example, to pay for their order with an invoice in full or in smaller instalments. For some of the micro-enterprise trading partners, volume or wholesale discounts might be available for certain products.

In some cases, the buyers might want to edit the orders afterwards or place similar orders based on the order history. To satisfy this, an invoicing feature was developed for the ERP plugin, which allowed the micro-enterprise to create invoices in PDF format and track the reference payments using a bank connection. The flowchart of the feature is presented in Figure 29.

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<sup>21</sup> Finnish Competition and Consumer Authority. Retrieved 18 October, 2020 from <https://www.kkv.fi/en/current-issues/news/2015/tip-of-the-week-if-you-paid-with-a-credit-card-you-can-to-turn-to-your-credit-card-provider-for-financial-compensation/>





**Fig. 29. Flowchart of the invoicing feature on the platform.**

Figure 29 indicates the multiple ways of initiating payments for the customers on the platform. Several payment options were offered on the e-commerce checkout page on the platform. The customers of the platform could choose whether they wished to pay in advance for their order with advance payment or later with invoice and reference payments.

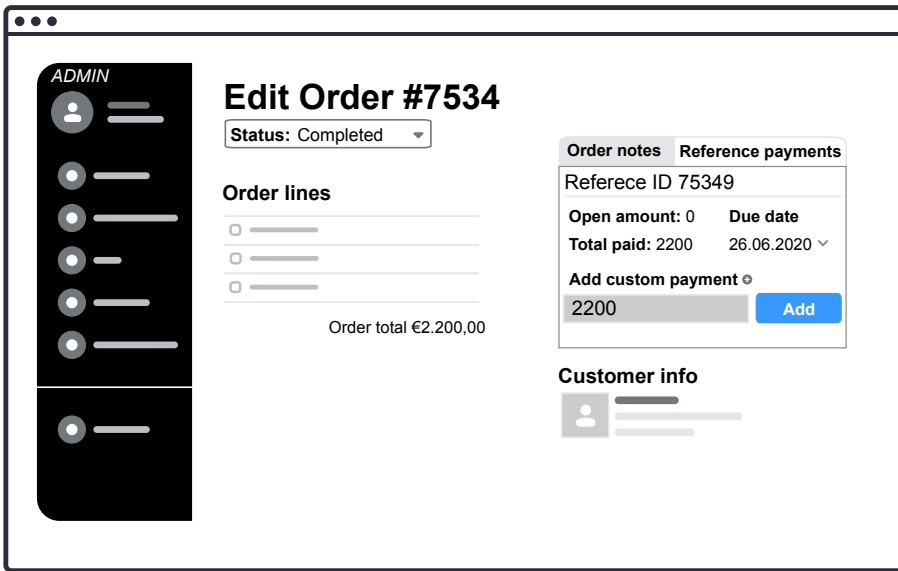
By using the invoicing feature (Figure 29), the customer had the option to pay for their orders with the invoice, having extended time to pay their orders. Once the orders were placed, the customer information and business/person ID went to a separate third-party service in which the customer credit information was checked automatically for possible payment issues and creditworthiness problems. If no problems were found with the customer’s credit validity, the order went ahead using the invoicing method. If there was a problem with the creditworthiness, the order

was automatically returned to the checkout page, on which the customer was given the option to make a prepayment using bank transfer, debit card or another direct payment method.

In case the payment was made on time, the platform marked the corresponding open invoice as paid by reading it from the bank statement. In case the customer failed to pay the invoice, a reminder was sent, and further actions activated to collect the open receivable. The invoicing feature was mainly limited to European payment transactions (SEPA), as the policies of transfers and banks could vary significantly from region to region. The invoice creation feature in WooCommerce was successful by utilising the same ERP plugin, which also included video features and additional product certification and video media content. The third party integrations that were customer and case specific, such as connections to separate debt collecting agencies, were created only on an architectural level and left for future developments at the time of this research.

Although the reference number and due date were automatically generated for invoiceable orders after the checkout page, the platform also made it possible to manually create orders and invoices for customers, sending the invoices to the customer's email in PDF format. For micro-enterprises using the platform, there was no need to create a separate invoicing system in addition to the WordPress platform with the WooCommerce plugin.

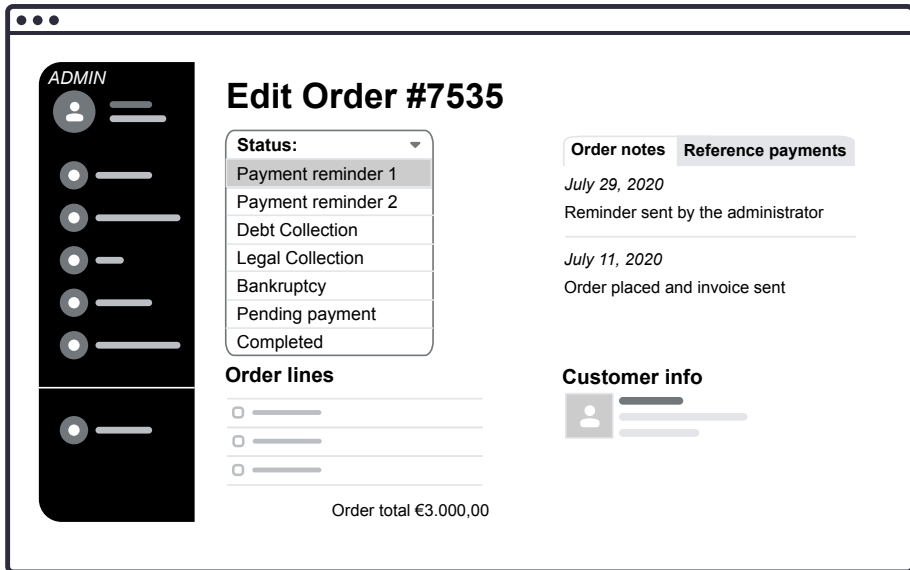
The customised ERP plugin, which was a central part of the current study, managed the creation of invoices along with e-commerce orders on the same combined platform, as presented in Figure 30. In the ERP plugin, two *metaboxes* were created for the WooCommerce subscriptions content type. The second metabox entered the due date for the invoice and another metabox showed the payments made with the reference number of that invoice. It was also possible to assign manual reference payments to the invoice in case, e.g., the reference number was missing on the payment. The logic of invoice generation and tracking/editing reference payments in WooCommerce orders is illustrated in wireframe in Figure 30.



**Fig. 30. Creating invoice manually on the platform.**

As shown in Figure 30, the functionality added to the ERP plugin via PHP code brought additional metaboxes to the WooCommerce order edit page. On the right is the *Reference payments* metabox, allowing for the administrator to specify the due date and monitor/add payments. The order edit page managing the WooCommerce e-commerce orders and invoices was the same for both sales types, e-commerce orders and invoices. As the invoices were technically orders in WooCommerce, they also appeared on the same sales reports as the normal e-commerce orders for seamless accounting.

Unique reference numbers that were generated for the individual invoices had to remain unchanged to allow the tracking of the payments related to those orders. In the case the payments were split into multiple parts, the platform was able to track multiple payments in total, as illustrated in Figure 30. In addition to that feature, a feature was added to the ERP plugin to add separate order states such as *Completed*, *Payment Reminder 1*, *Payment Reminder 2*, *Transferred to Debt Collection Agency* and *Legal Collection*, as shown in Figure 31. This helped the company to categorise the open invoices and orders.



**Fig. 31. Various order stages and order notes based on invoice payments.**

As shown in Figure 31, the customised ERP plugin offered the ability to expand the functionality of the WordPress e-commerce platform. It helped the platform to become a versatile invoicing tool that allowed the invoices to be sent in addition to managing traditional e-commerce orders in WooCommerce. It also allowed the creation of new content types for effortless content production.

The tracking of payments was also relatively easy to implement through utilising a reference number generation system based on the order number, completing an automatic check number to create a reference number supporting bank transfers. The lists of incoming reference payments were retrieved via the Web Services (WS) channel provided by the Finnish bank corporate services. The WS channel was provided by the bank, operated using public key infrastructure (PKI) technology by providing an encrypted and secure channel for the daily transfer of data between the banking account data and the web server running the WordPress installation.

For privacy and security purposes, the bank connection program operated in the local workstation of Valfi and retrieved the reference transaction data from the company's bank account. A file containing all daily incoming reference payments was then sent to the ERP plugin on the platform, checking the numbers and amounts

of the reference payments, automatically marking them as processed in the MySQL database.

The process was automated and triggered using a scheduled cronjob feature in a Unix server environment that the web server was running. An example of this Unix cronjob executing the reading of reference payments using a PHP script in the file *read\_statements.php* is:

```
30 9 * * * /usr/bin/php /var/www/wordpress/wp-  
content/plugins/ERP_plugin/read_statements.php
```

*Read\_statements.php* was a separate file in the ERP plugin directory and contained only the functions needed to read the reference payments from the seller's (micro-enterprise's) bank statement.

#### **4.2.5 PDF invoice and document creation**

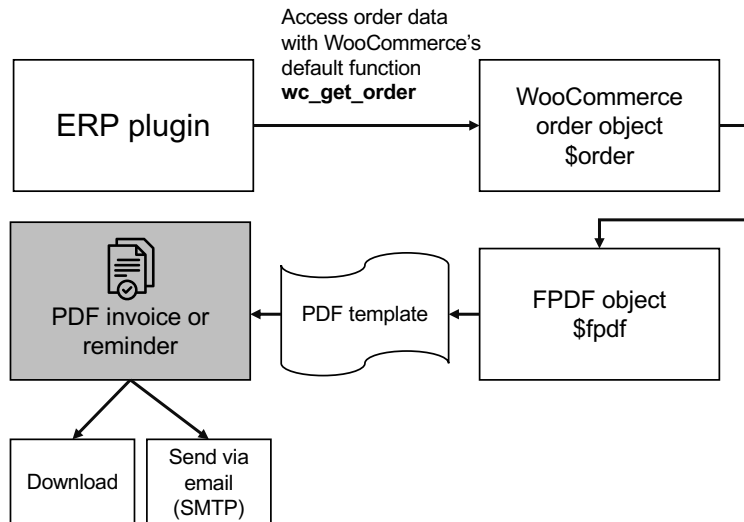
By default, the WooCommerce e-commerce plugin on the WordPress platform did not offer a feature to create PDF invoices from e-commerce orders. This function was achieved by adding the necessary PHP code to the ERP plugin, which allowed the creation and exportation of PDF invoices, mainly for the purposes of B2B sales similar to invoicing (see Chapter 4.2.4). The PDF invoices were assisted by a FPDF library that was an open-source licensed PHP library<sup>22</sup> for generating documents in PHP-based web applications. The FPDF library was installed in the */wp-content/plugins/ERP\_plugin* directory of the ERP plugin, which allowed it to be utilised in the functionality of the ERP plugin. The FPDF function was connected to the use of the platform by adding the command *require ('fpdf.php')*; to the ERP plugin's PHP file. This linked the FPDF functionality to the ERP plugin.

WooCommerce provided built-in functions for use in retrieving the order information using a ready-made *wc\_get\_order* function. This allowed the required information to be retrieved to the *\$order* object, from which required order information was retrieved for PDF conversion using the FPDF library. For example, a total amount of the order could be retrieved for an A4-sized PDF invoice with a command *\$order->get\_total()*;, printed to a PDF file using the FPDF's *\$pdf* object.

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<sup>22</sup> FPDF. Retrieved 18 October, 2020 from <http://www.fpdf.org/>

Figure 32 presents the functionality of creating the PDF invoices in the platform using the open-source FPDF library.



**Fig. 32. Process of creating a PDF invoice in the platform.**

As shown in Figure 32, the WooCommerce’s built-in functions, such as *wc\_get\_order*, could be utilised to retrieve order data for the PDF invoice from the platform’s MySQL database. Similarly, the data could also be retrieved from the orders for payment reminders, order referrals or offers. The separate templates for invoices, payment reminders and quotations were made in the generation of PDF files. FPDF provided the ability to visually build PDF files by drawing to a PDF file using the cell function *\$pdf->Cell*. The Cell function printed a rectangular area with customisable content, also allowing modification of colours, borders and positioning. The template was made for each purpose by using cells from top to bottom in order to build the complete invoice template.

The FPDF generator was also tested, automatically creating the product brochures in PDF format on WooCommerce products. Similarly, product data was accessed using a ready-made function *wc\_get\_product*, which retrieved the desired information about an individual WooCommerce product, such as price, title, inventory balance, description text, image and certificate. Some parts of the PDF templates were static, such as company contact and address information. To draw these on the template, HTML code and the editing capabilities provided by the

FPDF library were used. These elements were retrieved from the static variables for the printouts and there was no need to retrieve content from the WordPress database to present them in PDF printouts.

The automatic delivery of the invoice by e-mail was used to send the invoice to the customer after the order process. It was also possible for the administrator to download the invoice directly from the order settings. However, use of the PHP Mail function to send large numbers of emails was found to be challenging: some WordPress web servers' services limited the number of emails sent with PHP<sup>23</sup>. The receipt of these invoices and e-mails was also not confirmed or acknowledged using PHP Mail because there were no reliable logs about outbound email on the web server. To solve that issue, a third-party SMTP connection was used, which was possible to achieve in WordPress by using a separate plugin that routed all email traffic to a defined SMTP service. All email traffic from the PHP Mail function started passing through the SMTP server, which also generated logs about sent emails. Several different SMTP providers were found, such as Sendinblue, Mailgun, Sendgrid and Amazon SES. The Gmail service provided by Google also appeared to provide SMTP service to its customers<sup>24</sup>. The automatic sending of payment reminders was triggered by utilising WordPress' built-in WP-cronjob feature to complete tasks based on a schedule<sup>25</sup>.

WP-cron (the cronjob system provided by WordPress) was set to check every weekday to see if any overdue invoices were open. If overdue invoices were open, their statuses automatically switched to Payment Reminder 1 (see Figure 31) and the automatic email was sent to the customer with a payment reminder in PDF format. This took advantage of the ready-made template created by FPDF. In addition to WP-cron, a separate cronjob was also needed on the web server to trigger WP-cron to be active on a daily basis. WP-cron could not run independently unless the site had page loads. As a precaution, therefore, a separate Unix-type cronjob was also created for the server to trigger WP-cron despite page loads.

#### **4.2.6 Customer registry, CRM and REST API**

In addition to the reference payment of invoices, a feature was also developed on the platform allowing the customers to pay their orders later with WooCommerce's

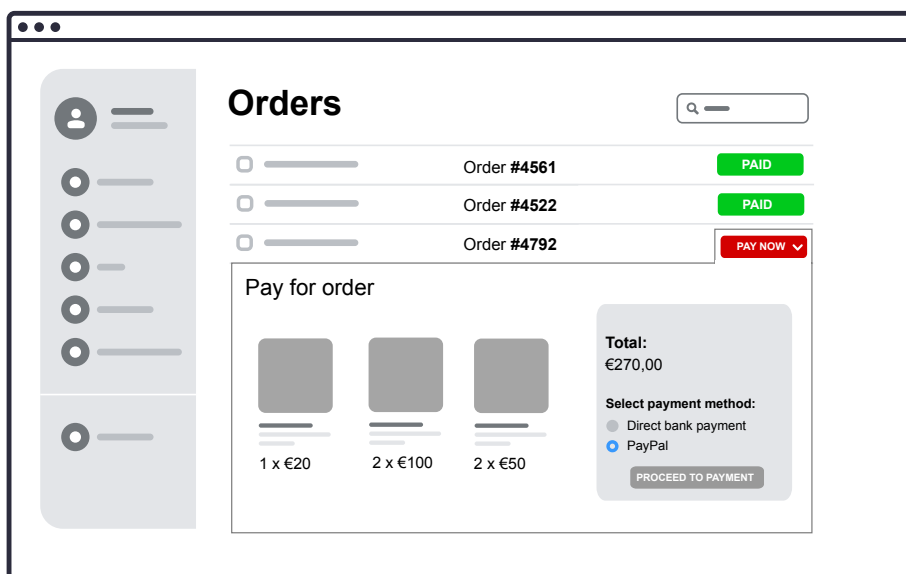
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<sup>23</sup> SiteGround. Retrieved 18 October, 2020 from [https://www.siteground.com/kb/i\\_get\\_too\\_many\\_recipients\\_error\\_message\\_what\\_does\\_it\\_mean/](https://www.siteground.com/kb/i_get_too_many_recipients_error_message_what_does_it_mean/)

<sup>24</sup> Google. Retrieved 18 October, 2020 from <https://support.google.com/a/answer/176600?hl=en>

<sup>25</sup> WordPress. Retrieved 18 October, 2020 from <https://developer.wordpress.org/plugins/cron/>

direct payment methods, such as PayPal and payment cards. This was achieved by sending the customers a link with the order confirmation that led directly to the e-commerce payment page, including the product and customer information already added to the shopping cart. In this way, the customers were also able to pay for their orders separately from the order date, which was perceived as good customer service, especially for B2B customers. Some customers could have wanted to pay for their purchases after the order date. It also potentially helped to recover late payments from customers. Customers also were able to access their paid and unpaid orders by logging in to the e-commerce site, as seen in Figure 33.



**Fig. 33. Paying unpaid invoice with other payment methods.**

As presented in Figure 33, the customers were able to monitor the progress of their orders from their customer account on the platform in multiple ways. It was also possible to handle the payments and cancellations related to the orders. The customer account was created automatically with the first order using the WordPress platform's user management system with the added WooCommerce e-commerce functionality. Only the order-relevant information about the customer was stored, taking into account data protection and the necessities of general data processing regulation (GDPR) rules. A customer relationship management (CRM) feature on the platform provided good quality for micro-enterprises' e-commerce

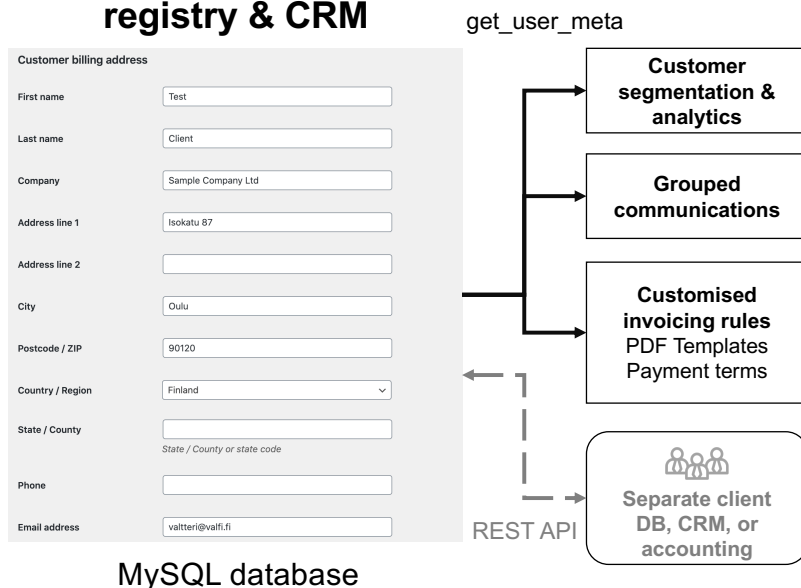


customers. The purpose of the CRM feature was to create a customer-oriented register by utilising the WooCommerce customer database, in which the same MySQL database contained information about the commerce customers and the micro-enterprise's other customers.

Each customer had their own login credentials that allowed them to log in to the platform to view and change their information and check the orders. The purpose of the combined e-commerce customer and invoicing register was to reduce the workload of the seller (micro-enterprise) when all the customer data was centralised into the same platform. Additionally, the administrator (micro-enterprise) had the opportunity to segment and categorise its customers to keep them informed of the custom post types, such as Bulletins (see Chapter 4.2.3). This could also be utilised for the supply chain and suppliers, generating targeted content for them with custom post type functions or other customisations.

Although the WooCommerce customer register contained only a limited amount of customer information, its customisability for further development was significant. WordPress provided the ready-made PHP function *get\_user\_meta*, which allowed the administrator to retrieve metadata from the WordPress database in a variety of ways, as seen in Figure 34.

## Platform customer registry & CRM



**Fig. 34. Getting and using user information from the platform database.**

The user metadata contained, for example, the user's (e-commerce customer's) first name, last name, invoicing address, linked orders, shipping address, telephone number, e-mail address and any other information collected on the payment page. For example, if the micro-enterprise wanted to utilise the customer data to make targeted offers or campaigns, a connection between the user data and the order data linked to it was an easy build because both data sources were found in the same WordPress MySQL database.

