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The return of enterprise resource planning system investment in a wood supply organisation

Master's Thesis

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Abstract

Enterprise resource planning system (ERP) is complex by nature and challenging for project managers to successfully implement. Organisations need good benefit realisation plan to evaluate and justify such investment. Only a few studies exist describing how to measure ERP system benefits in detail. This study investigates ERP implementation benefits to calculate investment return in a wood supply organisation. A guideline is provided for identifying and measuring benefits. The management team's estimations and organisation data is used to evaluate benefit values. The results show that 47% of benefits are quantifiable, resulting in positive net present value, 4% internal rate of return and investment payback of 3.8 years.

Keywords: ERP, return of investment, implementation benefits, wood supply organisation

1. Introduction

The purpose of most organisations is to be profitable and survive. To fulfil the purpose, it is necessary to manage in today's constantly changing economic environment and increasing global competition to gain sustainable competitive advantage (SCA). (Krivtsov *et al.* 2016; Murphy & Simon 2001)

Competitive advantage can be achieved through supply chain efficiencies and change management. To meet these challenges, organisations should improve internal business processes and develop external information exchange with supply chain partners (Sari *et al.* 2012). It is the duty of wood supply organisation to manage supply chain integration between suppliers, customers and many other stakeholders.

Today's complex business environment needs effective decision making to operate efficiently and that is why information should be available in time (Rashid *et al.* 2002). Business organisations are obligated to develop information systems (IS) that support decision making. It is the task of IS to provide high quality information and timely data flow to functional units on a day-to-day basis. Management can then anticipate problems and opportunities, control and monitor decision making on daily operations (Murphy & Simon 2001). Such close operations and management integration helps to reach the true potential of organisation`s performance that can lead to a competitive advantage through operation cost, cycle time reduction, increased quality and variety of products and services (Uçaktürk & Villard 2013).

Benefits are often a justification for the companies to implement an information system application called Enterprise Resource Planner (ERP). "ERP has many definitions proposed by people from all over the world. However, from the various definitions proposed, there is no agreed upon definition for ERP systems" (Sari *et al.* 2012, p. 2). The following comprehensive definition (Rashid et al. 2002, p. 2) is suitable for the current case: "Enterprise resource planning systems or enterprise systems are software systems for business management, encompassing modules supporting functional areas such as planning, manufacturing, sales, marketing, distribution, accounting, financial, human resource management, project management, inventory management, service and maintenance, transportation and e-business. The architecture of the software facilitates

transparent integration of modules, providing flow of information between all functions within the enterprise in a consistently visible manner". This definition combines different functions into large scale system as also in the case of this study. Based on authors definitions, we could collect ERP characteristics presented in Table 1.

Table 1. ERP system characteristics

Who is using it?	**What are the tasks?**	**Scope of usage?**	**What it is technically?**
• Manufacturing and service industries • Enterprise management, employees and partners	• Address business uncertainties • Integrate all departments and functions • Automate business processes • Enhance interdepartmental cooperation and coordination • Generate and communicate accurate and timely information • Support planning, decision making and controlling • Data sharing throughout the enterprise • Enabling information access in a real-time environment • Increasing effectiveness of management functions	• All business functional areas and value chain	• Interactive system • One solution for complete organisation • Information backbone • Database in which all business transactions are entered, recorded, processed, monitored, and reported • Set of integrated software modules • Common information system platform • Software system

Source: compiled by author, based on (Ağaoğlu *et al.* 2015; Johansson *et al.* 2016; Kumar and Gupta 2013; Murni *et al.* 2012; Murphy and Simon 2001; Nafeeseh and Al-Mudimigh 2011; Rashid *et al.* 2002; Sari *et al*. 2012; Shang and Seddon 2002; Teo *et al.* 2014; Uçaktürk and Villard 2013)

There are many roles and important tasks set for ERP. We could say that ERP characteristics depend on the implementor's understanding and expectations for the system.

Benefits of ERP system can be defined as new exploited organisational capabilities from the outcome of ERP implementation (Alshawi *et al.* 2003). In other words, the new system should provide improved functionality that enables higher performance through system use in some part of organisation activity area.