Combining the user metadata and related orders also appeared useful when identifying the customer's potential interests and buying behaviour in WooCommerce. However, targeted marketing and sales would have required strong customer approval because of the GDPR aspects. In WordPress, the users were one type of content, in a very similar way to products, blog articles and pages saved in the same MySQL database along with other data. It also was possible to flexibly add additional information to the user data by accessing the WordPress function *\$the\_user*. For example, in order to get the user's email address to a PHP variable, the following was invoked:

*\$the\_user = get\_user\_by( 'id', 3 );* and then retrieved the email address from the object with *\$the\_user->user\_email;*

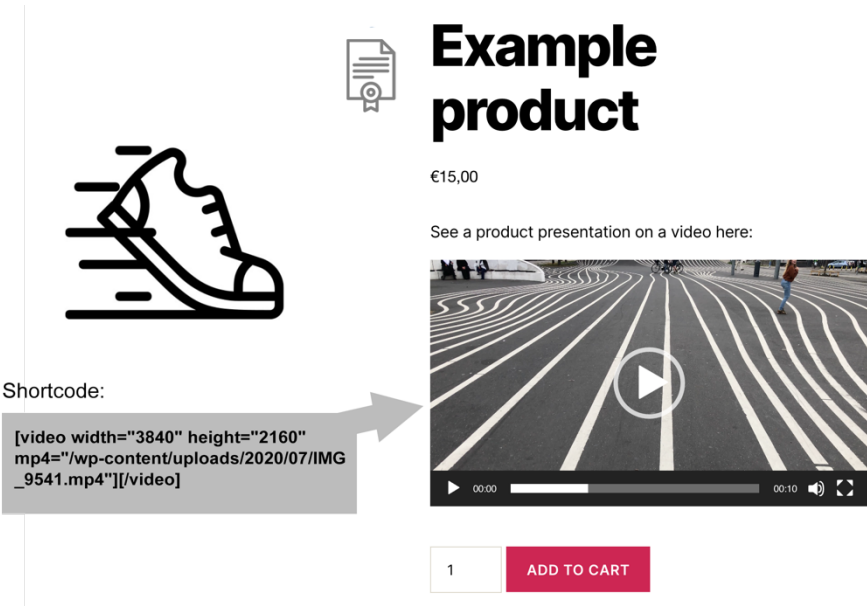
By accessing the user data with the *\$the\_user* function, the administrators could provide payment methods based on the user type (such as enabling invoice option to B2B customers) and store customer-related files or other information (such as additional quote, tax or delivery information). The administrator was also able to keep a log of the communication between the customer and the administrator. Possibilities to utilise customer information further in different external integrations between the different functions of the platform were useful for the micro-enterprise. When the micro-enterprise wanted to synchronise the customer data between the WordPress platform and other systems, the ready-made PHP function *register\_rest\_field* in WordPress' REST API interface provided an efficient way to do so, sending and receiving data in JavaScript Object Notation (JSON) format.

The WordPress REST API offered an efficient flow of data in a secure and protected channel, offering customisable endpoints to query, modify and create content between the separate systems and applications. However, deploying REST API integrations would have required work, especially in terms of defining user rights and linking the content to be used to different endpoints. One possible development of the ERP Plugin using the REST API would have been to automatically transfer sales data to a separate accounting agency's accounting software, without a need to check data manually on the platform to report the monthly and annual sales and payable taxes. However, it would have required additional integration work on the side of accounting firm systems, which would have been outside the focus of the current study.

### **4.3 Content and information in the platform**

Relevant content (information quality) was closely related to the combined e-commerce and ERP platform's product presentations and marketability. This was essential to achieve in the platform, because getting balanced cash flow was crucial for business growth (see Chapter 2.3) using the platform. The WordPress platform was originally a web publishing platform, enabling good web marketing and content producing tools out-of-the-box. The platform supported various content types in multiple ways, using the central ERP plugin (see Chapter 4.2). Because product text could be added and edited similarly on pages, blog posts and products,

videos were also added to the e-commerce descriptions without additional processing. For example, mp4 video could be uploaded to the site via media management as well as images or another media content. Once the pre-edited mp4 media file was on the administrator's computer, the file was uploaded and WordPress automatically generated a shortcode based on it, which appeared in the platform's content. The shortcode contained a link to the media file. Modern browsers were able to display the videos automatically in the platform, as shown in Figure 35.



**Fig. 35. Adding an .MP4 video to the product description.**

Similarly, adding videos from popular social media video sites was achievable using the embed codes they provided. In the construction, YouTube video embed codes were possible to use in the product description content. The default WordPress editor supported, for example, Vimeo and YouTube embed codes.

The advantage of using third-party video sites was that the platform did not have to host the videos in its own web server as the third-party video site managed the video file presentation, storage and distribution. Moreover, large videos did not

consume the web server's space or its resources when the videos were not uploaded to the platform itself. The other benefits of uploading videos to the separate sites also included their inclusion in the video sites' content delivery networks (CDN), which meant delivering video availability to multiple geographically separate sites, reducing download speeds and latencies across the world. This was useful for large video files, such as virtual reality (VR) type 360°, Full HD and 4K clips that were several gigabytes in size. Further, when videos ended up on the third-party video sites, the search results and algorithms with their respective social visibility opportunities started to bring additional traffic to the platform when its URL address was linked in the video descriptions.

Adding small videos to the platform was effortless through the WordPress media management system. It seemed practical to upload videos larger than 25 megabytes, such as long product demos, to the separate cloud video sites such as YouTube or the more feature-rich but chargeable Vimeo. In some cases, however, the platform wanted to distribute password-protected videos such as user manuals. In that case, the video was protected through the commercial Vimeo cloud video site, enabling the uploaded video to become protected with a password. Vimeo also supported uploading 360° VR videos that allowed the customer to watch the video with virtual reality glasses or by 'looking around' with different angles using a mouse or touch controls on handheld devices. Although the video was set to password protected via Vimeo, it could be inserted to the platform's product descriptions, as well as 360° VR videos (Figure 36).

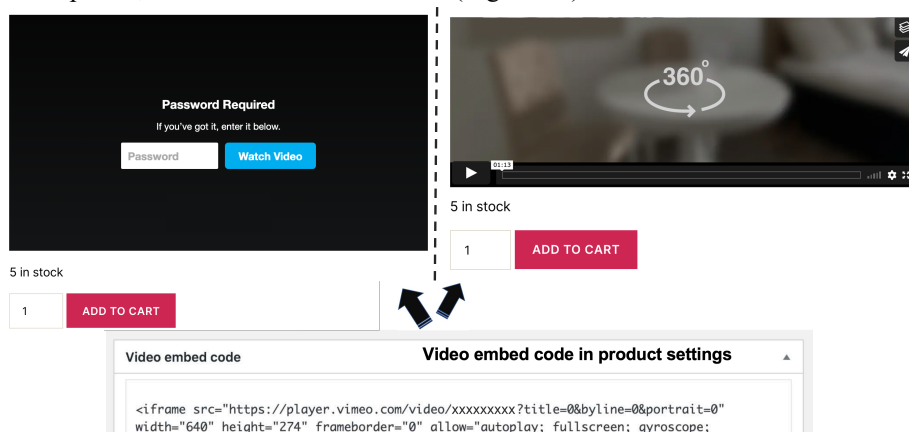


Fig. 36. Password protected (left) and 360° VR (right) videos on product description.

On the platform, Vimeo's service offered significant value over YouTube, especially when requiring password protected or 360° videos. Although the implementation of 360° videos required special hardware for filming and video post-processing, it seemed to provide exciting and captivating new content for the e-commerce product descriptions, especially for the presentation of facilities and large-scale products. In Figure 36, the 360° VR product presentation is demonstrated using the Vimeo cloud video service in WordPress.

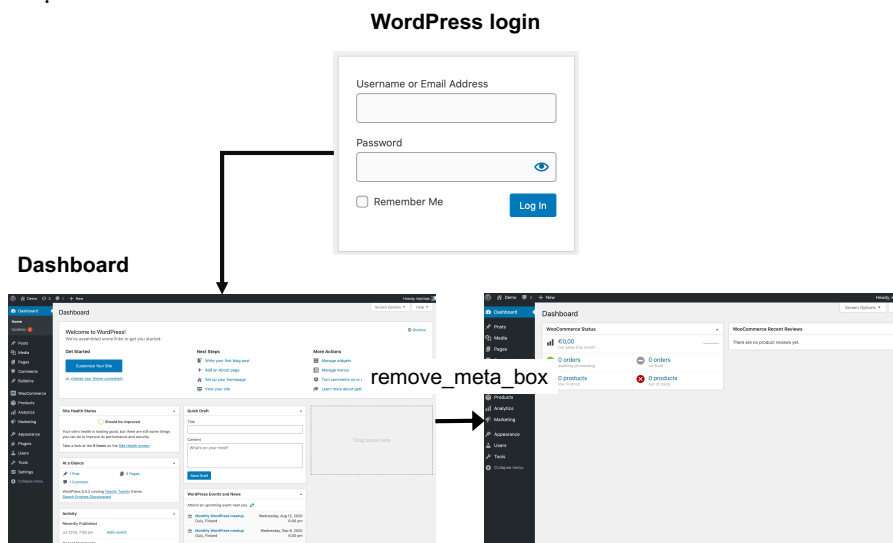
In the platform construction it was found necessary to keep product information and inventory balances up to date and as reliable as possible. When tested, WordPress seemed to automatically offer the ability to hide products that were no longer active. The hidden product was reactivated quickly, and the product information remained. This allowed, for example, out-of-stock products to become hidden and later become reactivated when necessary without the need to remove those products from the platform. This helped to keep the inventory consistent on the platform.

#### **4.4 Service quality on the platform**

WordPress version 5.4, used in the present study, and its default theme provided a suitable user experience system quality. Service quality could be linked with the user experience and usability, which are essential parts of sound information systems and e-commerce (see Chapter 2.2). Service quality was influencing the e-commerce user acquisition and retention. A flawless administrator experience to use and manage the platform with employees also was essential to maintain the interest to work with the platform.

Activating the features of the ERP plugin (see Chapter 4.2) brought almost no increase to the page or system performance (see Chapter 5.2.2). The most significant factor, and also a challenge for the efficient use of the platform, was uploading videos directly to the platform and also, to a small extent, uploading videos to the platform from external video services. This affected the usability of the e-commerce pages in the platform, as the large video files were taking time to load. Watching the videos on the e-commerce product pages also put a strain on users' computer CPU and memory, possibly causing decreased battery life and inconvenient fan noise. Considering micro-enterprises, the usability of the platform's administrator interface was tested and optimised for mobile devices, enabling the product information changes, price updates, invoice tracking and other functions to be achievable with mobile devices.

The platform's administration interface, which appeared immediately after logging in to the platform, appeared confusing and provided much unnecessary information. Because there were usually several micro-enterprise administrators using the platform, from employees to managers, it was practical to make this interface as clear as possible. The customisation of the administrator dashboard was done using the WordPress platform's default function `remove_meta_box`, which eliminated all the unwanted boxes on the administrator interface. Only the box containing information about the WooCommerce orders was left visible for the users on the administrator interface. The comparison between the default dashboard view and a more simplified view removing unnecessary meta boxes is shown in Figure 37.



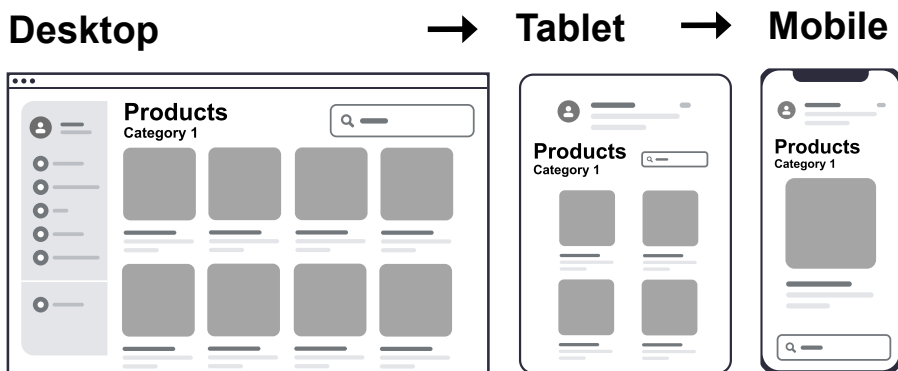
**Fig. 37. Cleaning the administrator dashboard for better usability.**

As seen in Figure 37, WordPress provided easy customisation of the display of various metaboxes on the platform's administrator interface (dashboard widgets). Similar to the product information and orders, the dashboard widgets were created in the administrator interface with the PHP function `wp_add_dashboard_widget`, which was written into the source code of the ERP plugin. On the platform, code for the new dashboard widget was a combination of HTML code and PHP code, allowing dynamic content to be presented for administrators. For example, a new

dashboard widget was created to present monthly sales and customer reports based on the WooCommerce order data retrieved from the platform's MySQL database.

The quality of the service was also directly dependent on the usability of the e-commerce product pages and the payment pages. Concerning the e-commerce pages in the platform, attention was paid particularly to loading speeds and product content, providing smooth and easy shopping experiences for customers and an intuitive editing interface for micro-enterprise administrators. Efforts were also made to get the customers to create user accounts so they could track purchases and pay for open orders and invoices (see Chapter 4.2.6). While it was possible to use e-commerce for both private and corporate customers on the platform, the focus was on the user experience and the business customers (B2B). For example, a chat service was added to the platform through which the customer was able to contact the micro-enterprise quickly. There were several chat providers found for the WordPress platform. A chat service called Tawk.to was tested, which provided an app for Android and iOS to manage an installable chat widget. This allowed the e-commerce chat to be tracked by the entrepreneur regardless of time or place.

On the e-commerce interface of the platform, its usability on mobile devices was positively influenced by the automatic responsive scalability for different resolutions and browsers. Figure 38 shows how the customer browses the shop category on various browsers (desktop-tablet-mobile) from the responsively scaled user interface. At the far left is an example of the responsive interface (category view), showing eight products, without the need for scrolling down the page. On a tablet device, the same view shows only four, and finally on mobile, just one product.



**Fig. 38. Responsive web design interface on the platform.**



As presented in Figure 38, the responsively designed user interface on the platform, automatically adopting to the end-user's screen resolutions, helped to provide a good user experience for both desktop and mobile users. Moreover, in the platform administration, micro-enterprises were able to manage the platform over the phone by using the responsive admin interface. The platform provided responsive scalability using a default WordPress interface theme and management dashboard without the need to customise it extensively. Still, it was possible to customise the interface to match it to a micro-enterprise's brand look by changing and customising it in a visual editor and by using the custom CSS/JS/PHP code. The platform also provided an opportunity to create child themes on top of the parent themes, such as the WordPress default theme. The child themes were built using the parent theme as a separate folder in the `/wp-content/themes` location in a web server (see Figure 26). A child theme folder contained only the changes that were desired to be made to the higher-level parent theme. Thus, the child theme did not need to be created entirely from scratch but only customised using CSS and PHP techniques to the extent of the parent theme to achieve the desired corporate image, with limited coding and technical work.

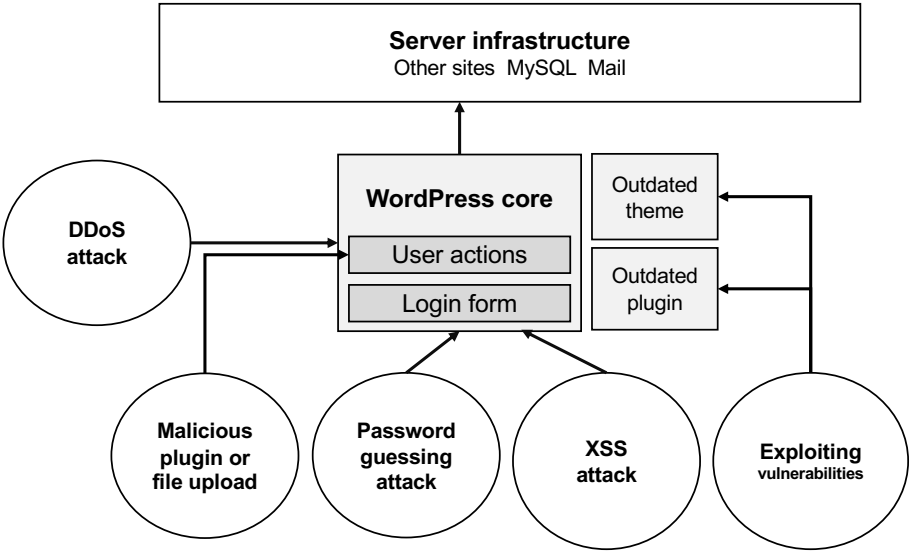
The quality of service on the site was also affected by organising the content and URL links in the menus used in the navigation of the platform. The navigation menus also changed their appearance based on the user's end device, meaning a separate mobile-optimised menu was appearing to browse the different categories and products of the platform. There was also a search function on the platform, through which it was possible to search for products and other content by name, description and categories. The menu and search functions were default WordPress features and did not require separate development work from the micro-enterprise administrators.

#### **4.5 Maintenance and security considerations**

Once the requirements and infrastructure of the ERP features on the platform had been defined and constructed, it was necessary to establish policies to keep updating and maintaining it in order to support the growing number of micro-enterprises using the platform. As illustrated in Figure 26, the WordPress platform already provided support for building an automated plugin or theme update tool. Although the updates were made automatically, the other system security and data protection measures had to be addressed. This included, for example, setting up a firewall, activating a WordPress file integrity service, activating an encrypted

HTTPS connection, enabling strong passwords, encrypting a login page and also considering GDPR implications on the platform. In most cases, the web hosting provider was providing the basic firewall for the platform running on its servers. However, this did not mean that the micro-enterprise-admin did not need to pay attention to potentially malicious visitors to the platform.

To add security on the platform, a web application firewall was activated through the Cloudflare service. This allowed suspicious traffic to be filtered from the platform effectively<sup>26</sup>. The service also made it possible to create selected security rules on the platform. For example, the platform’s login pages were given rules to restrict traffic if the visitor appeared to guess passwords programmatically. Addition to that, the rule was set to restrict traffic to the files in the critical files and folders on the platform, including the critical system files. In the `/wp-content/uploads` folder containing the media files (see Figure 27), only the media files, such as various video and image formats (e.g. .JPG and .PNG), were allowed, disallowing scripts (such as .PHP files). The potential security issues recognised in the platform construction are presented in Figure 39.



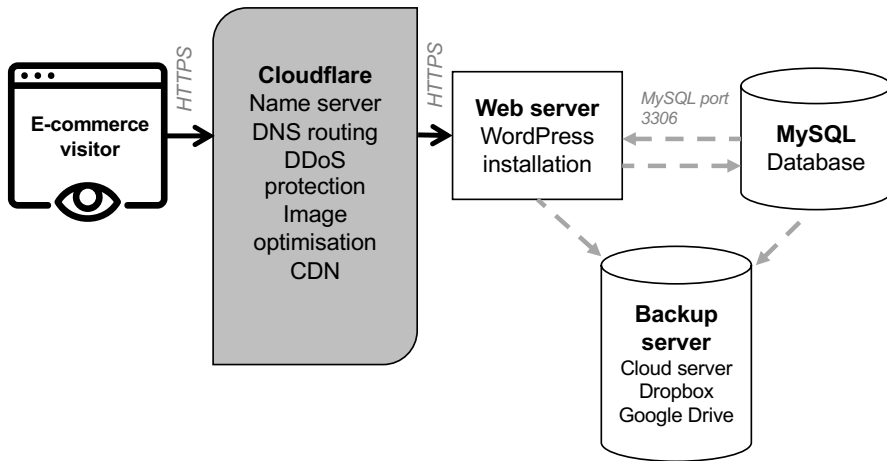
**Fig. 39. Various security issues of the platform.**

<sup>26</sup> Cloudflare. Retrieved 6 October, 2020 from <https://www.cloudflare.com/>

As Figure 39 presents, not only the WordPress installation powering the platform was in danger, but also the other applications and services, such as micro-enterprise's mail and cloud services running on the same web server. In particular, the self-developed plugins and themes in the platform were found to be potential attack targets. In the current study, the developer of the ERP plugin was focusing on making the functionality as simple as possible while still recognising the essential security issues. Because the selected WordPress infrastructure was popular and widely used, the platform plugin library also offered thousands of different plugins and themes to be installed with just a few clicks. This could entice the platform's micro-enterprise users to install unnecessary or 'testing-only' plugins that would otherwise linger on the platform without much use. Moreover, the support for these plugins might have ended, after which security vulnerabilities might have been identified. In addition to the security issues, many of the plugins were also consuming web server's bandwidth and slowing down the platform, as it was running additional plugin scripts every time someone was using it.

The login system was based on a username and password. Both had to be entered to log in to the platform. For these credentials, WordPress efficiently suggested strong passwords for the new users by default when adding them on the platform. The platform also warned about the use of the weak passwords and asked for additional confirmation to use them. The platform was more flexible in accepting usernames. Still, it appeared advisable not to use common usernames such as *admin*, *administrator* or *user* as platform usernames. The attempts to automatically guess administrator passwords were identified as among the most common types of attacks in WordPress. Gaining the right credentials would have given an attacker access to view and edit data on the platform freely.

To improve security on the platform, the Cloudflare service also managed the elimination of DDoS attacks, maintenance of a CDN network, implementation of an encrypted HTTPS connection and protection against password guessing attacks on the login page. A concept of Cloudflare securing the platform is shown in Figure 40.



**Fig. 40. Secure WordPress platform with Cloudflare.**

The activation of Cloudflare security on the WordPress platform was done by Cloudflare automatically, scanning the domain's DNS records and IP addresses with a set-up tool found on their service. The names of the web server running the platform were then pointed to the Cloudflare's name servers, which routed traffic through their firewall and secure DNS service (Figure 40).