Although great rewards are promised, many companies fail to receive the benefits of the ERP investment because ERP implementation projects are not simple by their nature. The measurement of ERP success has critical role to understand the value of ERP management actions and ERP investments (DeLone & McLean 2003). ERP implementation studies reveal that the projects are on an average 178% over budget, take 2.5 times longer than planned and deliver only 30% of promised benefits (Zhang, Lee, Huang, Zhang, & Huang 2005). Organisations must consider many critical success factors (CSF) including the detailed benefit mapping that impact the successful outcome of an ERP implementation.

This study investigates ERP implementation benefits to calculate investment return in a wood supply organisation. In the literature review, this thesis first gives an overview of the relevant studies of critical success factors and benefits of an ERP implementation to understand the benefits identification and realisation. Secondly, the literature overview focuses on benefit measurement methods, guidelines, and financial measures. The wood supply organisation's business case study is conducted based on an empirical study that results in a profitability analyses, discussion, and conclusions.

2. Literature review

2.1 Content and focus of past ERP implementation studies

To start the search and identification of relevant literature, the following primary keywords and combinations of keywords were used in Google Scholar and ScienceDirect: ERP implementation, ERP benefits, ERP success, cost-benefit analyses, supply chain factors, IS profitability, IS evaluation, IS investment valuation. Secondary search for original and relevant new sources was done by tracing the reference list of articles. To find meaningful content in articles, three main discussion points were searched for: 1)

how to identify and measure ERP benefits, 2) factors that are affecting successful ERP implementation and benefits realisation, and 3) ERP profitability measures.

During the literature review, content and focus was collected and mapped. Literature findings in Table 2 can give readers insight and shortcuts for their research. Article content is defined based on discussion points which are searched for this study. Benefits in content are grouped by Shang & Seddon (2002) benefit classification. Article focus is described shortly based on the main result in the relevant study.

Table 2. Literature findings of research content and focus.

Author	Content	Focus
Ağaoğlu *et al.* 2015	Critical success factors	User point of view
Alalwan 2010	Strategic	Sustainable competitive advantage
Badewi & Shehab 2013	Profitability measures	Net present value
Bobek and Sternad 2016	Critical success factors	Perceived usefulness and ease of use of ERP
Bokovec *et al.* 2010	Critical success factors	Global efficiency factors
Botchkarev and Andru 2011	Profitability measures, Operational	ROI, tangible & intangible cost reduction
Candra 2013	Critical success factors	Knowledge capability
DeLone & McLean 2003	Net benefits	E-commerce success metrics
Eckartz *et al.* 2009	List of benefits	Literature review
Hubbard 2014	Measuring benefits	Measurement methods
Ince *et al.* 2013	Critical success factors	ERP system and SCM practices relation to competitive advantage and firm performance
Jeyaraj and Sethi 2010	Operational, Strategic	Supply chain integration
Johansson *et al.* 2016	Profitability measures	Business case follow up
Kaplan & Norton 2001	Measuring benefits	Intangible assets, business score cards
Kimberling 2006	Critical success factors	Benefits realisation approach
Krivtsov *et al.* 2016	Critical success factors	Change management factors
Kumar and Gupta 2013	Critical success factors	ERP failure factors
Lee 2012	Operational, Managerial	Net benefits, actual & perceived performance
Leuschner *et al.* 2013	IT-infrastructure, Operational	Information, operational & relational integration relations to firm performance
Maiga *et al.* 2015	Operational	Internal and external integration relation to quality performance and cost performance