From the Cloudflare settings, it was possible to select the options appropriate for the platform's requirements by selecting the security and optimisation levels, such as the optimisations of the platform's media types (images, CSS, HTML, JS), HTTPS encryption, login page address and URL-specific rule settings. For example, in URL-specific rules, most of the URLs that mentioned WP-JSON were set as blocked, restricting the use of the API channel when it was not actively used on the platform. Figure 40 also indicates how a backup server was deployed to the cloud server, separated from the platform web server through external cloud services.

## 5 Evaluation

In this Chapter, the evaluation of the platform is described. The approach for evaluation originated from the DSR requirements and micro-enterprise environment of the Finnish software company Valfi and its customers using the platform. First, a performance evaluation using Google Analytics is presented. Second, a heuristic usability analysis is addressed. Finally, the user interviews indicating the utility of the platform are pointed out.

### 5.1 Evaluation approach

To meet the defined DSR requirements and research rigour, the current study engaged three various evaluation methods to evaluate the artefact, which was the platform built in Chapter 4. DSR suggests that evaluation should be conducted in the application domain, which determines the criteria for the evaluation (see Hevner, 2007). The application domain in the current study is presented in Chapters 3.4–3.5 and the requirements for the platform in Chapter 4.1, providing the foundation for evaluation parameters. The evaluations were conducted in the following priority and order:

*Platform performance—Chapter 5.2*

Performance evaluation with Google Analytics (end-user’s viewpoint)

*Platform usability—Chapter 5.3*

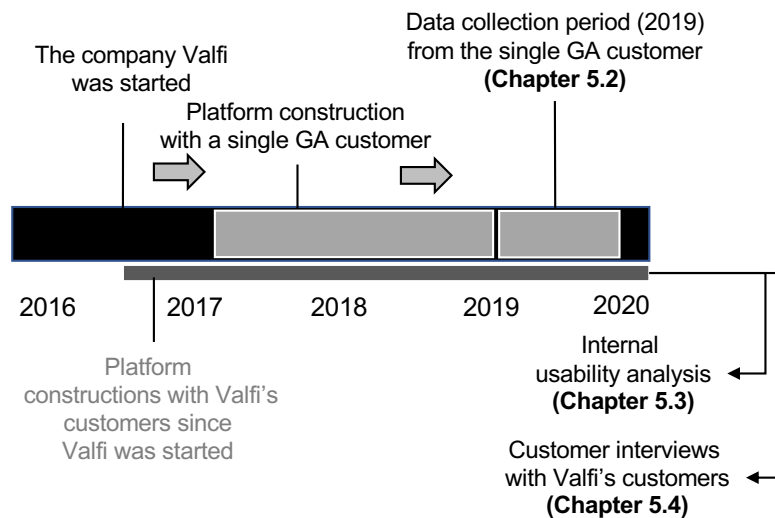
Usability analysis (heuristics) by Valfi (administrator’s viewpoint)

*Platform utility—Chapter 5.4*

User interviews (enterprise user’s viewpoint)

The unit of analysis was the platform as the DSR artefact (see Chapter 3.3). This platform, which was used by Valfi’s customers, was evaluated in the performance evaluation (Chapter 5.2). The usability analysis (Chapter 5.3) was conducted by Valfi itself and these insights represented the administrator’s insights. The interviews were conducted with multiple customers to indicate the enterprise user’s viewpoint (Chapter 5.4). In the present study, the evaluation requirements originated from the knowledge base, organisational environment and the platform requirements (see Chapters 3.4 & 4.1). Valfi, conducting the evaluation, was building and evaluating the platform with its customers between 2016 and 2020.

The performance evaluation (Chapter 5.2) was based on the visitor data collected from the platform between the first and last day of 2019 where a Valfi customer using the platform on retail B2C and B2B e-commerce use scope. These examples were selected for the evaluation as they seemed to present a good overview of the research environment. They also reflected the challenges that businesses generally experienced in their growth and digitalisation efforts (see Chapters 2.1–2.3). The usability evaluation (Chapter 5.3) was conducted in 2020 by the developer (Valfi) internally. The utility evaluation (Chapter 5.4) was based on Valfi’s customer interviews, where the customers had been using the platform or various parts of it between 2016 and 2020. The timeline of the construction and evaluation in the current study is presented in Figure 41.



**Fig. 41. Construction and evaluation in a timeline.**

As shown in Figure 41, a single customer of Valfi (GA user) was providing the data for the Google Analytics performance evaluation (Chapter 5.2). This single customer, accountable for performance evaluation, was chosen because they used the various features constructed in Chapter 4. Valfi was responsible for the usability analysis (Chapter 5.3) and multiple Valfi customers and partners took part in the interviews (Chapter 5.4). Some of these interviewees had been working with Valfi since its early days (2016) and some came along later in the various platform construction and customisation projects using WordPress.

## 5.2 Performance evaluation using Google Analytics

This Chapter presents the evaluation method and results originating from the Google Analytics (GA) evaluation. First, the background is presented on how GA was used in the evaluation. After that, the findings from the GA performance measurements are described.

### 5.2.1 Google Analytics as an evaluation method

The scope of the GA evaluation in the current study was to present insights about the platform's performance and efficiency, also comparing the results to fresh industry averages (see Chapter 3.3.2). The GA evaluation focused on the platform's public e-commerce interface (frontend), which received web traffic when the e-commerce function of the platform was live on the web, powered by the platform (WordPress). This approach gave insights about the end-user viewpoint, revealing how the e-commerce customer viewed the performance of the platform. However, the end-user perspective was not enough to provide a full outlook on the platform and its utility.

The usability analysis (Chapter 5.3) and interviews (Chapter 5.4) supported the evaluation with the administrator's and entrepreneur's perspective. First, a JavaScript-based GA Tracking code was generated in the GA suite on <https://analytics.google.com>. Then, the code snippet was written into the platform's source code (each time someone made a request to load the page, the tracking code registered the visit and sent the visit data back to the GA). After this sequence, the data was possible to read, visualise or export from the GA suite by the evaluator (Figure 42).

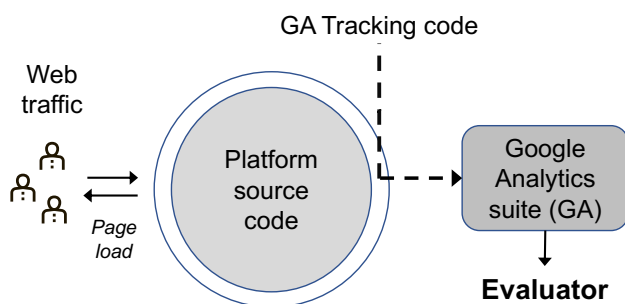


Fig. 42. Explanation of how GA was used in the evaluation.

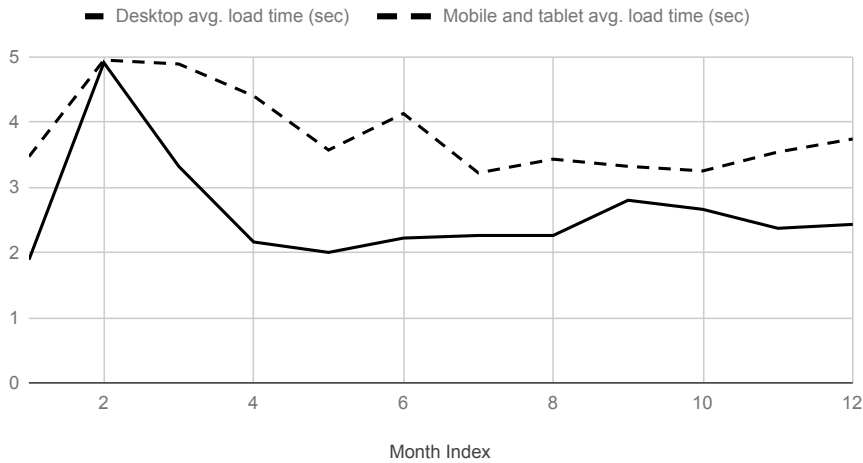
The GA evaluation was done when the platform was in-use by a Valfi customer, taking most of the combined e-commerce and ERP features and functions into account in the company's B2B and B2C operations during the year 2019. This company had used the WordPress platform almost since its beginning. The e-commerce sales revenue was around one million euro in 2019. The evaluation was carried out by using the essential performance metrics of Site Speed, Exit Pages, User Behaviour and Conversion tools to provide performance data about the web traffic on the platform. As GA was providing real-time usage data from the web traffic (Figure 42), it did more than evaluate the overall usability of the e-commerce sites. It also pointed out some potential problem areas that were limiting the site's growth potential, such as slow loading times on the individual pages, leading to exiting users.

The seller, from the data collected during the performance evaluation, was a Finnish fashion retailer, offering products to Finnish and international customers. Although the focus of the current study was on the different micro-enterprises with variable business models, the case used in the GA evaluation was determined suitable for the scope of the evaluation.

### ***5.2.2 Site speed and performance results***

The performance of the platform was identified as fairly satisfactory in terms of system quality. GA provided the ability to measure the platform's page load speed in real time. The data on the platform were measured when it was in use during 2019, when the average page load speed was 3.55 seconds. On the platform, the average mean load values were 2.47s on desktop browsers and 3.82s on mobile browsers. This was a good value compared to the average web loading times of around 10 seconds (see Chapter 3.3.2).

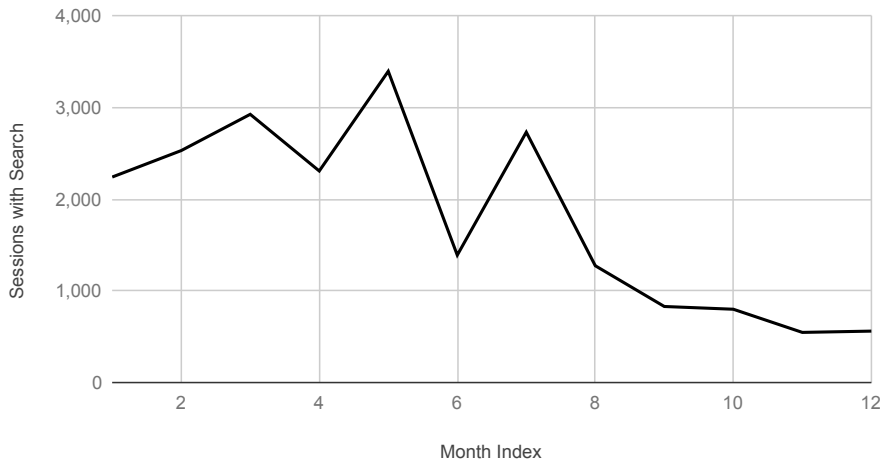




**Fig. 43. Average load times in the platform during 2019.**

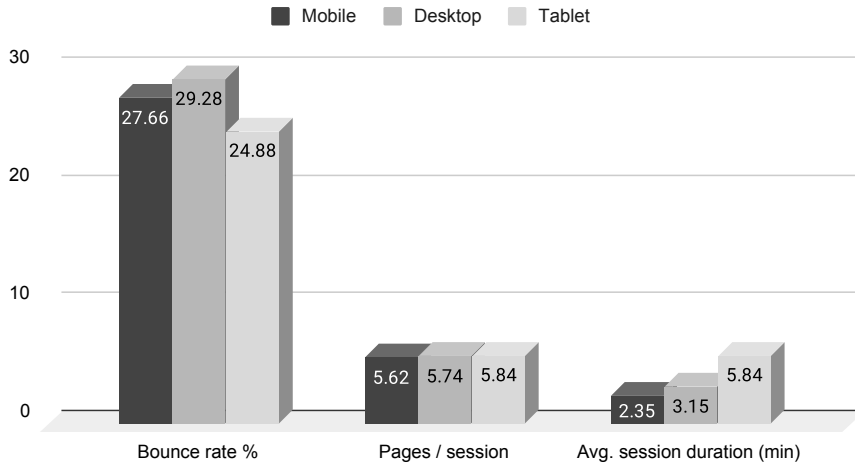
The average loading times during 2019 are indicated in Figure 43. The platform underwent a speed optimisation during the period of 2–6/2019, which is possibly reflected as a small, improved speed towards the end of 2019. The speed of the mobile devices is lower than the speed of larger devices. In conclusion, the speed of the platform could be considered satisfactory compared to other sites in general. The web traffic originated mostly from Europe, which was also the main focus of the business; growing traffic from Europe also meant new potential customers.

Another measure of effectiveness was the use of search functions in e-commerce. Figure 44 shows how the use of search functions on the platform decreased after 6/2019 when the platform’s user interface (theme) had been made easier to use. In the past, the search function of the platform was used mainly because no suitable products were found through navigation and links. Changes in the navigation structure were made during the summer of 2019 to make the platform’s user interface gain traffic. However, it potentially reduced the use of the platform’s search engine towards the end of the year, as seen in Figure 44.



**Fig. 44. Search performance on the platform.**

For usability aspects, significant attention was paid to the comparison between the different devices such as mobile phones, tablets and desktop computers using the platform. The highest bounce rate was in desktop users and the lowest in tablet users when comparing between the various end-user devices. The *pages/session* readings were close to each other, but especially in tablet users, the value was high, as they seemed to find the platform’s usability relatively good. In *avg. session duration*, the average time of one visit was indicated in minutes. The shortest duration of the end devices was for mobile e-commerce users and correspondingly the longest on tablet users, up to almost six minutes in length. Even on a desktop computer, the site could be used somewhat longer than on mobile devices. However, the essential value of these was the bounce rate, which also had an impact on search engine optimisation.



**Fig. 45. Key performance values between end-devices.**

Figure 45 shows the differences between the various devices in the platform’s bounce rates, number of pages browsed and the average session durations. As the graph shows, the low number of pages browsed was slightly related to the duration of the sessions, which were shortest on mobile devices. However, the differences were not significant between the different browsers, except for the duration of the session. If the duration of the session indicated the usability of the platform, the tablet users would seem to have spent time on the platform for the longest time, 5.84 minutes (Figure 45). The key values in Bounce rates, Pages/sessions and Avg Session durations seemed to perform satisfactorily when compared with global e-commerce averages (see Chapter 3.3.2), being lower in bounce rates and higher in Pages/session and Avg. session durations. Despite that, tablet users accounted for only a small proportion of the total users on the platform, 5.14% as shown in Table 10.

In e-commerce conversions, a small correlation was observed with session length. The users using a desktop browsing device spent a little more time on the platform, and on average, these visitors bought slightly more. Although the session duration was the shortest for mobile users, it did not cause significant differences in the conversions or the number of pages browsed, as shown in Table 7. Desktop users were bringing only around 20% of total traffic, which called more attention to the mobile user experience.

**Table 7. Comparison between devices and E-commerce conversion rates.**

Device category	Users	Bounce rate	Pages / session	Avg. session duration	Ecommerce conversion rate
Mobile	74.68%	27.66%	5.62	0:02:35	2.15%
Desktop	20.18%	29.28%	5.74	0:03:15	2.52%
Tablet	5.14%	24.88%	5.84	0:03:03	2.30%

Although the interface was implemented to scale to screen size on mobile and desktops responsively, the data appear to be slightly lower on mobile interfaces (Table 7). The bounce rate on mobile was marginally lower than on a desktop with almost the same number of pages being browsed. Table 8 shows a conclusion about social networking sites on visitor acquisition in the platform. Facebook seemed to be the most effective channel for driving visitor traffic to the site, accounting for about 78% of the traffic generated by social media pages. Instagram and its Stories section brought traffic with the lowest bounce rate, meaning that visitors had stayed on the site longest once they arrived there, compared to Facebook. A comparison of social media sites as sources of traffic is shown in Table 8.

**Table 8. Comparison between social networks and page views.**

Social network	Sessions	Pages / session	Avg. session duration	% New sessions	Bounce rate
Facebook	78.00%	5.01	0:02:04	22.47%	30.28%
Instagram	10.82%	7.07	0:02:30	68.86%	8.40%
Instagram Stories	10.92%	5.49	0:01:58	37.80%	26.64%

Instagram Stories had a close relationship with Instagram, with the same users possibly using the Instagram timeline and Stories. Facebook also offered the best features for linking pages in its publications, offering more opportunities to generate traffic. Instagram did not allow direct links to be embedded in publications; a fan had to manually type the link address that was mentioned in a post text into the browser's address bar.

The e-commerce conversion rate referred to the total number of visitors on the platform that led to transactions. However, the conversion rate could not be considered as the only measure of system quality, as the conversion rate could be affected by, for example, customer interest in products, links from other sites, the balance of products in inventory and the number of active campaigns. Further, for

example, a newspaper article or a single post of a popular social media influencer could cause a visitor peak on the platform, bringing in many visitors who did not have an active purchasing desire in the platform. Nor did the conversion rate look at the number of average purchases or the margin generated from the conversion. However, it was considered a practical idea to pay attention to the e-commerce conversion rate by combining those data with other data sources, such as site load speed, providing possible indication and correlation of e-commerce development areas.

**Table 9. Comparison between acquisition channel, bounce rate and conversion rate.**

Default channel grouping	% of users	Bounce rate	Pages/session	Avg. session duration	E-commerce conversion rate	Transactions
Organic search	46.25%	25.70%	5.99	0:03:08	1.56%	5,554
Direct	27.87%	35.42%	5.09	0:02:21	1.42%	2,238
Social	23.07%	25.45%	5.59	0:02:08	1.21%	2,373
Referral	2.81%	27.50%	5.07	0:02:51	15.51%	6,435
Other	0.80%	56.00%	2.6	0:00:37	0.00%	0

As shown in Table 9, *Organic Search* referred to visitors who were coming through Google and other search engines. These visitors accounted for around 46% of the total number of visitors to the site, also having the most extended session in the number of pages browsed (approx. 6 pages/session). The bounce rate on these pages was quite high; over one fourth of visitors left after they had arrived on the pages. However, the number of conversions was not very significant for those who came through search engines. In contrast, the conversion rate was reasonable from referral sites, peaking at over 15% on conversions.

Compared to industry averages (see Chapter 3.3.2), conversion rates appeared to be underperforming in Organic Search, Direct and Social. However, Referral traffic seemed to perform well. These visitors were particularly committed to the payment transaction. Of the visitors, 27.87% came via direct traffic, which means those who came to the service by typing the address into their web browser. The conversion rate for these users was 1.42%, which was slightly better than that for those who came via social media (Table 9).

### 5.3 Usability analysis

In the current study, the usability analysis was conducted by using a heuristic analysis approach to support the performance-oriented GA evaluation (Chapter 5.2). The platform and the features that were present in Chapter 4 underwent the usability analyses. The operational environment of micro-enterprises was taken into account, addressing the specific needs of the target group of micro-enterprises from the knowledge base and Valfi's organisational environment and platform requirements (see Chapter 4.1). The heuristic usability analysis was conducted in 2020 for the built features, described in Chapter 4. The main focus was on the platform administrator interface that the micro-enterprise would use in its day-to-day activities.

The usability analysis accompanied the results of the performance evaluation (Chapter 5.2) and interviews (Chapter 5.4) by bringing insights from the administrator's viewpoint. Because it was challenging to find all the usability-related problems at once, the focus was on those that seemed to pose the most challenges to users, originating from GA performance testing and interview insights. The goal of the scheme was based on the usability guidelines that originated from the prior studies regarding usability heuristics (see Nielsen, 1994; Nielsen & Molich, 1990).

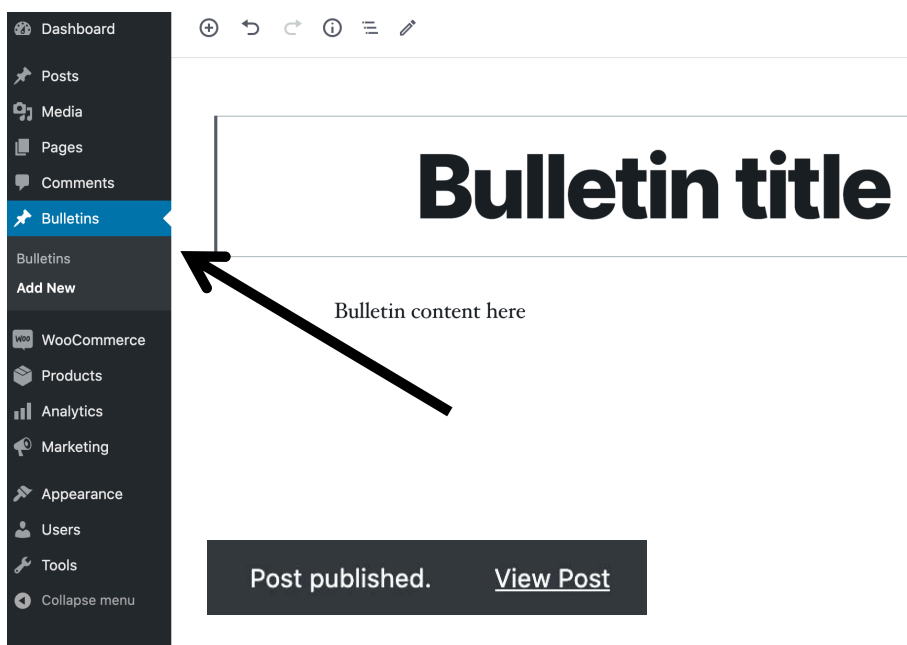
The requirements for the satisfactory levels of usability came from the research environment and requirements. On the platform, usability was seen an essential factor increasing especially e-commerce transactions, followed by conversions and cash flow to keep the firm growing. According to this concept, the usability had to be tested especially through the features that brought new sales and transactions. Mobile usability also was referenced in the performance evaluation, as the visitors were mostly using mobile devices to access the platform. Simple and easy-to-use features helped with the platform's adoption in micro-enterprises. The usability analysis collected the most significant insights that affected the usability of the platform and supported the other evaluation methods. The more detailed insights from the heuristic analysis (see Nielsen, 1994; Nielsen & Molich, 1990) are described in the following sections:

#### *1. Visibility of the system status*

A similarity of various custom content types in the platform facilitated usability issues. One is that a new piece of content in the platform could be accidentally

miscategorized, for example, by creating a Bulletin message (see Chapter 4.2.3) in the blog post category instead of creating it correctly in the Bulletins category. Moreover, new posts were often automatically marked as ‘public’ by pressing the Publish button in the administrator interface. If the user intended to save a draft and resume it later, a draft version could be accidentally published on the site. However, the problem was somewhat alleviated by the fact that the accidentally published content did not necessarily appear directly on the pages but required a separate linking so the users could find it on the platform.

As shown in Figure 46, it was easy for the administrator to monitor the status of the platform on both the administrator side and the public side of the e-commerce. The platform indicated changes, but these could have been more visible.



**Fig. 46. System status and notification example in Bulletins custom type.**

The platform continuously provided feedback about the updates, changes and deletions through the pop-up notifications. An example of the notification ‘Post published’ is seen at the bottom left corner, which can also be seen in Figure 46. The platform used notifications on the administrator control interface side and on the public e-commerce frontend. The notifications advised the administrator when

something was saved, deleted, moved, completed or required an update on the platform.

## *2. Match between system and the real world*

The elements of the user interface and the buttons that required interaction on the platform had clear meanings, which facilitated the sensible perception of the platform. In addition to the descriptions, the platform engaged icons and graphic elements to enhance the ‘match the real world’ principle (see Nielsen, 1994; Nielsen & Molich, 1990). The icons and buttons in the platform used were familiar from other e-commerce platforms and web applications. However, on the administrator interface, the problem was that the multiple administrators, such as managers and employees, were editing content on the platform.

The interface of the used responsive design approach that scaled automatically was based on user’s screen size. The function of the responsive design was indicated in Chapter 4.4. The responsive design interface (see Figure 38) especially helped mobile and tablet users, as the content was adapting to the screen with large pictures and readable titles and text paragraphs. Moreover, the platform administrator panel’s graphical user interface scaled responsively according to the admin’s browser display resolution, whether it was a mobile or desktop-sized display. The graphical interface of the WordPress platform was easy for entrepreneurs to use and it could be easily translated into their own language using the platform’s translation files.

The information content on the platform, such as product descriptions, could be edited in the so-called ‘undisturbed’ mode, which hid all the other UI elements during editing. This caused confusion for some users, as it was not clear to them how to get the UI elements back to the editor. The compatibility with other business cloud services, such as Google Docs and Office 365, also posed challenges, as copy-pasting content from them left a large amount of useless HTML code that broke the platform’s text editor. The solution was to paste the code, for example, through the browser’s address bar, which removed the extra HTML from the text being pasted from Google Docs. Moreover, the graphical user interface of the platform used clear language and it was also translatable into different languages using a translation tool in WordPress.



### 3. User control and freedom

The WordPress installation and activation of WooCommerce's e-commerce feature was an exercise that could be achieved through the use of tutorials provided by the open-source platform's support documentation and community (see Chapters 3.3.1 & 4.2). The platform allowed creating different user accounts with different management rights. When creating content, the platform saved the old versions of different content types, such as product descriptions, in the platform's backup history, allowing the administrator to revert the pieces of content back to the previous versions.

The platform's interface automatically recognised the screen resolutions of the end-user's web browsers, adjusting the interface and theme layout accordingly. The automatic UI scaling was referred to as responsive web design (see Figure 38). One of the features in the platform was an electronic order form to support agency-level e-commerce practitioners. To make this form feel 'natural', an electronic signature feature was built. This feature is presented in Figure 47.



**Fig. 47. The digital signature field in the platform.**

The user and brand experience especially contributed to sales, leading to the potentially increased cash flow and sales in the micro-enterprise that was using the platform. Interactive elements, such as the handwriting input in Figure 47, were not only relevant to the user experience, but also increasing the time spent on the platform. This also increased the performance in search engine optimisation.

### 4. Consistency and standards

The WordPress platform had had a big impact on web development standards due to its popularity. It had been around for more than a decade, but it had used

consistent names to organise the data structure of the database. The database structure had remained mostly constant over the evolution of the software<sup>27</sup>. Logging in and using the platform logically corresponded to many similar and familiar e-commerce and online platforms.

The open-source nature helped to achieve consistency. Almost everything in the platform was built by utilising the various open-source technologies and applications. The ERP features were constructed by coding additional PHP, JavaScript and CSS scripts to enrich the information quality on the platform. Those programming languages were popular, active and well-documented. Moreover, different open-source libraries were utilised to construct the ERP features to improve the information flows, such as invoicing and financial data. For example, the PDF invoicing feature was assisted by the FPDF library, a free and openly licensed PHP class for generating documents in PHP-based web applications (see Chapter 4.2.5).

### *5. Error prevention*

The errors in the platform were handled naturally, especially when editing textual content using automated backups. The old versions of the automatically backed-up articles also remained in the revision history. However, this backup system did not work correctly for all content types. One of these non-functional types of content was, for example, the WooCommerce products. This was a problem, for example, when the several different administrators were updating the content at the same time, modifying the pricing info, inventory balance or product details. Still, the error management seemed effective in the platform, giving relevant notification messages about the possible mistakes and preventing the catastrophic error events from occurring.

### *6. Recognition rather than recall*

The descriptions written in the platform's text editors were mostly automatically cached, without the need for remembering to save the entered content separately. There was no record of the change in the inventory balance in the platform's logs or information about the users who had changed the balances. This allowed the product to be sold 'over' the stock after the same person had already changed it. A

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<sup>27</sup> WordPress. Retrieved 18 October, 2020 from [https://codex.wordpress.org/Current\\_events](https://codex.wordpress.org/Current_events)

reason to remove the product from the inventory balance was, for example, a defective product that could not be sold. Creating different user levels with meaningful rights helped to prevent errors related to overwriting content.

### *7. Flexibility and efficiency of use*

The WordPress OSS platform's popularity, versatility and active developer community<sup>28</sup> provided the best combination of functionality, security and quality. The platform provided flexibility to customise it for the micro-enterprise's needs. Its satisfactory loading speeds in the frontend and backend brought efficiency. However, the long history of WordPress was observed as not fully complying with the latest web technologies that could have made it faster and easier to use. The Google Analytics data showed (see Chapter 5.2) that the share of the mobile users on the platform meant shorter visit times and fewer pages browsed. However, it did not provide in-depth details about specific problems such as detailed suggestions on how to change the user interface for better e-commerce retention or conversions.

Using an administrator interface that also worked on a mobile device was possible, but not particularly useful to the micro-enterprise. The efficiency of use could be affected by removing all the extra content from the mobile interface, for example, by removing the unnecessary metaboxes, as described in Chapter 4.4.

The platform's file infrastructure was clearly organised to help the administrator to manage, update and develop it further. For example, in a WordPress root folder, a folder called `/wp-content` held all functionalities and files not related to the core platform files. Inside the `/wp-content` folder, there were at least three subfolders called `/plugins` (containing plugin features), `/themes` (containing interface theme files) and `/uploads` (containing images and content media files).

### *8. Aesthetic and minimalist design*

The aesthetic and minimalist look of the platform was achieved through the customisation that was described in Chapters 4.3–4.5, utilising the customisable WordPress platform and responsive design user interface. The customisations changed the platform's interface, its content and its functions as the custom PHP, JS and CSS code was activated in the custom ERP plugin. Significant additional

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<sup>28</sup> WordPress. Retrieved 18 October, 2020 from <https://wordpress.org/support/>

help was found in WordPress' built-in functions, such as `add_meta_box()`. This made it possible to collect added content in a standardised way, reminiscent of adding and editing existing content in WordPress.

### 9. Help users recognise, diagnose and recover from errors

The error messages were in plain language and notified the administrators about the potential problems on the platform. The platform also reminded the administrator in advance about potential security issues and update needs. The platform was automatised to be up to date using the automated updating function on the WordPress platform (see Figure 26).

The platform provided feedback about its use through notifications and various navigation menus that showed the users' current locations on the pages being browsed. The platform appeared to have multiple potential security issues if the upgrades and maintenance were neglected (see Chapter 4.5). The platform automatically reported update needs and was able to download the required updates by itself. In the case the updates failed to download, the platform issued an error message and suggestions for possible solutions. An example of an automated update monitoring feature is shown in Figure 48.

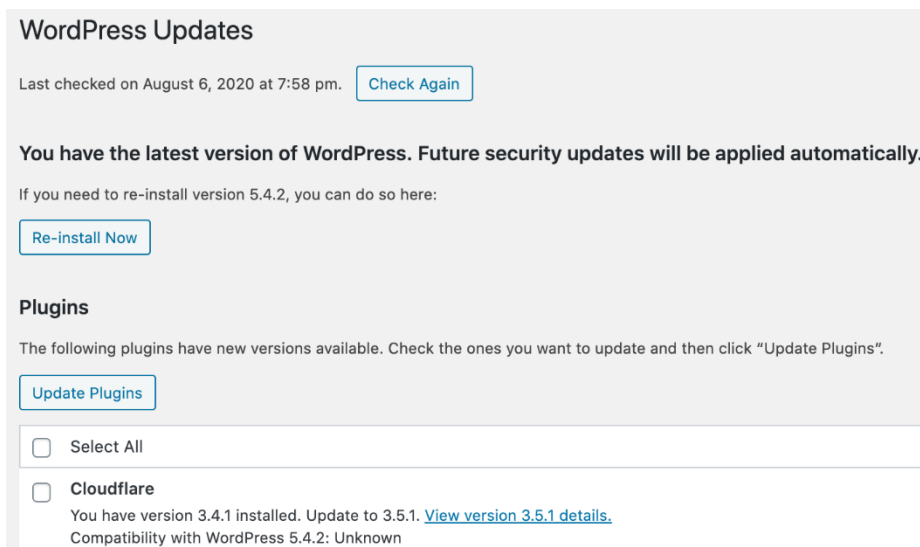


Fig. 48. Automated updates in the platform.

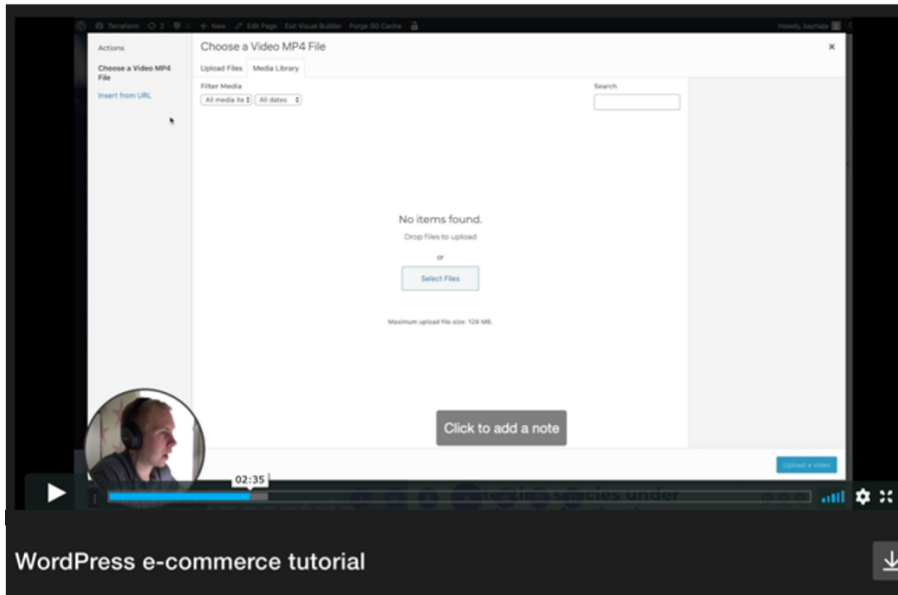
As Figure 48 shows, the platform performed many automated tasks to reduce the user input and actions to remember, especially in updates, backups and maintenance.

### *10. Help and documentation*

Because WordPress had been a platform for so long, it had developed a large community of independent and commercial developers, as well as tutorials on blogs, forums and YouTube videos. The existing tutorials and ready-made examples were among the essential features in this rule of thumb, as it made it possible to find quick help and support for the micro-enterprise constructing the platform.

In order to guide the use of the platform, instructional videos were made about the various features of the platform by the systems integrator (Valfi). These videos indicated how to use the platform in a micro-enterprise's business. Making the videos was found to be an effective way to familiarise the users with the products and features of the platform. The instructional videos had to be high in visual quality in order to help the user follow what the instructor (Valfi) was clicking on the screen. For example, in the WordPress administrator interface, many font sizes turned out to be small for the instructional videos, making it necessary for the micro-enterprise to pause the video for a closer look.

The best channel for implementing the video instructions was Vimeo, on which the videos could be password protected and where the videos received comments from the micro-enterprises watching them. As mentioned in Chapter 4.3, the integration of 360° videos into the product information on the platform was also successful through the Vimeo video service. An example of an instructional video using the Vimeo service is illustrated in Figure 49.



**Fig. 49. Guiding the users to use the platform with an instructional video.**

### *Concluding insights about usability analysis*

The usability analysis in this Chapter supported the performance evaluation originating from Google Analytics data and the interviews, providing an opportunity for the administrator to examine the functionality of the platform through heuristics.

The platform was easy to use, especially on mobile devices, which arose from the responsive web design approach (see Chapter 4.4). The responsive design interface especially helped mobile end-users to make purchases and browse the content on the platform. Extensive mobile use was also indicated in the performance analysis (see Chapter 5.2). The open-source platform's infrastructure, support and documentation provided utilisable resources to achieve required customisations to efficiently make the usability on the platform satisfactory. Continuous usability improvements were achievable with simple modifications using well-documented web standards, such as PHP, CSS and JS programming languages.

It was noticed in the current study that it was possible to return to the usability testing whenever necessary during the platform development. Moreover, the

introduction of the new features along with the real-time Google Analytics data provided significant value in the development. As a by-product of the usability analysis, attention was also drawn to the fact that the easy customisability of the WordPress platform could also increase the tendency to install and develop unnecessary features on the platform, slowing down its use. The added unnecessary features could also bring unnecessary elements to the user interface, confusing the users. It would have been a practical idea to return to the basic rules of heuristics (see Nielsen, 1994; Nielsen & Molich, 1990) in the further development of the platform to support the continuous build-evaluate loop (see Hevner, 2007).

## **5.4 User interviews**

This Chapter shows how the user interviews were used in the present study along the performance and usability evaluation. First, the background is presented, followed by the interview questions and results.

### **5.4.1 *The interview setting***

The scope of the user interviews in the present study was to provide more utility insights about the platform, providing more validity for the selected platform (see Chapters 3.3.1 & 4.1), its features (Chapter 4) and other evaluation methods in Chapters 5.2 and 5.3. In the present study, the quantitative data collection was the performance evaluation using Google Analytics (see Chapter 4.2). The quantitative method was supported with empirical usability heuristics and interviews, as all these methods supported the DSR principles (see Chapter 3.1) of rigorously evaluating the solution for the specific business issue. In order to receive feedback about the use of the platform, interviews were conducted with micro-enterprises (or ex-micro-enterprises) that had experience with the platform in their business and those that saw opportunities in the platform to grow their business.

The interviewee group was put together from Valfi's customer base, having characteristics of the player-level stakeholders in the power-interest grid (see Ackermann & Eden, 2011). The selected interviewees appeared to be sufficiently presenting a satisfactory group providing their insights to the current study conducted with the DSR approach (see Chapter 3.1). This group was selected by respecting the requirements that are presented in Chapter 4.1. The business environment that is described in 3.4 provided the frame to choose interviewees, presenting mostly micro-enterprises using the open-source WordPress platform.

The purpose of the interviews was to reflect the experiences of the business utilising the platform. Moreover, the purpose was to get support for the necessity to use the platform in the daily operation of the businesses. The interviews were conducted remotely in the summer and autumn of 2020 using video and teleconferencing. Recording tools were used in the talks to extract insights from the calls.

In the current study, the appreciative interview method was chosen as the interview approach (see Chapter 3.3.3). This created a positive and forward-looking situation for the interviewees by forming an understanding about the current situation and the business development opportunities using the platform. During the interviews, in the summer of 2020, it was also taken into account that the coronavirus epidemic had had a significant impact on the prospects of many companies, reducing the potential willingness and resources available to develop new information systems or make other investments.

Seven of the interviewees had business in Finland and one in the neighbour country Estonia. All the interviewees had expertise utilising the WordPress platform in their business, and they were also customers of Valfi, presenting a satisfactory view about the firm regarding the study's organisational environment. The determined quantity of interviewees was found sufficient, as the interviews were only supporting other evaluation methods in Chapters 5.2 and 5.3, being lower in significance. Some of the companies interviewed had been micro-enterprises in the past but had grown out later. All of the companies had had the WordPress platform in place at some point in their business. The utilised features in the WordPress platform varied; some used e-commerce through WooCommerce, some had e-commerce and ERP platform integration done and some simply had a WordPress-powered website with a contact form receiving quotation requests. The interviewer was the researcher of the present study.

About half of the companies had a development project underway, or were planning for the development of the WooCommerce e-commerce and ERP platform. Table 10 presents the demographic characteristics of the entrepreneur interviewees.



**Table 10. Interviewee characteristics.**

Characteristic/interviewee number	1.	2.	3.	4.	5.	6.	7.	8.
<i>Business was still at a micro-enterprise level</i>			x	x	x	x	x	x
<i>Business had grown out of micro-enterprise level</i>	x	x						
<i>Used the WordPress platform for business</i>	x	x	x	x	x	x	x	x
<i>Used the WordPress platform with WooCommerce</i>	x	x	x	x				x
<i>Had customised the platform for their needs</i>	x	x	x	x	x	x	x	x
<i>Had employees</i>	x	x	x		x		x	
<i>Years of operation &gt; 5</i>	x	x		x				x

The following questions were used in the semi-structured appreciative interview setting (see Table 3) with the users utilising the platform in their business. The following topics were discussed briefly and openly with the interviewees. All the discussions were conducted in Finnish.

The questions included:

1. *What kind of vision and strategy do you have for business growth?*
2. *Do you have business growth processes, what are they?*
3. *How is the business process digitalisation done?*
4. *What kind of characteristics are needed from the entrepreneur to succeed in digital transformation?*
5. *What e-commerce tools do you use on your website to generate cash flow?*
6. *How could you improve your e-commerce and ERP to grow your business?*
7. *Do you see any challenges in e-commerce and ERP combination?*
8. *What are the most crucial factors in e-commerce and ERP success?*

The knowledge base (see Chapter 2) provided the primary foundation for the questions, as the discussion topics varied from business growth, digitalisation, e-commerce and ERP presented in the earlier knowledge. Moreover, the DSR business environment (see Chapter 3.4) called for answers to these questions.

The interview setting was semi-structured, as this is a common approach in empirical software engineering interviews (see Hove & Anda, 2005). The interviewer had questions in mind, but these were extended with follow-up questions and open and appreciative discussion. The first question was related to defining the strategy and vision regarding digital business goals the company had and how they were defined. The second question sought to clarify the essential

digital processes used in the company, such as the sales or logistics processes. The third question focused on the automisation of the business processes through digitalisation, which sought to identify the tools to automate the essential business processes through the platform.

The fourth question focused on the qualities and abilities of the micro-enterprise as a leader in the digital business development field. The fifth question was derived from the fourth question, mapping the tools that mostly affected cash flow, originating, for example, from the invoicing system and sales generation tools (see Chapter 4.2). The sixth question regarded the potential of e-commerce and ERP platforms through business growth. The seventh question identified the potential challenges and adversities in the combined e-commerce and the ERP platform. The eighth question identified the key factors regarding the combined platform. The interviews were also supported with the insights and documentations that Valfi had in its archives, for example, regarding the characteristics of the companies that used the platform historically.

#### ***5.4.2 Interview insights***

For each interviewee, the average duration of the interview was about 22–45 minutes. The interviews were done in 2020 using remote connections. The brief descriptions about the interviews and their relations to the platform are described as follows:

##### ***Interviewee 1***

Interviewee 1 had earlier ran a micro-enterprise. The firm had been utilising the WordPress platform with WooCommerce in their marketing and operations. It had been using it mainly when delivering the services, almost since the beginning of the company. The company had grown rapidly in the recent years. When the company had been at the micro level, WordPress had also been utilised, but without the WooCommerce e-commerce plugin. In the early stages of the company, WordPress had been used in the company's website.