Marinagi *et al.* 2014	Critical success factors	IT practices and techniques role on sustainable competitive advantage
Matende and Ogao 2014	Critical success factors	User impact
Mitra and Mishra 2016	Critical success factors	Critical behavioral factors
Molina 2003	Profitability measures	Methods for evaluating IT investments, business process simulation approach
Murni *et al*. 2012	Operational	Increase sales rates, cost saving rates
Murphy and Simon 2001	Measuring benefits	Quantifiable benefits, including tangibles & intangibles to cost-benefit analyses
Nafeeseh and Al-Mudimigh 2011	Measuring benefits	Traditional vs comprehensive business case
Nofal and Yusof 2014	Operational, Managerial	ERP + business intelligence integration
O'Leary 2008	List of benefits	Benchmark based on industry
Orougi 2015	Critical success factors	Accounting perspective
Pérez-Méndez and Machado-Cabezas 2015	Operational	IS strategy and quality relations to ROI
Power 2005	Operational	SCI integration
Rajan and Baral 2015	Managerial, Organisational	Perceived usefulness and ease of use or ERP relations to individual impact
Ranti 2008	List of benefits	IS/IT business value category
Rashid *et al.* 2002	Operational, Managerial, Strategic, IT-infrastructure	Historical perspective
Ross *et al.* 2002	Profitability measures	Corporate finance, NPV, IRR, payback period
Rouhani and Ravasan 2013	Critical success factors	Organisational factors
Sari *et al.* 2012	List of benefits	Shang & Seddon`s + Ranti's benefits` category
Shang and Seddon 2000	List of benefits	Benefits framework and classification
Swink and Schoenherr 2015	Operational	Financial benefits of internal integration
Tams 2010	Strategic	Business-IT alignment
Teo *et al.* 2014	Operational, Managerial, Strategic, IT-Infrastructure	Relations to organisational learning & innovation
Themistocleous *et al.* 2004	Operational, Strategic	Enterprise application integration (EAI)
Uçaktürk and Villard 2013	Operational, Managerial, Organisational	Strategic advantages of ERP
Velcu 2005	Operational	Change in financial performance after implementation
Ward *et al.* 2007	Measuring benefits	Business case examples

Wei *et al.* 2005	Critical success factors	How to choose ERP, affects all benefits
Woolman 2014	Critical success factors	Enterprise performance solution systems
Young 2006	Operational	IT governance point of view
Zhang *et al.* 2005	Critical success factors	CSF in China

Source: Author

There are 16 studies describing the critical success factors and 22 discussing the benefits. Based on literature mapping, 40% of the reviewed studies refer to ERP implementation, 12 guidelines can be found regarding how to achieve certain goals and only 5 articles identify and measure benefits of an ERP system. Eckartz *et al.* (2009) has found a similar problem in their study where 8 out of 30 articles identify guidelines and 4 of them refer specifically to ERP implementation. In addition, they noticed that "most authors do not focus on benefits but assume that benefits are clear and that their identification, realisation and assessment do not need to be discussed" (Eckartz *et al*. 2009, p. 5). It is found that guidelines and business cases are on a too general level of detail to use them directly, so the reader can only find some similarities with their own work.

2.2. Critical success factors

It takes a lot of effort to implement an ERP solution successfully. The system needs to fulfill the current and future requirements of the business. There should be skilled team in place who knows the business. Also, the organisation's top management support is important during the implementation process. The ERP system provider should be professional with a dedicated consultant and sufficient development capability, with best solution package and well-planned implementation execution for the company. Users must be involved and trained so they know how to use the system. On top of that, communication and cooperation between company and ERP provider and in company internally needs to be at good level. If described factors will be not managed properly, there is a possibility of system failure, increased project completion time and cost. (Kumar & Gupta 2013; Orougi 2015)

Project managers must do careful planning and consider many factors to meet all expectations of the system. Eckartz *et al.* (2009) brings an example that there could be more implementation benefits realized when users are well trained than users without

training. The understanding of critical success factors has crucial meaning for realizing the benefits. In addition, Murphy and Simon (2001) state CSF as a useful source of information to support the identification of intangible benefits.

Followingly, literature findings are divided into four sub-chapters of organisational, individual and ERP usage, supply chain integration, system and vendor factors. As in this study an organisation functional in the field of supply is concerned, then supply chain integration factors are important and therefore addressed separately.

2.2.1. Organisational factors

Rouhani and Ravasan (2013) have made a complete list of organisational factors which affect ERP success: clear vision and mission, defined goals/objectives, strategic IT plans, business process re-engineering, organisational culture, training and education, management and user skills, organisation-wide commitment and shared beliefs. They bring out that organisational factors, in addition to implementation issues, have important role in achieving ERP system success.