When the company had started to grow, the WooCommerce e-commerce platform had been utilised on a separate web site. The company had a separate ERP system integrated into the WooCommerce platform, enabling order synchronisation for invoicing. The company defined strong commitment, entrepreneurship and

problem-solving attitude as their central success factors. In their IS development, proper delegation and competent partners were found essential in business growth.

### *Interviewee 2*

Interviewee 2 also had a long history with the platform, almost since the company was started. The company offered its customers both products and services. Although the company had grown out of the micro-level, WordPress had been used in the company when it was on the micro-level. The development of the platform was similar to that of Interviewee 1's as the company scaled its business bigger. First, the firm started using WordPress for a company's website. Then, e-commerce features were added to the business. The WooCommerce plugin was installed to the website, which enabled the sales of the company's main product supplies to the customers. The company had a separate ERP system in place. When developing their business processes, the company had paid attention especially to the sales and production process. These processes could be supported with ERP that the company had utilised separately from the WordPress platform.

The company indicated transparent and mature processes as their essential growth drivers. The firm wanted to do much as possible by themselves; from manufacturing to logistics and maintenance. Controlling the strategy and sustainably managing the growth was essential for growth in the firm. The interviewee also underscored the importance of the HR process and finding the right people to work with.

### *Interviewee 3*

Interviewee 3 had started their business about one year before the interview. In the early stages of the business, both WordPress and WooCommerce had been deployed. The company offered its customers services that were sold through the WordPress platform using the WooCommerce plugin. WooCommerce was customised extensively, for example, to provide enhanced product editing features and customer lists. Although the firm's customers were able to pay for their purchases through WooCommerce, there was also an ordering option whereby the customer placed an order through WooCommerce and the seller provided the invoicing through their separate invoicing and ERP system.

The firm had operated for about one year but had gone directly to e-commerce from their start. However, multiple other sales channels were used as well, such as

quotation requests from the WordPress website. The WordPress platform and e-commerce store had been translated into two languages on the same platform. The company underscored the importance of good personal and customer relationships in their strategy.

#### *Interviewee 4*

Interviewee 4 had started his business several years ago. He used WordPress both in his own business and in the business of his clients. WordPress was mainly used to receive requests for quotations and to communicate, but WooCommerce had also been tested. The business was offering mainly consulting services for other companies, in which the WordPress platform was used along with other information systems. This company saw the importance of integrations across the different systems.

#### *Interviewee 5*

Interviewee 5 used WordPress as their website platform, offering professional services. The company also had experience using WooCommerce. On the WordPress platform, the company tried to accumulate as many contacts as possible. The company hoped that WordPress would evolve in a direction in which more automated tools could be brought to the platform to help with marketing and search engine visibility by extending the length of sessions. The potential ERP features could have related to marketing and automating content publishing based on the users and their behaviour.

The company had a large growth appetite. It also indicated numeric goals for business growth. The firm was well networked with other professionals and freelancers. It also underscored the importance of effective 'call to action' processes and social media marketing in their operations.

#### *Interviewee 6*

Interviewee 6 worked for a micro-enterprise that provided expert services to other companies. He also had experience working in his micro-enterprise. The WordPress platform was used as the platform for the company's website and an application was also developed for it to provide virtual and experiential presentations. The company was newly established and sought a form of operation. Much of the

company's web strategy was based on an open-source infrastructure. The potential ERP features that the firm wished for could have been related to information management and arranging customer data visually.

#### *Interviewee 7*

Interviewee 7 had started the business activity in a physical store. In the beginning, in addition to the business, the company had only a WordPress-based website. Later, the company had expanded the site to an online store by implementing the WooCommerce plugin. Currently, the WooCommerce plugin in use did not utilise specific customisations. However, logistics and invoicing required much work and automating; these were seen as the next logical steps. Moreover, ERP development seemed practical in terms of invoicing and logistics features, helping to automatise the firm's daily work. Further, B2B sales could have gained efficiency from the better invoicing features that could be part of potential ERP features in the future.

#### *Interviewee 8*

Interviewee 8 had worked as a part-time worker in her company alongside other jobs. Her business was a fashion and apparel related webstore. For this industry, WordPress and the e-commerce plugin WooCommerce were good selections as they provided both a sales channel and product catalogue, providing high-quality images and detailed information about products. Although the business operations were small in scale, the company dreamed of growth in e-commerce globally. The company also had done marketing at trade shows, events and pop-up shops, but saw online marketing as the most effective form of all. The company saw a need for ERP features in the future.

#### *Concluding remarks about the interviews*

The interviews indicated that simplified digital platforms could help grow the business. The interviewees that had grown out from the micro-enterprise level all had more clearly defined strategies and business processes compared to micro-level companies that had not achieved significant growth. The companies that had grown out also had more precise growth strategies and mentalities. The same open-source WordPress platform infrastructure had been following the companies through different stages of their business, from start-up to micro-enterprise level and finally

growing business operations with more customised e-commerce and ERP features. The concluding remarks from the interviews are summarised as following. Table 11 indicates concluded remarks from the interviews based on the questions.

**Table 11. Concluding remarks from the interviews.**

Question	Concluding remarks
1. What kind of vision and strategy do you have for business growth?	The companies had growth targets where the digital platforms and other digital tools played essential roles. However, only a few of the interviewees indicated euro-denominated goals for the periods of about 3–5 years. The companies that had the most precise strategies had mostly grown out from the micro-level (interviewees 1–2).
2. Do you have business growth processes, what are they?	About 1/3 of the respondents indicated that they have some business processes. The most common and essential business process was the sales process. After that indication, the production process also emerged from the answers. All the firms that had grown out from the micro-enterprise level had business processes.
3. How is the business process digitalisation done?	Almost all the interviewees called digital business processes that could be automatised better and simpler. Many of the respondents complained that the process automatisation had remained more or less complete in their business. About half of the interviewees stated that some degree of automatisation had been done. The automatisation was achieved e.g., by utilising invoicing and order related features.
4. What kind of characteristics are needed from the entrepreneur to succeed in digital transformation?	Almost every respondent indicated that a strong commitment and interest is essential to adopt new digital tools for their business models. The firm has to be committed and ready to act for digital change. Moreover, success in recruitment and partnerships also became an essential factor enabling the business digitalisation.
5. What e-commerce tools do you use in your website to generate cash flow?	In addition to the website, most of the interviewees reported using active marketing work by utilising customer-oriented tools, video, social media and e-commerce features. The roles of social media tools and interesting content became an essential factor in e-commerce using the WordPress platform.

Question	Concluding remarks
6. How could you improve your e-commerce and ERP to grow your business?	The interviewees called seamless and simple platforms. The interviewees raised the issue of the complexity of several separate systems and the fact that they may not integrate with each other. Some of the companies had introduced, for example, the use of financial management and e-commerce, or it was under construction. The majority of the interviewees called for simple digital platforms that could help them to manage and grow their business.
7. Do you see any challenges in e-commerce and ERP combination?	Some respondents saw the use of separate systems as a problem, where data had to be recorded in two systems at the same time. The import of technological know-how within the company also came up. The majority of the interviewees did not answer the question as they had not yet deployed ERP-related features, but this was under consideration.
8. What are the most crucial factors in e-commerce and ERP success?	The essential features were related to simplicity, commitment to adopt new tools, ease of use and marketing-oriented activities.

Some of the results from the interviews were limited as some of the interviewees did not fully understand or did not answer all the questions. The ERP related questions especially were lacking insights from interviewees 4–8 due to their small size. In Question 1, the interviewees were asked about their strategies and visions for their business. Half of the interviewees had quantified goals over several years. Firms with targets were larger than smaller firms with no clear targets. Still, many of the interviewees were missing strategies and visions. One interviewee underscored flexibility and going ‘with the flow’ over the clearly planned visions:

*The vision we planned when finding the company didn't work out at all. The operation got off to a fast start, changing all the plans. ... The prevailing coronavirus situation, of course, put all our plans to reconsideration. ... However, we believe that we will survive because we have entrepreneurial employees. ... You have to go with the flow and make decisions accordingly. Our company has a wide range of skilled entrepreneurs doing the great work.*  
(Interviewee 3)

Question 2 asked about the business processes, for which at least the sales process was raised by almost everyone. The importance of creating processes was found important in the company’s operations, which most interviewees considered as an

essential factor. One successful interviewee, being a micro-enterprise, earlier described their growth processes as the following:

*We want to keep the processes in our own hands as much as possible. ... The whole sales process must be mature enough. ... We make a great use of our video in customer acquisition. ... The most important thing is to find a correct state of mind that helps with digital solutions adoption. (Interviewee 2)*

The companies that had grown out from the micro-enterprise level underscored the importance of pre-defined processes and strategies. Question 3 addressed the digitisation of the processes described in Question 2. Slightly less than half of the respondents named automated and electronic tools that could be used to automate the firm's processes.

However, almost all the respondents were willing to start using digital tools to reduce HR costs. Question 4 addressed the personal characteristics of the entrepreneurs as enablers of growth and digitalisation. About one-third of respondents mentioned commitment and success in customer and staff relationships as essential factors for a successful business, as well as the delegation of tasks and areas of expertise. One respondent indicated that when selling expensive items, such as high-quality apparel, supply chain communication played a central role in success.

*If you want to sell expensive goods, the production process is playing a central role. ... Written instructions should be given to the supply chain contractors to ensure quality. (Interviewee 8)*

Several interviewees also highlighted the importance of interest and motivation to acquire new technology. Question 5 identified essential tools for cash flow collection in e-commerce and e-sales. Active sales work was seen as a vital factor for sales. Its automatisation was perceived as challenging, as the needs of corporate customers, in particular, were seen to change significantly on a customer-by-customer basis. For those involved in consumer trade (B2C), the use of social media tools was highlighted as an essential factor. Utilising video also was an important tool in both corporate (B2B) and consumer (B2C) sales. Tailoring a sales funnel to customers' needs also was crucial:

*A sale process usually starts from a social media site. ... Handling B2B companies also is important and requires special expertise. (Interviewee 7)*



Question 6 highlighted the importance of integrability in ERP and e-commerce. Multiple separate systems or applications seemed problematic, such as trying to integrate financial management systems and accounting reports. Some companies had introduced an ERP system and WooCommerce integration, which was facilitating the sales process: a work order came through WooCommerce, from which it automatically went to a separate financial management system without dual manual input in both systems. However, the combination of e-commerce and ERP was only at the planning stage for the interviewees, or it was entirely missing. The interviews discussed future opportunities in those cases.

Question 7 focused on the challenges of ERP and e-commerce implementations. The integrability of the different systems was challenging, requiring the same information to be duplicated in many other systems. The multiple respondents identified the diverse and changing needs of corporate customers as a problem. The interviewees representing the largest businesses felt that bringing technological know-how into everyday corporate culture was a challenge. The customers' preferences were also changing rapidly, and the seller's preparation was indicated, for example, as follows:

*When we are developing new technologies, everything depends a lot about our customer base. ... The customers may no longer need a facial contact. We always want to offer the best possible service. If the customer feels that they are getting the best service through digitalisation and e-commerce, we are ready to take the necessary steps developing it further. (Interviewee 1)*

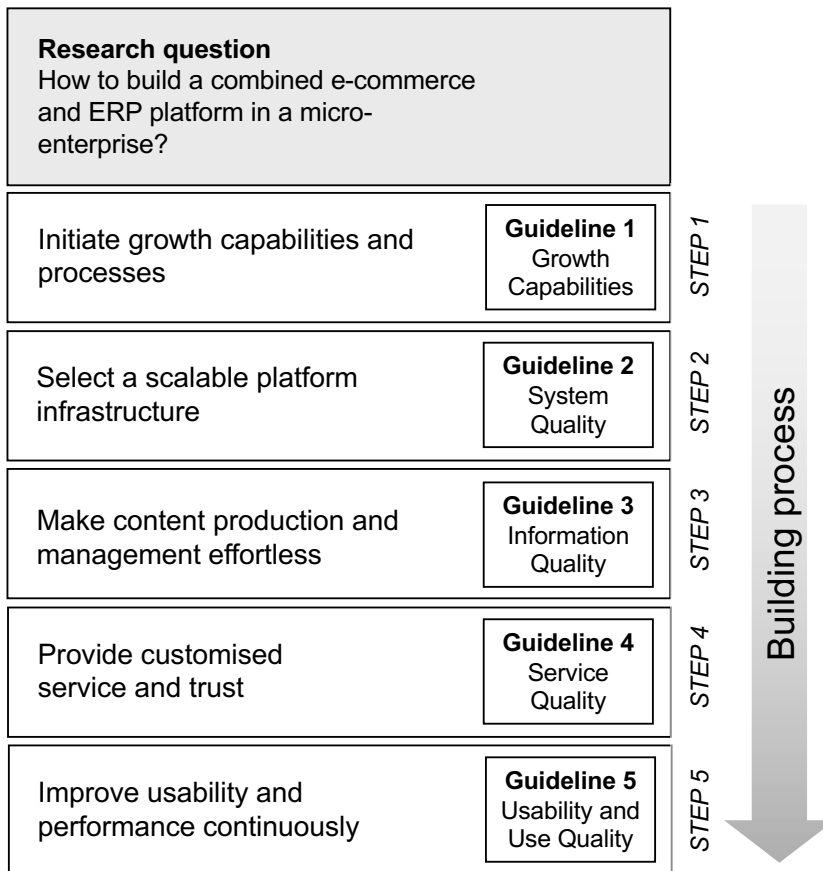
When answering Question 8, the respondents mentioned the critical factors regarding the integration of ERP systems and e-commerce. The crucial factors were, for example, the success of the sales process through the new platform and its ease of implementation and speeding up and automating the company's sales process, which also was considered essential to bring new cash flow, as highlighted in Question 5.

As shown in Table 11, there was a lot of variation in the interviewee responses based on their industries, company sizes and backgrounds. Still, the common factors can be summed up. From the best performers, the common factor seemed to be pre-defined strategies, business processes, commitment and simple digital platforms supporting growth efforts. Here is one example from the interviewees about essential growth-related factors:

*It is simply a matter of persistence. ... A complete dedication for doing is crucial, there has not been an option that we would not succeed. ... For example, in the coronavirus crisis, the first two days I was completely lost and feeling down. But after those days, the solution-oriented thinking began and every decision took the firm further. We started engaging video meetings with customers and other digital tools ... I want to change the industry (where I am operating) and leave a mark in this world. (Interviewee 1)*

## 6 Findings

This Chapter presents the findings of the current study as the building guidelines and process to use them. If a micro-enterprise would like to build a combined e-commerce and ERP platform to support its growth, it should follow the five guidelines presented in Figure 50.



**Fig. 50. The guidelines and process answering the research question.**

Described in more detail, Chapter 6.1 presents the guidelines to build the platform and Chapter 6.2 indicates the process of using them in the right order.

## 6.1 Building guidelines for the platform

Table 12 shows the main research findings as building guidelines for the combined e-commerce and ERP platform. Guidelines 1–5 are presented in chronological order. First is initiating the firm’s growth capabilities and processes, and after that, continuing with the platform infrastructure selection. Table 12 elaborates the guidelines with more detailed descriptions.

**Table 12. Guidelines to construct the combined e-commerce and ERP platform.**

Guideline	Description
<b>Guideline 1</b> Initiate growth capabilities and processes (Growth Capabilities)	Focus defining the business processes clearly before the major e-commerce and ERP developments. Take reasonable risks, learn technology and be willing to invest time and leadership into the new platform. Define manual tasks to be automatized and create your platform-driven digital business model.
<b>Guideline 2</b> Select a scalable platform infrastructure (System Quality)	Define first the strategy and business processes with allocated resources. Then, select a scalable platform such as WordPress that has an active open-source development community and capacity to grow with your business.
<b>Guideline 3</b> Make content production and management effortless (Information Quality)	Manage invoicing, sales and marketing to achieve a constant cash flow. Extend content creation and publishing features, such as using videos or other embedded social media content to be linked to product information for marketability and quality.
<b>Guideline 4</b> Provide customised service and trust (Service Quality)	Customise the platform to support specific e-commerce models. Manage security and ensure the safety and reliability of the platform. Utilise the ready-made automatic functionality and build extended features (ERP).
<b>Guideline 5</b> Improve usability and performance continuously (Usability and Use Quality)	Use and combine multiple active measuring methods such as Google Analytics, heuristics and customer interviews to ensure constantly evolving usability and user satisfaction. Follow-up with changes to the platform. Pay attention to load speed and usability, especially on mobile devices.

The quantity of guidelines, five, was influenced by the elements of the IS success model (see DeLone & McLean, 2003) and the five stages of small business growth (see Lewis & Churchill, 1983). However, the first guideline, Growth Capabilities,

was brought to the IS success model completely independently of the original IS success model to supplement it in the micro-enterprise setting and research environment (see Chapter 3.4). Guidelines 2–5, influenced by the IS success model (see DeLone & McLean, 2003), provide summarised instructions to guide the construction of the combined e-commerce and ERP platform in the micro-enterprise environment.

### *Guideline 1—Initiate firm’s growth capabilities and processes*

In the current study, pre-defined business requirements and processes helped build the platform (see Chapter 4). Further, the interviews (see Chapter 5.4) highlighted the importance of processes and technological interest in making development leaps respecting customers and others, as well as utilising remote meetings and social media marketing skills, such as video.

A firm starting to develop the combined e-commerce and ERP platform should have knowledge and understanding of the company’s digital vision and strategy. The interviews revealed that many companies did not have significant pre-defined business processes. However, the interviewees who had some level of pre-defined processes and strategies had achieved business growth. Moreover, many of the interviewees saw it as important to listen to the preferences of their customers when constructing a digital business model. The current study also revealed that firm commitment, entrepreneurial spirit and pre-defined processes, such as sales process, were essential in growth along with the combined e-commerce and ERP platform.

Business growth should be supported with a simple and reliable digital platform that helps the micro-enterprise to grow its business. This platform supports the micro-enterprise in several ways, for example, by automatising processes, providing stable cash flow and keeping the management stable during the growth efforts. The platform is easy to use and customise, preferably by the micro-enterprise administrators themselves.

The combined e-commerce and ERP platform of the study reduced complexity in micro-enterprises. For example, without a suitable platform, growing complexity in the e-commerce and ERP environment in a growing company could mean that the firm would get overloaded with information from growing orders, customer requests, financials and management. When this situation becomes mixed with incompatible information systems, data processing requirements and low budgets to invest in IT systems, the result could be stagnation of growth, missed sales, inadequate data protection and low profitability of the firm.

The interviews indicated that firms growing out from micro-enterprise size had clearer strategies and business processes compared to firms still at the micro-level. The interviews also highlighted the importance of processes and technological interest in making development leaps, respecting customers and others, as well as utilising remote meetings and social media marketing skills, such as video. The current study showed that the ERP features were possible to achieve with a certain level of technical understanding of web development and learning the material, utilising the open-source support and community pages. The entrepreneur-users could potentially learn from the open training resources, such as the WordPress Plugin Handbook (see Chapter 3.3.1), covering the basics of installing, using and customising the platform with the plugins without the need to hire any external contractors.

The interviews called attention to the importance of adopting new technology, such as automated sales processes, utilising video features and social media sales channels. In the platform, the marketing and content functions, in terms of information quality, made a contribution to sales, leading to improved cash flow. The results from the interviews were also mixed in terms of business progress. The gap appeared to be quite significant between the micro-enterprises and larger SMEs. The biggest difference that divided the interviewees seemed to be confidence and business planning.

The interviewees whose companies were the largest among the respondents had clearer visions and long-term goals, while the smaller micro-enterprises were mostly conducting business on a day-to-day basis. The interviewees who had achieved growth underscored the importance of the entrepreneurial mindset and balanced growth. Moreover, having essential business processes, such as sales and logistics, under control seemed necessary. However, many of the interviewees realised they did not have pre-defined processes. They underscored the need to identify the processes in more detail so they could later start implementing the e-commerce and ERP solutions to grow the business.

### *Guideline 2—Select a scalable platform infrastructure*

The present study showed that a combined e-commerce and ERP platform could be built through the use of the scalable open-source platform WordPress with the WooCommerce e-commerce plugin (Chapters 4.1–4.3), taking into account the definitions and limitations of micro-enterprises (Chapter 2). This approach meant that the platform had to be built at low cost and flexibly. In the current study, the

low cost was achieved by utilising the open-source infrastructure as the basis for the platform architecture (Chapter 2.5), which was reasonably easy to customise due to the extensive documentation and active support provided by the open-source community.

Because the platform in the current study was for micro-level companies, it had to be technically simple, scalable and easy to customise. The company could develop the platform by itself through the use of WordPress online documentation, ready-made built-in functions and open-source communities' learning resources.

The interviews also called for entrepreneurs to utilise the advantages of new platform technologies, also accepting the technological preferences of their end customers (see Chapter 5.4.2). However, the open-source platform WordPress offered a relatively low-risk alternative in e-commerce and ERP platform development. It seemed possible for the micro-enterprise to gain knowledge from the documentations provided by open-source communities in order to develop the platform itself or to acquire platform implementation services from other WordPress experts.

When constructing the platform itself, in a possible failure scenario, perhaps the most significant loss would be just the time spent on the platform's learning and development process. Even though the aim of the current study was to discover the guidelines and process of constructing the platform without external help, the external developer expertise was also available in technical development (see Chapter 3.3.1).

The building and customisation of the ERP features was found achievable with a certain level of technical understanding in web development and learning the material, utilising the open-source community support and community pages. The entrepreneur-users could potentially learn from the open training resources, such as the WordPress Plugin Handbook (see Chapter 3.3.1), covering the basics of installing, using and customising the platform with the plugins without the need to hire external contractors.

### *Guideline 3—Make content production and management effortless*

It was possible to integrate the video features into the open-source platform through a separate cloud service such as Vimeo. In the interviews, the importance of video also was noted as a confidence builder in promotion and when meeting new customers. In the construction phase, the 360° VR type video was found easy to integrate with the platform, bringing potential interest and added value to the

platform's information content, such as immersive product presentations. However, one of the challenges involved in producing 360° VR video content was the special camera equipment necessary to create it.

The platform took advantage of the ability to embed video in the current solution's product information, which made it possible to incorporate experiential 360° video content with reasonable effort into the product information. This video worked on both mobile and desktop browsers in addition to text and image product information. Registered users also had the opportunity to view their events and payment status and also pay for their subscriptions in arrears. The interviews revealed the importance of video, especially in marketing and social media, in bringing new traffic to the site and serving customers. The current study's platform offered a responsive and user-friendly interface to create new content.

Using video was found an essential way to improve information quality on the platform. The interviews also elaborated the importance of interesting content and story to accelerate marketing on the platform.

#### *Guideline 4—Provide customised service and trust*

In terms of the platform maintenance, of all web-based content management systems (CMS) platforms, WordPress had the worst history with security issues and vulnerabilities (see Chapter 2.8). The WordPress core infrastructure being separated from plugins and themes also provided additional stability for the platform (see Figure 26). Automated updates helped to manage the security without extensive effort. Due to the WordPress platform's popularity on the web, the interest of attackers towards the platform is understandable. The platform's security issues were mitigated partly by Cloudflare (see Figure 40) providing comprehensive protection by routing domain name servers through them. It implemented, for example, anti-denial of service attacks, maintaining a CDN network, an encrypted HTTPS connection, anti-password guessing attacks on the login page and custom rules made for the site.

The invoicing feature was a customised feature on the platform that helped the micro-enterprise to manage sales and continuous cash flow (see Chapter 4.2) on the platform. This also supported business growth with the platform. As the platform combined both e-commerce and ERP features, there was no need to have a separate invoicing system for the business as the combined platform handled both e-commerce sales and invoicing. In terms of service quality, the platform could be quickly and effortlessly customised for the company's operations without extensive



programming skills. This was accomplished by utilising the built-in PHP functions in WordPress, such as *add\_post\_type* and *add\_meta\_box* (see Chapter 4.2).

A comprehensive WordPress support site and documentation were found useful when utilising PHP functions, as well as significant amounts of material from their Plugin Handbook and the open-source community (see Chapter 3.3.1). In the ERP system, the customisation was done while respecting both the micro-enterprises' business customers (B2B) and consumer customers (B2C). Several different payment options were built into the platform to achieve better service quality in both customer segments.

In the platform, the users of the system were mainly administrators (micro-enterprises) and e-commerce customers (B2B & B2C). For the administrators, the technical service was provided primarily by the WordPress platform's comprehensive online documentation and open-source community, which seemed to actively provide updates, extensions and documentation for the use and development of the platform.

Support was also available from several discussion forums, YouTube and other open channels. For the e-commerce customer, the support was mainly provided by the micro-enterprise, who understood the platform and were able to guide buyers in its use. In the current study, the construction was conducted by Finnish software company Valfi, who also provided support to micro-enterprises using the platform.

Considering various micro-enterprise customers using the platform, the ERP invoicing feature (see Chapter 4.2.4) monitored the payments of the B2B customers who paid their orders using the invoice with the payment reference number. The email automation and PDF-feature also played a significant role in the ERP features, sending, for example, payment reminders to the customers. The platform used PHP mail and SMTP functions and services to send invoices.

### *Guideline 5—Improve usability and performance continuously*

The usability analysis conducted within heuristics provided iterative insights about the platform's user interface and experience, respective to the organisational environment and requirements defined for the platform. The usability was addressed, especially with the mobile-first approach that indicated satisfactory usability on mobile devices through the use of the responsive design in the interface (see Figure 38). Heuristics appeared to be a suitable way to iteratively improve the platform's usability continuously, as easy customisability of the platform allowed

making quick changes to the platform's user interface through the use of theme and plugin update function (see Figure 26) and built-in PHP functions.

The platform's performance was evaluated with an automated method through the use of the Google Analytics (GA) tool, accompanied with heuristic usability analysis by specialists. The construction and evaluation in the current study proposed that the mobile usability in the platform could be achieved quite well using the default responsive design of the platform. The administrator interface could be customised through the use of the predefined functions such as *remove\_meta\_box* to hide the unnecessary content from the admin, providing a more minimalist and aesthetically pleasing user experience.

In order to discover usability aspects, the evaluation of the platform was done using the multiple methods of the GA performance testing, usability analysis and interviews. In the GA evaluation, the data was obtained automatically from the platform that had been used by a micro-enterprise customer in a real business setting. The data had been collected about the e-commerce end-customers visiting the platform, including detailed but anonymous information such as the browser of the visiting user, pages browsed, the download speeds of various pages and other metrics that affected the use and usability of the e-commerce system.

The performance indicators, such as page loading times and sessions from the GA evaluation also indicated that the platform's performance was acceptably comparable to other e-commerce site averages (see Chapter 3.3.2). Even though GA was used in the performance evaluation of the platform, it also was found to be a practical tool to be constantly used in the platform optimisation.

After the construction, the evaluations were conducted. A primary method for evaluation in the scope of the present study was an automated performance metering using GA. For example, the GA evaluation showed that on mobile devices, time spent on the platform was lower and the bounce rates were higher compared to those of the desktop-based end-users. These results supported the indication that usability had to be improved, especially for the mobile browsers that were used widely by the end-users in the current study. Compared to e-commerce and industry averages, the performance of the platform seemed satisfactory in terms of loading times, sessions and conversions.

The usability analysis (see Chapter 5.3) revealed that WordPress was ready and usable software in the e-commerce and ERP setting for the defined requirements and use scope. Small customisations, such as changing *metaboxes* (see Chapter 4.4), improved the usability of the platform. The graphical user interface of the platform, both the backend and frontend, could be customised with built-in PHP functions,

for which comprehensive documentation was found on the WordPress online documentation.

The platform construction and evaluations revealed that growth-orientation, motivation to adopt and develop new technology and marketing play crucial roles in platform building. Related risks could be reduced due to the nature of the utilised open-source platform WordPress, which was free to use and utilise for various micro-enterprise business needs. However, some costs originated from the web server fees and third-party cloud services such as Vimeo, which allowed for generating video content to be embedded in the e-commerce product pages. Still, freedom and customisability won over other competitive and commercial SaaS e-commerce platforms, such as Shopify (see Chapter 3.3.1).

## 6.2 Process of building the platform

A process for building the platform originated from the guidelines when they were ordered sequentially (Figure 51). The process aligned the five guidelines as five steps in the micro-enterprise’s platform development sequence.

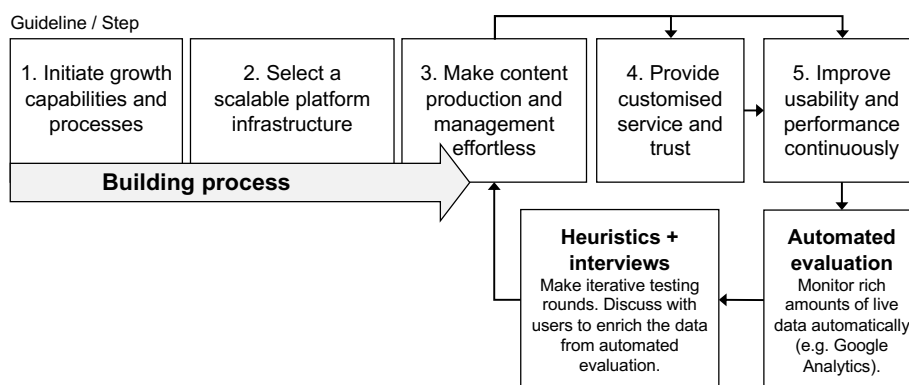


Fig. 51. Platform building process.

The process indicates that the micro-enterprise must first define and implement the capabilities for growth, such as a clear digital strategy and the business processes originating from it. The platform selection and implementation can begin after this step has been initiated (see Chapter 4.1). The platform should support effortless content creation, such as additional content types, extended product descriptions, videos and other ERP features (see Chapter 4.2). Automisation of specific tasks,

such as invoicing, should be addressed. Customisation should make the user experience relevant to the internal users (micro-enterprise administrators) and end-users (customers). Finally, continuous monitoring should be engaged to improve the platform continuously with automated performance evaluation, heuristics and customer feedback (see Chapter 5). This final guideline forms the loop around continuous improvement and growth for the platform, which means measuring the performance and improving content and customisations according to the customer feedback and firm's growth (Figure 51). Two major stages are also indicated in Figure 51: for new enterprises, guidelines 1 and 2 could be initiated at the start-up phase and the final guidelines (3–5) when the company is achieving growth with the platform.

The research process occurred in the present study by building the actual combined e-commerce and ERP platform in Chapter 4. The construction meant developing the platform using the open-source platform WordPress as the backbone infrastructure. Developing the e-commerce and customised ERP features, such as electronic invoicing and marketing, involved installing the other open-source plugins and customising them further. Various features were tested in building iterations to improve the platform's suitability to various micro-enterprise cases. For example, if the visitor data showed issues with various end-user devices, an action to change the platform's user interface was taken (see Chapter 5.2).

The building process could be used as a strategic tool in micro-enterprises' platform and IS development. In practice, micro-enterprises could follow the guidelines in the currently presented order in their digital strategies to achieve successful platform development. Academic audiences and entrepreneurship education institutions, on the other hand, could utilise the process, for example, when planning and visualising new platform-driven start-up ideas.

## 7 Discussion

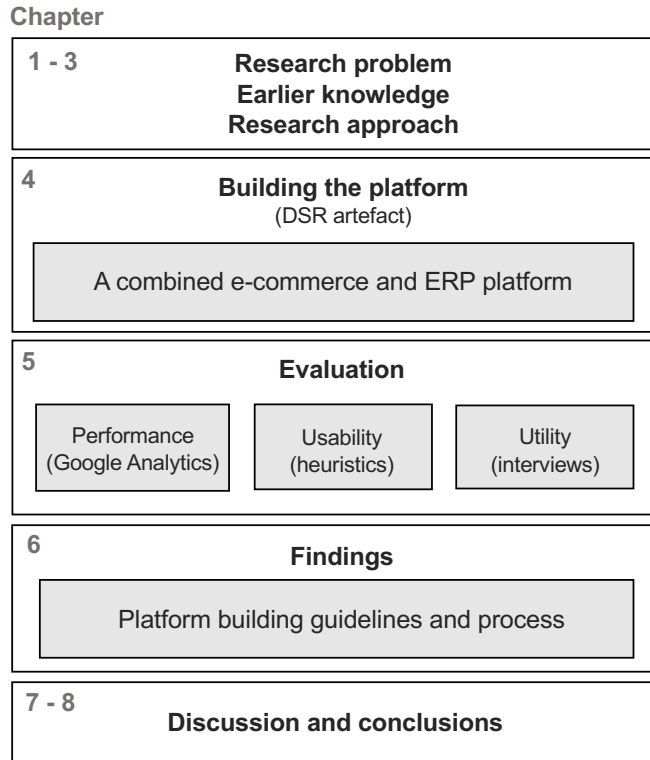
This Chapter discusses the results of the study and relates them to earlier knowledge. It also describes the research on the theoretical, managerial and methodological levels. First, a research overview is presented. Then, the results are viewed through the earlier knowledge, followed by the managerial contributions and methodological implications, validity discussion and limitations. Finally, the future outlook and conclusions are presented.

### 7.1 Research overview

The research problem of the study arose from the insight that firms require suitable systems to support business growth (see Lewis & Churchill, 1983; Kosalge & Ritz, 2015). Moreover, digitalisation and digital platforms are changing business models rapidly in the global economy (Manyika *et al.*, 2016; Nambisan *et al.*, 2018). Design science research is a method that can solve organisational issues with utilisable technical constructions (Hevner *et al.*, 2004).

The present study was conducted in the Finnish software company Valfi, which also engaged its customers in the research by providing the research environment (see Chapter 3.4) for the DSR study. The purpose of the study was to explore the building guidelines and process for the combined e-commerce and ERP platform to help micro-enterprises to achieve growth. The guidelines answered the research question (see Chapter 6).

The research approach explored the existing knowledge (Chapter 2), DSR method (Chapter 3), building of the platform (Chapter 4), evaluation (Chapter 5) and Findings (Chapter 6). Figure 52 presents the overview of the research.



**Fig. 52. Overview of the research.**

The platform building guidelines were developed for the micro-enterprises that had a limited number of available resources, such as investable capital, support and technical expertise (Chapter 2). Organisational environment framed the problem domain in a real business setting (Chapter 3). With these perspectives in mind, the popular open-source software WordPress was chosen as the backbone infrastructure, utilising the scalable and cost-effective platform for development, e-commerce, ERP and customisations (Chapter 4).

Various methods were used to evaluate the platform and indicate the relevance and rigour of the solution (Chapter 5). The purpose of the evaluations was to measure the performance, usability and utility of the platform with respect to the research environment and requirements. Performance was found to be one of the key elements in web applications, interfaces and information systems (Nielsen, 1999; International Organization for Standardization, 2018; DeLone & McLean,

2003). Page loading speed is one of the most important factors in web usability. Loading speeds gives indications about the efficiency of applications that should be respected to offer good user experiences (see Nielsen, 1999; International Organization for Standardization, 2018). The benchmark numbers that were addressed in terms of performance are introduced in Chapter 3.3.2. The performance analysis was supported by the usability analysis and user interviews to address utility, as these also were essential objectives for the study (see Chapters 3.4 & 4.1).

## **7.2 Research contributions**

The current study produced research contributions on the managerial (technical) and theoretical levels. The theoretical contributions are presented in Chapter 7.2.1 and managerial contributions in Chapter 7.2.2.

### **7.2.1 Theoretical contributions**

The main contribution of the current study was the five building guidelines for the combined e-commerce and ERP platform that helps micro-enterprises to grow their business (see Chapter 6.1). From a theoretical viewpoint, the guidelines help not only micro-enterprises, but also future IS researchers and practitioners to understand the temporal process of planning, construction and maintenance of the platform to grow in the rapidly digitalising business environment.

The new theoretical view arose first from the existing knowledge by connecting the IS success model (see DeLone & McLean, 2003), stages of small business growth (see Lewis & Churchill, 1983), ERP development (see Umble *et al.*, 2003), DSR method (see Hevner *et al.*, 2004) and other earlier studies presented in Chapter 2. The existing knowledge was then put through construction and evaluation in a purposefully defined business environment that formed the guidelines and process in the research findings (see Chapter 6).

The process of using the guidelines in the right order was indicated (see Chapter 6.2). The guidelines and the order to use them are presented as:

1. Initiate growth capabilities and processes
2. Select a scalable platform infrastructure
3. Make content production and management effortless
4. Provide customised service and trust
5. Improve usability and performance continuously

The scope of DSR is to provide not only technical contributions but also theoretical methods and concepts back to the knowledge base (see Baskerville *et al.*, 2018). For DSR contributions, it is essential to provide a rigorously evaluated approach towards how the defined problem is solved (see Hevner *et al.*, 2004). The in-depth theoretical contribution of each guideline is presented as follows:

#### *Guideline 1—Initiate growth capabilities and processes*

The findings (see Chapter 6) revealed that the predefined business processes and strategies and the firm's commitment and growth mentalities had to be initiated before starting to build the platform. This result was not only supported by the building process (Chapter 4) but also the interviews (Chapter 5.4), as the companies that had grown out of the micro-enterprise level had more precise business processes and growth strategies compared to the micro-enterprise-level companies. Carneiro (2007) also underscored that new technologies should be combined with decisive processes and mentalities to create sustainable growth. According to earlier studies (see Thong, 1999; Jasra *et al.*, 2011; Gruber *et al.*, 2008), the other growth enablers appeared to be adequate innovative attitude, risk-taking capacity, leadership and decision-making skills and identifying market opportunities.

It is suggested to first to identify whether the company wants to grow, just keep afloat on the market or maintain a comfortable 'lifestyle' business (see Nummela *et al.*, 2005; Weber *et al.*, 2015; Burns & Harrison, 1996) to determine growth progress and development. This indication was also acknowledged in the current study by targeting the guidelines for growth-oriented micro-enterprises as they benefitted more from the platform. The development also was easier with clearer visions. Moreover, integrating technology with the organisation's growth ambitions also supports the competitive growth (see Carneiro, 2007; Street & Meister, 2004; Levy & Powell 1998).



Thong (1999) indicated that an appropriate amount of risk-taking capacity, combined with innovation and knowledge, was vital to success in IS projects where the potential failures could be devastating, particularly for small businesses. Moreover, Kosalge and Ritz (2015) indicated that ERP implementations especially can pose significant business risks and costs. In the current study, the open-source infrastructure in the platform's development potentially reduced the risk of significant failures.

The open-source approach included the idea that the motivated and innovative entrepreneurs would mostly do or manage the construction work themselves by familiarising themselves with the extensive open-source documentation and community resources. In that scenario, the significant risk would have been potentially limited only to the lost time spent on building and testing the platform. Other risks when using the platform could be related to data security, as Kyaw *et al.* (2015) indicated that the WordPress platform may have significant issues with security of passwords. These security-related risks could be possibly mitigated with automatic updates (see Chapter 4.2.2) and cloud services like Cloudflare (see Chapter 4.5).

Umble *et al.* (2003) suggested that the ERP system especially should be supporting the firm's business processes. When building the platform, the business had to have predefined business processes that could be digitalised. Without transparent business processes, such as the sales process, it seemed difficult to start building the digital tools to assist business growth. Marketing and sales skills also seemed essential in business growth based on the interviews. By using the platform, the micro-enterprises could educate themselves in particular about the technological skills necessary to customise and scale the platform by utilising the open-source platform's built-in functions and community resources. Technical competencies were also found to be essential entrepreneurship education elements (Almahry *et al.*, 2018).

The curiosity about technology and a capability to adapt it were emphasised in both the earlier knowledge (see Wymer & Regan, 2005; Choshin & Ghaffari, 2016) and the interviews. Innovativeness and creativity also seemed to be more important than the risk-taking capabilities in entrepreneurial competencies (Al Mamun & Fazal, 2018). According to Mahdikhani and Yazdan (2020), leadership also appeared to be important, especially in terms of service quality in an e-commerce-based business. Leadership and success in HR were also addressed in the interviews.

## *Guideline 2—Select a scalable and flexible platform infrastructure*

Digital platforms are changing the nature of business and transforming traditional business models (see Kraus *et al.*, 2018; Nambisan *et al.*, 2018). Moreover, openly designed platforms can help entrepreneurs with limited resources create new digital opportunities (Nambisan, 2017). To support platformisation in micro-enterprises, the constructed (see Chapter 4) combined e-commerce and ERP platform provided a satisfactory approach to using an open-source infrastructure. This was also supported by the interviews and other evaluation methods in the current study (see Chapter 5). Many of the entrepreneurs indicated to have first started their web presence with a WordPress website, then implemented e-commerce, and then to have considered the combination of e-commerce and ERP, where the platform was built as the business was growing, using the same open-source infrastructure through all these steps.

System quality refers to quality and performance in an information system, including, for example, ease of use, functionality, reliability and integrability associated with the platform (see DeLone & McLean, 2003). According to Iivari (2005), perceived system quality and perceived information quality are essential elements to predict user satisfaction with the system. Moreover, Kuan *et al.* (2005) indicated that perceived system quality plays an essential role in e-commerce customer retention and conversions. Good user experiences also contribute to customer acquisition and retention in e-commerce (DeLone & McLean, 2003; Järveläinen, 2007).

Kosalge and Ritz (2015) indicated that the ERP system should be scalable and seamless, supporting the increasing complexity of a growing enterprise. Based on the current study, the combined platform with respective customisations operated seamlessly with scalable e-commerce and ERP features. Moreover, the platform was easy to use and customise through the use of ready-made functions, responsive design interfaces and customisable content types. The previous studies have proposed that cost and infrastructure are essential factors in e-commerce (see Choshin & Ghaffari, 2016). These were taken into account, with the popular open-source WordPress platform being selected as the platform infrastructure, bringing costs mainly from the web server and maintenance.

A central background for the guidelines was adopted from the IS success model. The IS success model indicates a concept that can help plan IS research or deployments. The model also can help to build a causal understanding of the different variables. (see DeLone & McLean, 2003.) For example, the open-source

platform in the present study allowed the micro-enterprise to customise the system to its own needs. It resulted in good system quality and led to better efficiency in developing the platform further and achieving business growth as a net benefit. The research results are presented through the IS success model in Table 13.