Woolman (2014) has defined organisational management barriers to ERP success in multinational enterprises. He noted that factors as financial reporting fiefdoms and organisational metadata structure synergy can be real road blockers, management should drive for divisional overhead reduction, non-enterprise standard legacy transactional systems should be reduced and ultimately replaced, and the chief financial officer (CFO) must be actively involved.

Many studies find that information technology (IT) itself does not ensure competitive advantage for the organisation. Also, when business and IT plans are synchronized the value of ERP project will be higher. It is more likely to generate SCA if ERP strategy, IT infrastructure, business and corporate strategy fit together. (Alalwan 2010; Tams 2010)

Bokovec *et al.* (2010) has defined 5 global efficiency factors to manage complex ERP projects: business process re-engineering based on ERP system requirements, legacy systems, system configuration, alignment with the corporate level, and project synergy. Analysis showed that global common elements have to be aligned with corporate guidelines and standards to ensure common data flow. Global-wide ERP needs unified

and harmonized business processes accordance with the global design to achieve expected benefits.

Lee (2012) finds that the success of an ERP system does not always significantly improve an organisation's competitive advantage. The organisational capabilities such as performance management, customer management and process management capabilities have a limit. If novel services are not introduced to the customers, then the impact to the organisation's performance will not be significant.

So, IT may be the enabler, but it is the people within the organisation who make the ERP work. They implement, use and maintain the ERP systems. Further, most ERP implementation success and outcome depends on the organisation not on software vendor (Mitra & Mishra 2016; Nofal & Yusof 2014).

In addition, Young (2006) have found that organisations can improve the outcome of successful projects that deliver all the promised benefits with experienced and good IT project governance.

Yet, Ağaoğlu *et al.* (2015) argue that organisational factors do not have a great impact on ERP project's success and organisation's performance after all. Their empirical study on user's point of view in the multinational organisations indicates that most important CSFs of ERP implementation are user involvement and user training.

Mitra & Mishra (2016) study from human perspective on organisational behavior aspects shows that end user acceptance, attitude of managers and users, perception of managers and users, technical competency of individuals and groups, effectiveness of the group and team, leadership/change manager, leadership traits, leadership styles, organisational power dynamics and organisational culture have great impact on ERP implementation. In summary, they highlight the importance of people in organisations.

2.2.2 Individual and ERP usage Factors

The new ERP system brings a lot of new things to the working space. The user interface is changed, new buttons and views, different report layouts and data input is introduced. Most of the old habits must be forgotten and new ways must be learned. The uncertainty will raise among people and they start to doubt the necessity of a new system. Users then

refuse to accept and to adopt the changes. There are some ways how to reduce the uncertainty and increase the acceptance.

One of the ways is to involve and to encourage user participation in the ERP project. Users should participate in system development and implementation processes and should be involved in the stage of defining organisational needs, process re-engineering, customisation and testing (Matende & Ogao 2014).

Another way that will lead to a favorable attitude towards the acceptance is considering two major factors of ERP implementation - ERP ease of use and usefulness. Both, Bobek & Sternad (2016) and Rajan & Baral (2015) studies defined the factors that influence ERP system use. Rajan & Baral (2015) noticed that computer self-efficacy, organisational support, training and compatibility are positively related to the ease of use and usefulness. They further noticed that the acceptance is larger if the existing technical systems and operational practices are compatible with the implementation of ERP. But at the same time the complexity of the system could affect the usage of the ERP negatively. They also found that the proper usage of ERP will positively affect the end user panoptic empowerment and individual performance. Same has been found by Bobek & Sternad (2016) who's study was wider than previous work, adding aspects of personal innovativeness, user manuals and social influence. Overall result is that ERP ease of use and usefulness influence attitude towards using the system and affect benefits rising from individual perspective which is the basis for operating the system.