**Table 13. Research results discussed with DeLone and McLean IS success model (2003)**

IS Success principle (see DeLone & McLean, 2003)	Research results originating from the current study
System quality	The selected open-source platform WordPress-WooCommerce provided a scalable infrastructure that addressed usability and reliability concerning the organisational environment in micro-enterprises. The platform adapted to micro-enterprises' needs and it was possible to customise and extend the platform accordingly to the enterprises' growth efforts.
Information quality	The threshold for using, customising and producing and maintaining content on this platform was effortless. The importance of marketing and video, in particular, was perceived as an essential feature for content production in micro-enterprises' marketing efforts.
Service quality	Installing the WordPress platform provided a good foundation for the service quality out-of-the-box. On the other hand, the pre-installed infrastructure also came with many features that confused or drew attention to the wrong points. Security was highlighted as an essential factor in WordPress, as it was facing a lot of malicious hacking attempts because of its popularity on the web as the number one publishing platform.
Usage	The user interface was responsive to the user's device resolution, providing easy navigation and use. For e-commerce, improving the quality of the platform use seemed to lead to improved conversions and retention. As the users seemed to stay longer on the platform on desktop-based devices, it also possibly turned out to be better in conversions.
User satisfaction	User satisfaction was considered a significant factor in the implementation of the platform. It was improved with faster loading times and responsiveness by optimising the platform for greater performance and usability.
Net benefits	The combined platform had to produce value for the micro-enterprise using it, such as increased sales, cash flow and operational efficiency. Although there were large customer-specific differences in sales execution between companies, invoicing process automation especially was providing value in cash flow.

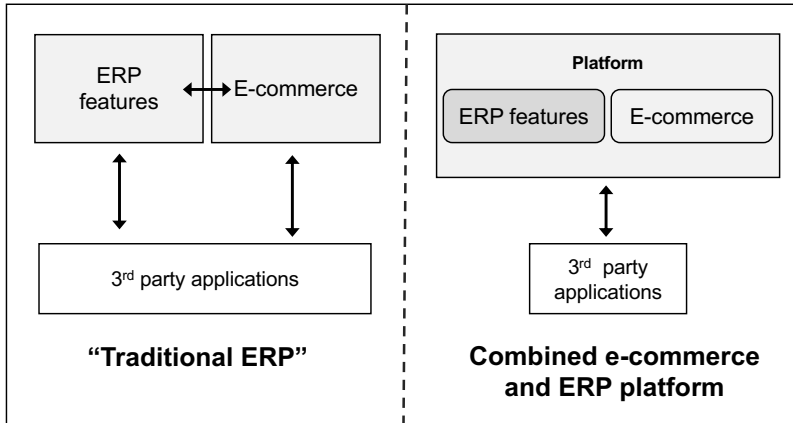
As shown in Table 13, the research results could be possibly adapted with the IS success model and e-commerce perspectives (see DeLone & McLean, 2003). Although the IS success model provided a good starting point for the platform development, the growth capabilities, pre-defined processes and specific needs of micro-enterprises, such as cost-effectiveness and usability on mobile devices, had to be taken into account (see Choshin & Ghaffari, 2016; Al-Ismail & Sajeev, 2014) to achieve growth in a micro-enterprise environment.

Poong *et al.* (2006) pointed out a model for e-commerce definition, stating that the user perspective needs to be concerned with other components. The current study employed a flexible open-source platform, WordPress, with the WooCommerce e-commerce plugin and customisations that enabled various forms of e-commerce for different business models. Various e-commerce definitions for different user cases could be further achieved through the platform, giving freedom to the micro-enterprises with a broad range of business models (see Chapter 4.1).

For example, a traditional shopping cart with a catalogue could fit a retailer selling physical items, such as clothing, parts or food items. A booking system could be used by travel service providers, lawyers, accountants and other service providers selling time as a resource. A simple contact form tool could work for more straightforward services and small volumes, such as selling webinar or event tickets with an unlimited inventory. Abebe (2014) indicated that e-commerce could also bring efficiency to internal processes. On the platform, for example, the custom content types and video features helped with communication and marketing that was also underscored in the interviews.

Trust plays an essential role in the e-commerce business, requiring active security measures and efforts by vendors (Martins *et al.*, 2001). The reliability of WordPress seemed to stem from the fact that the large open-source development community behind the platform was actively involved in the development, also providing automated updates to potential security vulnerabilities. The platform also provided a ready-made REST API interface to be utilised, enabling secure data transfers between the platform and external applications. The e-commerce payment gateways were possible to move to third parties, such as PayPal.

ERP systems have generally been challenging to implement, involving great risks and costs (see Huang & Palvia, 2001; Umble *et al.*, 2003; Kosalge & Ritz, 2015). To reduce complexity in ERP systems, the EAI model is pointed out, offering a single middleware between applications (see Lee *et al.*, 2003). The combined e-commerce and ERP platform, built using the WordPress open-source infrastructure, could act similarly to the EAI model, as indicated in Figure 53.



**Fig. 53. Benefits of a combined platform, connected to EAI approach (see Lee *et al.*, 2003).**

As seen in Figure 53, the combined e-commerce and ERP platform could bring simplicity to micro-enterprises' IS development. In the combined ERP and e-commerce setup, the platform would not need to do separate integrations between multiple systems, such as separate websites, e-commerce and ERP systems, being instead one single combined system. Along with this, handing various external tasks to third-party applications could be achieved through REST API (see Chapter 4.2.6). Seamless ERP structure also was suggested by Kosalge and Ritz (2015). In general, platformisation can help to tackle the issues with various unintegrated and rigid information systems as it can create unified central layers that streamline the communication between various systems, services and data sources (see Bygstad & Hanseth, 2018).

For the current study, the required functionality, such as ERP features, was possible to develop using the built-in PHP functions in WordPress without need to construct those functionalities from scratch. One of the most essential features that the ERP functions included was the automated invoicing system (see Chapter 4.2.4), which was built to improve cash flow in the micro-enterprise. The importance of cash was presented in various small-business-related studies (see Cantamessa *et al.*, 2018; Lewis & Churchill, 1983; Burns & Harrison, 1996). Increased capital is also connected to one of the main growth dimensions (Carneiro, 2007).

Phan and Vogel (2010) indicated that the CRM system could bring customers customised services. A similar concept was also present on the platform, as it enabled the user management system out-of-the-box. This kind of user system

could be extended further to a full CRM system with custom development. For example, the micro-enterprise could follow the actions of their customer base, keep the clients informed and generate more sales through the use of the CRM as a part of the ERP web-based ERP system. The CRM system was possible to deploy on top of the WordPress-WooCommerce customer registry in the same MySQL database that the platform used to run the system.

### *Guideline 3—Make content production and management effortless*

According to DeLone and McLean (2003), the quality of information refers to the output coming out of an information system. In e-commerce, the quality of content is essential for both the customer and the administrator of the information system. The customer wants to receive product information to support the purchase decision and possibly also find information about previous orders and their information on the platform. The use of customised video content on the platform was described in Chapter 4.3. The interviews also indicated the importance of video on the platform, marketing and customer interactions. In earlier studies, the exploitation of mobile video was also connected to purchasing behaviour (see Alamäki *et al.*, 2019). Still, the current study found much broader utilisations for video, such as using 360° VR product presentations and support with the platform (see Chapter 4.3).

As Iivari (2005) proposed, perceived information quality is seen as predicting user satisfaction with the system. The interviews (see Chapter 5.4) elaborated the importance of interesting content and stories to accelerate marketing on the platform. Using video was found to be an important way to improve information quality on the platform. Moreover, the custom post type functions on the platform enabled a creative way to create different content (see Chapter 4.2.3). For example, the developer of the platform was capable of creating new content types for communication and marketing.

### *Guideline 4—Provide customised service and trust*

A service quality dimension in IS can be seen as representing a tangible up-to-date system along with responsive and reliable service that the user receives when using the IS (see DeLone & McLean, 2003). To provide trust and reliability, the platform was installed on the web server that was separated from the payment channels through separate plugins, thereby reducing complexity and risks related to the

payments. Outsourcing payments to third-party operators may improve trust in e-commerce (see Lanford & Hübscher, 2004). Trust was indicated by recognising possible threats on the platform (see Chapter 4.5) and utilising strong precautionary actions, such as automated updates (see Figure 26) and Cloudflare firewall (see Figure 40). PKI infrastructure was used in the invoicing feature to secure bank connections.

Stockdale and Sanding (2006) suggested recognising multiple specific groups for e-commerce rather than claiming e-commerce adopters to be one monolithic group. It was possible to use the platform in various business models (see Chapter 4.1). The flexibility came from the open-source WordPress platform and its easy customisability to different business needs using built-in functions of the platform. The presented ERP feature construction in Chapter 4.2 also presents the exemplar features and capabilities of the WordPress platform in terms of building various features in a flexible way. Customised service on the platform was tailored for specific customer segments, such as B2B and B2C customers. For example, the automated invoicing feature (see Chapter 4.2.4) was helping especially B2B customers to purchase goods and services with the invoicing method.

#### *Guideline 5—Improve usability and performance continuously*

DSR aims to iteratively improve solutions as a process, where heuristics can be implemented in the business environment (Hevner *et al.*, 2004). Simon (1996) also underscored the value of heuristics to discover good designs. The last guideline calls for a continuous evaluate-improve loop for usability and performance in the system, as the business grows with it. This could mean, for example, to conduct heuristic usability analysis by the developer and then to implement changes to the user interface of the platform. Observing visitor statistics with Google Analytics could also help to spot insights on real-time performance and user data to improve the platform further with heuristics and other observation methods.

In the platform's user interface, attention was paid especially to handheld devices, which improved usability on mobile devices through the responsive design approach (see Chapter 4.4). Al-Ismail *et al.* (2014) indicated that usability challenges in mobile-web experiences are related to effectiveness, efficiency and satisfaction. In this study, these potential issues were investigated through the use of various evaluation methods.

The performance indicators, such as page loading times and sessions, from the Google Analytics evaluation also indicated that the platform's performance was

acceptably comparable to other e-commerce site averages (see Chapter 3.3.2). Even though Google Analytics was used in the performance evaluation of the platform, it also was found to be a practical tool for continuous use in the platform optimisation.

Earlier studies have found that GA is a practical tool for evaluating website and e-commerce effectiveness (see Hasan *et al.*, 2009; Plaza, 2009; Petersen & Martin, 2015). In the current study, the GA tool was used on a system with WooCommerce and ERP features installed. In earlier research, Hasan *et al.* (2009) also underlined the importance of user experience in e-commerce systems that could be efficiently evaluated with GA, accompanied with heuristic analysis. The evaluation indicated that a significant proportion of visitors accessed the platform through mobile devices with good performance. Effectiveness, efficiency and satisfaction were essential elements in earlier mobile-web related studies (see Al-Ismail & Sajeev, 2014). However, Matera *et al.* (2006) indicated that the evaluator could not trust solely automated tools, for example, when deciding reasonable design options.

The cost of employing the evaluation in e-commerce websites can be low by using the free web metrics tool Google Analytics (see Hasan *et al.*, 2009). This finding was respected in the current study as the cost-effectiveness and efficacy of the evaluation tool was considered. Moreover, Hevner *et al.* (2004) indicated that resources used in construction and evaluation should be balanced respective to the goals of the DSR studies.

Regarding usability and trust, the WordPress infrastructure provided achievable structures suggested by earlier studies as presented in Table 14.



**Table 14. Usability and trust in the guidelines.**

Concepts	How applied in the platform
Customisation, scaling, speed (Palmer, 2002; Kosalge & Ritz, 2015; Hasan <i>et al.</i> , 2009; Nielsen, 1999)	The WordPress platform is open-source software that is easy to customise and scale. The platform offers an extensive developer community as well as comprehensive documentation. It can be optimised for speed.
Mobile interface, Ease of navigation (Al-Ismaïl & Sajeev, 2014; Palmer, 2002; Molla & Licker, 2001; DeLone & McLean, 2003)	The platform provides a clear interface for building navigation that can be customised according to business needs.
Trust (Lanford & Hübscher, 2004; Molla & Licker, 2001)	The platform provides comprehensive privacy for handling customer data. Third party payment options can be used as well as other trust measures.
Security (Trunde & Weippl, 2015; Molla & Licker, 2001; DeLone & McLean, 2003)	The platform developer community actively monitors the platform and provides security updates, bringing security as long as the updates are attended to.

The left column in Table 14 indicates the essential theoretical concepts regarding usability and trust issues. The right column presents how those concepts were utilised in the construction of the platform. The usability analysis revealed that the mobile-friendly approach at both the frontend and backend seemed important to users. Moreover, the performance evaluation, the mobile version loading times and conversions were satisfactory. These supported mobile-friendly elements when designing the system (see Al-Ismaïl & Sajeev, 2014).

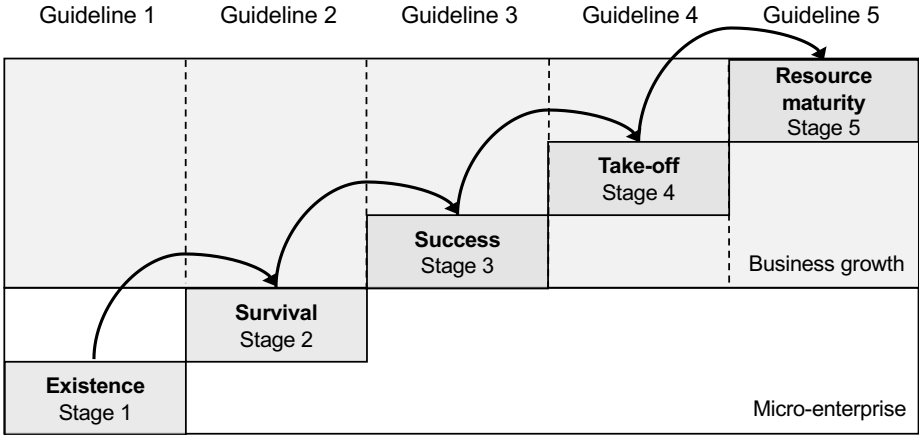
### *Building process*

The five-step building process, based on the guidelines, is presented in Chapter 6.2. In the building process, the guidelines were arranged in a temporal order that could be followed by the micro-enterprise when building the platform.

Micro-enterprises usually employ only a few employees (European Commission, 2003). In small businesses, the owner-manager accumulates many day-to-day tasks, taking precious time from strategic planning (see Beaver, 2007). The current study acknowledged this issue by suggesting the micro-enterprise consider organising the firm's processes and strategies before starting the platform's technical development. After developing the platform, content and

customised features could be added as the business grows. In addition to the platform development, the entrepreneur should lead the company towards innovation and development by utilising performance data and customer feedback. Subsequent features in the platform could devise appropriate new functions for the platform, developing the business further, thus also enabling more stable growth. The entrepreneurs could utilise the resources of the open-source documentation and platform to make the development efforts themselves.

To get from each step towards the next level, the company must meet the requirements of the previous level. Each level requires different leadership and abilities to focus on specific issues. If the company cannot rise towards the next level, the result is stagnation in the company’s growth, returning to previous levels or collapsing its business. Suitable IS should support the firm’s growth process. (see Lewis & Churchill, 1983.)



**Fig. 54. Stages of business growth connected with the guidelines**

Figure 54 connects the five stages of business growth (see Lewis & Churchill, 1983) to the five platform building guidelines discovered in the study (see Chapter 6.1). It suggests that the firm should start framing its essential business processes (Guideline 1) and selecting the platform (Guideline 2) at early stages of the company’s growth, when the firm is still at the micro-enterprise or start-up level. Business growth can be expected when utilising Guidelines 3–5. In order to maintain business growth, the company should continuously iterate and evaluate the platform (Guideline 5) and improve its content (Guideline 3) and customisations (Guideline 4) further. Figure 54 is also supported by the finding

from the interviews that grown-out ex-micro-enterprises had more detailed business strategies and processes compared to micro-enterprises.

Lewis and Churchill (1983) also indicated that the company has to go through all the growth stages to achieve development or die attempting them. However, the process explored in the present study takes a softer approach, as all the guidelines and 'stages' can be flexibly revisited. This does not mean the company is 'dying' but instead 're-creating' its old business models with a suitable digital platform. Kosalge and Ritz (2015) also called for ERP systems that scale with the business.

Many businesses are stuck at one stage and may never achieve growth (see Burns & Harrison, 1996). The building process of the platform (see Chapter 6.2) indicated that the platform should be continuously improving and evolving with business growth. The planning could be started already at the start-up stage by first defining the business processes and then moving to the selection of the platform. This might work especially for the born-global firms offering high-know-how products and services (see Gabrielsson *et al.*, 2004).

E-commerce and ERP could be considered as wide-ranging terms, meaning a different mix of software and tools to other business models and perspectives (Poong *et al.*, 2006; Umble *et al.*, 2003). To address these definitions, the platform was selected and developed to be flexible. The building process of the platform that was indicated in Chapter 4.1 showed exemplar features that could be used in various business models with the combined e-commerce and ERP platform.

The business continuity during growth was addressed in the platform, especially ensuring continuous cash flow that helped the business to achieve financial stability. For example, the invoicing feature in the ERP side of the platform helped to achieve this (see Chapter 4.2.4). Umble *et al.* (2003) suggested that the ERP system should support the firm's strategy and business processes as well as the functionality of the supply and information chain. Moreover, cash is an essential variable in business growth and plays a role in preventing business failure (see Lewis & Churchill, 1983; Cantamessa *et al.*, 2018). Considering these elements, the invoicing system with automated payment tracking was added to the platform to help with firms' cash flow (see Chapter 4.2). Along with this, custom post types and video features for better communication were developed (see Chapter 4.3).

According to Järveläinen (2013), managers, IT specialists and other groups in the organisation should have good relationships to enhance IS business continuity. In the current study, active collaboration was utilised in the organisational

environment, as the construction and evaluation involved collaboration between the companies' internal people as well as the customers.

### **7.2.2 Managerial contributions**

The managerial contributions of the present study focused on the guidelines for constructing the combined e-commerce and ERP platform for growth-oriented micro-enterprises. Moreover, the process indicated to use the guidelines in correct temporal order. One of the major managerial contributions was to suggest one single platform combining both e-commerce and ERP features for reduced complexity. This concept was partially influenced by the EAI approach (see Lee *et al.*, 2003). It could have been possible to use multiple systems over one combined open-source platform (WordPress in the current study). An alternative model of using the separate e-commerce and ERP systems would have required transferring the business data, such as orders and customer information, between the multiple, incompatible systems. However, this appeared to be too complex in the micro-enterprise scope, potentially bringing duplication and compatibility issues to the intended solution.

The WordPress platform was pre-installed with a mobile-friendly, scalable user interface that optimised the interface to suit the resolution of the end-user devices, such as mobile devices and desktops (see Chapter 4.4). Due to its popularity and broad open-source community, the WordPress platform with WooCommerce's e-commerce plugin provided extensive documentation and community support, which helped to raise the knowledge and skills related to the platform, as well as being associated with other free or affordable support resources.

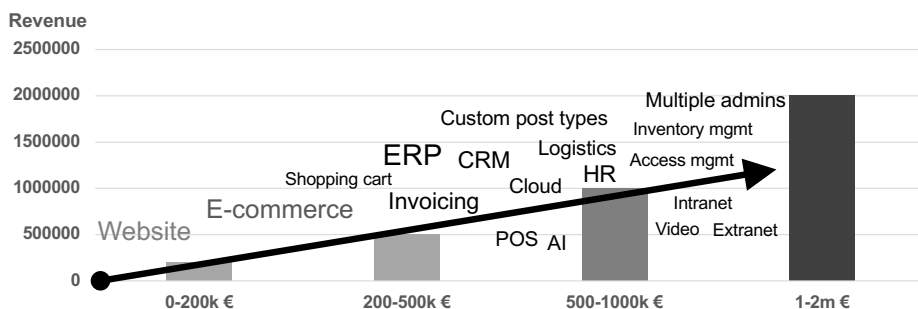
The ERP functions of the platform were developed using the PHP programming language, utilising the built-in PHP functions found in the WordPress software. The developed ERP-functionalities (see Chapter 4.2) included, for example, the invoicing feature, new content types, added product information, embedded videos, API integrations with third-party systems and user interface customisations.

In the platform, the payment server could be connected to the platform flexibly through the installable plugins, thereby reducing the risks that were related to having a payment gateway and data, such as credit card information, in the same server as the platform. It was also possible to develop new payment methods, such as sending invoices directly on the e-commerce server, interacting with the bank or other third-party services. The requests between the client browsers and the web

server could be secured with an HTTPS connection and a Cloudflare service (see Chapter 4.5).

Nielsen (1994) suggested that the user interface should support consistency and standards. In the current study, consistency was achieved by retaining the same open-source platform (WordPress) through the various growth stages, with a new plugin (e-commerce) and new customisations (various ERP features) added along the way.

Due to the versatile customisation, user-friendly interface and ready-made plugins in the selected WordPress platform, it was potentially possible to develop and customise the platform as the company grew to meet its changing needs. For example, first starting with the firm’s website, then installing an e-commerce plugin and finally adding ERP features, utilising the same open-source platform. Figure 55 presents a scenario about a micro-enterprise growing from 0 to 2 million Euro (€) in revenue, first starting with the open-source platform providing the company with just a website, then adding e-commerce, ERP and other related features to the same platform as the company grows bigger in revenue. A similar process happened in Valfi and some of the firms presented in the interviews.



**Fig. 55. Using a single platform as the firm grows.**

As indicated in Figure 55, a micro-enterprise should focus on a single well-planned and constructed open-source platform and scale it up, rather than multiple different systems. For example, Valfi had utilised many of the features presented in Figure 55 by 2020 and reached a revenue area of €200–300k. The benefit of selecting and planning the platform’s backbone infrastructure in the firm’s early stage plays a vital role in the company’s growth. A combined and scalable open-source platform, as presented in the current study, provides simplicity, efficiency and digital business continuity. A single EAI middleware over multiple integrations was also proposed

in earlier ERP-related findings (see Lee *et al.*, 2003). Further, seamless ERP approaches were suggested for growing companies (Kosalge & Ritz, 2015).

Based on the interviews in the current study (see Chapter 5.4), several entrepreneurs saw the study's combined e-commerce and ERP platform as utilisable when growing the business. However, many of the interviewees lacked predefined business processes that were essential, for example, in ERP implementations (see Umble *et al.*, 2003). The interviewees also saw opportunities in scaling the business with the platform more efficiently. The platform also helped create an image of a technologically disruptive brand for themselves and digitalising the existing, previously manually conducted sales processes. The improved cash flow, reduced staff costs and better access to information originated from the use of the platform. The interviews, especially with the users that had grown out from the micro-enterprise level, underscored the importance of strategies, predefined processes, commitment, actual sales work and the use of social media in the successful digital business.

### **7.3 Methodological implications**

This Chapter indicates the methodological implications of the current study in the design science research (DSR) methodological setting. The DSR methodology (see Hevner *et al.*, 2004) was used in the current study. According to Hevner *et al.*, (2004), the essential part of the DSR study is to define and create a valid artefact, such as technical construct or prototype that addresses new problems. Nambisan (2017) indicated that the DSR methodology may be helpful to gain new theoretical insights related to digital artefacts and platforms in digital entrepreneurship. By acknowledging these perspectives, DSR seemed the most appropriate method for this study. The artefact in this study was the combined e-commerce and ERP platform that was found to be a valid DSR construct due to its popularity in open-source software fields (see Chapter 3.3.1). For example, Baskerville *et al.* (2018) pointed out that the popularity of the DSR artefact could indicate its impact. The findings of the study (see Chapter 6), the building guidelines and process, were extracted from this artefact.

Hevner (2007) underscored that the balance between construction and time spent evaluating the artefact should be adjusted in DSR. The problem environment of micro-enterprises and their requirements (see Chapter 4.1) determined the balance between the construction and evaluation. Gregor and Hevner (2013) presented a DSR contribution framework that indicated various forms of

development through the use of the DSR approach. The current study utilised the existing, well-functioning platform WordPress to address the new problems in the micro-enterprise field, where companies have growth and ERP implementation issues as *exaptation* DSR approach (see Figure 14). Moreover, Peffers *et al.* (2006) presented a DSRP model addressing different entry points for DSR. The present study addressed DSR from objective-centred solutions (see Figure 13), as the scope was to generate guidelines for micro-enterprises' platform building, originating from the construction and evaluation of the platform (see Chapter 4 & 5).

The construction and evaluation of the platform also provided new insights into the research methodology, providing the guidelines and process for DSR-driven micro-enterprise IS development. DSR seemed to serve as a useful tool in the development of micro-enterprise information systems in a strategic way. Due to the limited resources of micro-enterprises, particular attention was paid to cost-effectiveness in the construction and evaluation. As shown in Table 15, DSR guidelines (see Hevner *et al.*, 2004) were connected to the current study.

**Table 15. DSR implementation according to Hevner *et al.* (2004) in the current study.**

DSR Principle	Implementation
1. Design as an artefact	The present study constructed an artefact, the combination of e-commerce and an ERP platform suitable for micro-enterprises. The artefact also included the building process of the platform, evaluation, maintenance aspects and growth capabilities regarding external factors accompanying the technical platform.
2. Problem relevance	Previous studies (see Chapter 2) found that a vast majority of small firms faced challenges in growing the business. Moreover, the organisational environment of Valfi and its customers called for a new solution to help with growth efforts (see Chapters 3.4 and 4.1). The purpose of the study was to explore the building guidelines for constructing the combined e-commerce and ERP platform that would help micro-enterprises to grow.
3. Design evaluation	The artefact was evaluated with multiple methods in Chapter 5. The evaluation of the platform was conducted based on the requirements and needs of the micro-enterprise environment. As the study explored relevant cost-efficient evaluation methods for micro-enterprises, a free tool, Google Analytics, was utilised in performance evaluation of the platform, providing real-time user data from the one site using the platform. The usability analysis and interviews were conducted to support the performance evaluation and suggest evaluating the platform further with continuous improvement efforts.

DSR Principle	Implementation
4. Research contributions	Five building guidelines and a process were created as the research contributions (see Chapter 6), which were based on existing research, construction and evaluation in a micro-enterprise environment. The research contributions suggested that a scalable platform could be utilised in business growth. Moreover, micro-enterprises could implement the platform by themselves through the use of open source and community support.
5. Research rigour	The rigour of the research came from the problem domain (see Chapters 1.1 and 3.4), knowledge base, construction, multiple evaluations and well-defined organisational environment. The knowledge base was visited multiple times when making the design decisions, underlining the implications and results originating from existing knowledge and other similar systems. The popularity of the existing artefact WordPress was utilised as an exaptation DSR approach.
6. Design as a search process	The study findings indicated the design process in Chapter 6.2. The main foundation of the search process originated from this study, combining it with existing knowledge and theories (see Chapter 2).
7. Communication for research	The research is communicated to academic audiences in technological and entrepreneurial fields as a form of dissertation.

Along the seven DSR guidelines, the relevance, rigour and design DSR cycles were followed in the research approach (see Chapter 3.2).

Iivari (2007) pointed out that design science should not be a monopoly conducted by academic researchers but that individuals constructing information systems might also participate by respecting scientific evaluation and other rigorous research approaches. Similarly, developing new innovative e-commerce and ERP platforms should not only be a research interest of larger companies' R&D units but also of growth-oriented micro-enterprises. Iivari (2007) also underscored that the scientific evaluation of artefacts makes the difference between design science and constructing simpler IT constructions. In the current study, the artefact was evaluated with three different evaluation methods, presented in Chapter 5. The decision to use these three evaluation methods emerged through considering the knowledge base and the business environments of micro-enterprises. Eisenhardt (1989) also suggested using multiple data sources in case-study-driven studies. As the present study was built on Valfi's case customers and software deployments, earlier insights about conducting case studies were appropriate to present (see



Eisenhardt, 1989; Runeson & Höst, 2009). According to Hevner *et al.* (2004), case studies can be used to investigate DSR artefacts in business environments.

One of the methodological by-products of the current study was to demonstrate how DSR could be applied to micro-enterprises' IS development and still respect the resource-efficiency in the construction and rigorous DSR evaluation. Acknowledging these factors, GA was used to measure the performance of the platform along the heuristic analysis and interviews. Simon (1996) also connected the performance of the artefact to the speed at which it loads. Heuristics, as a search process, can provide good results in a business environment to find good designs (Hevner *et al.*, 2004). Simon (1996) also pointed out that satisfying designs can be found through heuristics. In the current study, a heuristic usability evaluation was engaged to address the usability issues of the system in Chapter 5.3. That method was selected, as usability is determined to be one of the essential drivers in IS and e-commerce success (see Choshin & Ghaffari, 2016; DeLone & McLean, 2003). The insights that the heuristic evaluation gave were found to be satisfactory for the problem domain and requirements.

The IS success model (see DeLone & McLean, 2003) also appeared to be a suitable backbone theory together with DSR methodology for the current study. These foundations provided a flexible research framework for creating a new solution in the organisational environment, underscoring the specific requirements of micro-enterprises such as cost-effectiveness and scalability.

## **7.4 Validity discussion**

This Chapter discusses the validity of the current study. The validity of this study emerged primarily from the research method used, design science research (DSR). The study, conducted in the Finnish company Valfi's organisational environment, defined a research problem (Chapter 1 & 3.4) and explored the knowledge base (Chapter 2), research approach (Chapter 3), platform's requirements and building process and evaluations (Chapters 4 & 5) according to DSR. The seven DSR principles (see Table 15) were followed throughout the study and those principles are discussed further in Chapter 7.3 through the research results. Moreover, the DSR cycles were followed in the research approach (see Chapters 3.2 & 3.5).

The previously created platform constructions by Valfi that finally framed the complete platform in Chapter 4 played an essential role as software-related 'case studies' of the case organisations that were using the platform and where the various evaluations were conducted. Runeson and Höst (2009) indicated that the validity

of the research results in software engineering case studies should not be biased by the point of view of the researcher. However, by its nature, DSR methodology is pragmatic and problem-oriented, producing actionable solutions to real-world issues that can originate from organisational problem domains (Hevner *et al.*, 2004). Valfi, providing the organisational environment for the study, worked to approach the research objectively. In order to distinguish between information systems as a design science and routine IS construction practices, DSR should be rigorously originating from the knowledge base and scientific evaluation methods supporting the defined problem domain (see Hevner *et al.*, 2004; Iivari, 2007). This was followed as the DSR principles were noted in the research approach.

The relevance of the research problem appeared in the business environment, where Valfi and its customers had to develop the platform to support business growth. The researcher of the current study also worked in Valfi, where the research was conducted. Valfi's customers participated in the study. Special care was taken to decrease the potential interference with the objectivity of the study. The material was collected for the platform construction through multiple years of Valfi's operation from numerous e-commerce and ERP software development cases made for diverse customers and Valfi's daily operation. The material and data that was selected originated from the requirements (see Chapter 4.1) and knowledge base (see Chapter 2).

DSR allows employing multiple data collection methods, such as case studies (see Hevner *et al.*, 2004). Valfi's organisational and customer cases were essential data sources for this study. Case study research in software engineering should address the four main aspects of validity: construct, internal, external validities and also reliability. Construct validity means that the actions conducted in the study should represent the research questions and goals of the study. Internal validity indicates the causal relations in the study, such as third factors that the researcher is not recognising. External validity refers to the aspects concerning the generalisation of the study's findings, such as how the study relates to other similar cases. Reliability refers to the aspect of how other researchers would interpret the study's data and analysis. (see Runeson & Höst, 2009.)

The current study approached the construct validity by defining one primary research question and clear research objectives in Chapter 1. Baskerville *et al.* (2018) noted that a DSR artefact's popularity could indicate its state-of-the-art validity. Accordingly, a popular and widely used open-source platform infrastructure was selected as the technical infrastructure of the artefact (see Chapter 3.3.1). With the constructed and evaluated platform, focus was placed on

answering the research question by exploring the building guidelines and process through the DSR method (see Chapter 3).

The internal validity in the study was addressed by combining three different evaluation methods (see Chapter 5) to measure the performance, usability and utilisation of the platform for the targeted research problem. The current study also explored a diverse range of existing knowledge foundations, from information systems to business growth and entrepreneurial competencies (see Chapter 2). The external validity is pointed out by explaining the construction and evaluation processes to the reader in Chapters 4 and 5, finally extracting the guidelines as the research contribution in Chapter 6. By following the guidelines, other researchers or practitioners could build their own platform and evaluate it using the methods indicated in the present study. Open-source platforms and free tools that were used in the study would enable a diverse range of researchers to repeat the process.

The design science research process (DSRP) provided a framework to conduct DSR from different entry points for research (see Peffers *et al.*, 2006). In the current study, the objective-centred solution was followed to create the guidelines for micro-enterprises as a research objective. Existing research (see Peffers *et al.*, 2007; Peffers & Tuunanen, 2005) also employed characteristics of an objective-centred solution, similarly utilising participative interviews to create new concepts related to digital business.

According to Hove and Anda (2005), interviewing is a commonly used tool in empirical software engineering research, and it can provide new insights that are missing in quantitative data collection methods. Semi-structured and appreciative interviews were utilised in this study to provide more validity to other evaluation methods, such as quantitative performance evaluation and qualitative usability analysis (see Chapters 5.2–5.4). The interview setting was set according to DSR principles where a relevant business problem and its solution as the artefact had to be purposefully explained and evaluated (see Hevner *et al.*, 2004).

After constructing the platform (Chapter 4), the evaluations were conducted with three various data collection methods: performance, usability and utility in micro-enterprises. The primary evaluation method was a Google Analytics performance analysis (see Chapter 5.2). Earlier studies underscored the importance of efficiency and performance in IS (see Nielsen, 1999; International Organization for Standardization, 2008; DeLone & McLean, 2003) and GA was found to be a suitable tool to measure web applications (see Hasan *et al.*, 2009; Plaza, 2009). The performance of the platform was found to be satisfactory, compared to similar industry averages (see Chapter 3.3.2).

When evaluating solutions for micro-enterprises, the cost-effectiveness of the evaluation played an essential role, also being a part of the evaluation process. Simon (1996) underscored that heuristics can provide satisfying results that are good enough respective to the suitable design solutions. Moreover, Hevner *et al.* (2004) indicated that heuristics can bring the design close to the desired solution, if the requirements were specified, for example, in the business environment. The second evaluation method, the heuristic usability analysis, was conducted by the developer, Valfi, respective to the business environment (see Chapter 3.4) and requirements (see Chapter 4.1). Heuristic analysis is a cost-efficient tool to evaluate software development (see Tan *et al.*, 2009). It also can be used to evaluate e-commerce with Google Analytics (see Hasan *et al.*, 2009). However, as only a few evaluators can investigate heuristics (see Nielsen & Molich, 1990), it may pose threats to research objectivity. Hevner *et al.* (2004) called for specifications of how the solution could be defined as ‘satisfying enough’ for the problem scope in DSR. This was addressed in the requirements (see Chapter 4.1).

According to Hove and Anda (2005), interviews can be used as effective data collection methods in empirical software engineering studies. The third evaluation method in the present study, interviews (see Chapter 5.4), pointed out the utility of the platform in real companies that were using the platform. For example, the interview results supported the indication that the predefined processes were essential to build the platform in the development process. All the various evaluation methods, from numeric performance evaluation to qualitative interviews and heuristics, contributed to the construct’s validity. This meant that diverse user perspectives were investigated from end-user, administrator and enterprise viewpoints (see Chapter 5).

## **7.5 Limitations**

Limitations were present within the research approach, context, environment and objectives. The study was conducted in DSR methodology that included data collection from performance evaluation, usability heuristics and interviews in case organisations. By using other data collection methods, the results might have possibly varied.

From the research context viewpoint, this study constructed a solution for growth-oriented micro-enterprises having a desire to grow and digitalise their business. The guidelines would not be practical for the small businesses aiming to cease or maintain their current state of operations and technological levels, which

covers most small businesses. For example, according to Nummela *et al.* (2005), most small firms are not interested or oriented to grow.

Limitations related to the research environment originated from the organisational environment where the study was conducted. The current study was conducted on the Finnish company Valfi and its customers, whose environment could vary from those of other countries. Some of Valfi's customers who were interviewed had deployed more platform features than others; ERP functions especially were missing or under construction in respondents who were micro-level during the interviews.

The researcher in the present study had worked as an entrepreneur throughout his adult life, and this could have shaped the motivational viewpoint to conduct the present entrepreneurship-related study. He was also working in Valfi, where the present study was conducted, forming objectives for the research. Those of Valfi's customers who collaborated with the study operated in retail, consulting, construction, advertising and IT fields, possibly leaving less attention for other business sectors.

## **7.6 Future outlook**

As micro-enterprises are playing an increasingly essential role in the global economy and platformisation is increasingly shaping the global entrepreneurship, the development of information systems for micro-enterprises will possibly become a growing issue (see Chapter 2.1). For example, productivity growth had lagged significantly in Finland compared to other EU countries, even though Finland had previously showed evidence of digital success, such as in the gaming and mobile phone industries.

E-commerce and digital entrepreneurship have expanded in the 2020s to many different areas. Fruitful topics for further research in this field could be investigating scalable e-commerce systems for large volumes and enterprises through the use of various open-source platforms. The guidelines and process that were discovered in the present study could be tested and evaluated in larger organisations and institutions as well, and also with commercial technologies without open source.

Based on the findings (see Chapter 6) in this study, a call for research in multidisciplinary fields is needed to support IS development in growth-oriented companies. Moreover, micro-enterprises could benefit more from a disciplined process of connecting multiple methodologies, such as DSR and case studies, in

their R&D efforts. For entrepreneurship educational institutions, such as universities and schools, technical aspects of digital platform building processes could be added into their curriculums to boost platform-driven entrepreneurship globally.

## 8 Conclusions

This study resulted in five guidelines for micro-enterprises to build the combined e-commerce and ERP platform to support business growth. These guidelines answered the research question *How can a combined e-commerce and ERP platform be built in a micro-enterprise?*

The study was conducted with a design science research (DSR) method by building and evaluating the platform, as a valid DSR artefact, in the Finnish software company Valfi. This organisational environment and the company's customers using the platform provided the research environment to produce the solution. The study indicated that it is vital to initiate growth capabilities and predefined business processes before starting to develop the platform. The platform should be customisable and scalable, such as the open-source software WordPress. Continuous improvement and evaluation should keep the platform scalable and active during the firm's growth. Automated performance metrics tools, such as Google Analytics, could help to achieve better performance in a continuous process, and heuristic usability analysis could help to improve the usability iteratively. Further, Hevner *et al.* (2004) indicated that design science research should seek satisfying solutions to organisational problems through innovative artefacts in a continuous design process.

From a theoretical perspective, this study presented new knowledge about the process to develop the platform that could help the business grow in increasingly digitalising markets. It granted more validity to the conception that entrepreneurs should gain platform development expertise. In a micro-enterprise context, platformisation can be defined as a transformational process that requires certain temporal steps, as indicated in the guidelines.

Leveraging open-source platform infrastructures, such as WordPress, could help. The entrepreneurs should also have active participation in continuous evaluation and improvement. As small businesses and entrepreneurs often have limited resources (European Commission, 2003; Thistoll *et al.*, 2013), this study brought the new insight that the solution can be built with relatively low technical skills and costs. Nevertheless, motivation is needed, as many entrepreneurs are not interested in technological innovation (see Wong *et al.*, 2005).

Small firms are increasingly contributing to the global economy and society. Business growth may be influenced by the entrepreneur's preparedness for growth, suitable digital platforms and desire to grow (see Weber *et al.*, 2015; Nambisan *et al.*, 2018; Beaver, 2007). However, in order to build and grow an e-commerce

business, entrepreneurs should address entrepreneurial orientation, customer satisfaction, costs, infrastructure selection, technological expertise and usability (see Abebe, 2014; Choshin & Ghaffari, 2016). The results of this study suggested that a scalable platform supporting growth is crucial in a rapidly digitalising economy. The study discovered that successful IS implementations are not solely determining the success of the digital platforms, but that the pre-initiated growth capabilities and sequential process of using the building guidelines should be addressed along with the existing theories, such as the IS success model (see DeLone & McLean, 2003).

The guidelines are practical primarily for technologically motivated micro-enterprises or start-ups starting their digital transformation through e-commerce business. Open-source platforms could be the playgrounds to learn software and platform development with small resources and good community support. However, the company or entrepreneur needs to be ready to ignite its other growth capabilities and motivation to create sustainable growth.

The study illustrated the combination of the e-commerce and ERP applications into one single platform, providing scalability and efficiency through the use of open source. This combination potentially helps micro-enterprises to focus on one single platform over multiple separate systems, reducing complexity and costs. The infrastructure of the platform utilised the open-source WordPress platform with the WooCommerce e-commerce plugin. The platform's ERP functionalities were developed with custom code that took advantage of the open-source platform's online documentation and its built-in PHP functions. The ERP functionalities mainly focused on micro-enterprises' continuous cash flow in an invoicing feature integrated into the e-commerce, CRM and customised content types. The user interface of the platform was customised for various end-users, as the platform's graphical interface scaled responsively according to the end-user's browser display resolution.

The study showed that micro-enterprises could acquire technical knowledge by themselves to build the platform instead of purchasing a ready-made ERP package solution or relying on external contractors. Although the development of the combined platform was found possible without high costs and with little technological know-how, the micro-enterprises should have clear predefined business processes, such as sales processes, along with a strong desire to grow. Without these capabilities, the platform construction may potentially end up providing disappointing results for the micro-enterprise trying to utilise the guidelines.



The relationships between business growth and sophisticated IS supporting it have also been indicated previously (see Lewis & Churchill, 1983). Moreover, the company conducting IS development would benefit from being innovative and positively motivated, able to adopt new technology, willing to take risks and having skills in decision making and sales (see Jasra *et al.*, 2011; Thong, 1999; Arasti *et al.*, 2012).

Future research is called for to indicate further benefits of digital platformisation in micro-enterprises with and without open-source technologies. Methodologically, new studies are called for to connect DSR with small firms and their R&D endeavours. Furthermore, more collaboration is proposed between researchers and micro-enterprises to create new inventions together.



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