2.2.3. Supply Chain Integration Factors

Since the competition is moving from "among organisations" to "between supply chains", organisations are increasingly adopting Supply Chain Management (SCM) practices to reduce supply chain costs and secure competitive advantage. Effective SCM practices and ERP success are leading to increased performance and competitive advantage of the organisation. (Ince *et al.* 2013)

Organisations that are looking for extended and integrated supply chain can expect that proper infrastructure must be established. There is crucial role of IT techniques and

practices in SCM to reach sustainable competitive advantage. Therefore, organisations need to manage IT infrastructures in order to enable effective information access and use, supply chain visibility and streamlined logistics. (Jeyaraj & Sethi 2010; Marinagi *et al*. 2014)

"The integration of supply chain processes can provide an effective means by which costs can be reduced and customer service levels improved. The formula for integration, however, is not a simple one". (Power 2005, p. 7)

There are benefits which are related to the integration of supply chain systems such as gaining competitive advantage, reducing operational costs and achieving better collaboration among supply chain partners (Themistocleous et al., 2004). Internal and external information integration is correlated with cost and quality performance. Proper information in the right place at the right time enables access to know-how, mutual understandings and sharing resources. This can lead to improved ability to meet customer needs on high-quality products at low cost. (Leuschner *et al.* 2013; Maiga *et al.* 2015)

Closer integration with customers and suppliers can have intangible benefits such as satisfaction, trust and commitment, that improve partners relationships (Leuschner *et al.* 2013). Evidence shows that internal integration mainly improves sales, general and administrative efficiency, which in turn lead to reduced cost and increased profits (Swink & Schoenherr 2015).

Supply chain integration is the basis for wood supply organisation process automatisation. Providing streamlined information between stakeholders makes the process efficient and creates a competitive advantage.

2.2.4 System and Vendor Factors

ERP system selection can be intense and time consuming because of its complex nature. Variety of ERP alternatives, limited development resources, complexity of business environment and future requirements, potential benefits and risks of financial investment have all to be considered at time and can't be underestimated.

Vendor hype can complicate the ERP selection. Vendor must be co-operative and understand clearly the company objectives and requirements in order to make a proper offer. There is no system on the market that will fit perfectly for all business functionalities. (Wei *et al.* 2005)

Organisations should choose a flexible system where tailor made functions are not an issue and in-house development is supported. “It is predicted that only around 40-60% of the best practice business processes will be adopted, the remaining will be customized to follow the old (existing) business processes of the company“ (Ranti 2008, p. 3). Pérez-Méndez and Machado-Cabezas (2015) find that ERP software as a service (SaaS) has higher performance than traditional IT system. Uçaktürk & Villard (2013) find that achieving all-round cost savings and service improvements is very much dependent on how well the chosen ERP system fits to the organisational functionalities and how well the tailoring and configuration of the system matches with the business culture, strategy and structure of the organisation. Wrong selection can lead to delayed and weak systems with poor logics and low functionalities or even project termination and investment loss. To prevent this, Wei *et al.* (2005) offer comprehensive ERP system selection framework where appropriate attributes are specified to provide detailed guidance for ERP system technical evaluation. Two main issues, “Choosing the most appropriate ERP system“ and “Choosing the best ERP vendor“, could be solved. They provide a detailed list of 69 factors which are followed to make a complete selection. In conclusion, right vendor and right system could provide support for benefits realisation but there are more risks of failure with poor implementation and system performance.

In summary, we can agree with Candra (2012) research findings that system quality and information quality support the ERP success and highest contribution comes from individual impact and organisational impact to the system implementation and use. Internal and external information integration provide many benefits that positively influences organisation performance and profitability, but it comes with great effort. It is important to consider CSF’s to maximize the realisation of benefits and to gain competitive advantage.

2.3. ERP Benefits

ERP system benefits are searched from literature for their identification and behavior. In this sub-chapter, previous author's views on benefits should lead to an understanding of benefits` nature and to the ability to measure them.

ERP benefits vary in nature as tangible, intangible, short-term and long-term. Short-term benefits like savings in labor and time, quicker decision making and replacement of legacy systems are inherent to the ERP outcome (Shang & Seddon 2002; Teo *et al*. 2014).

One benefit often achieved after installation of an ERP system is the improvement in information quality, access, and use (Murphy & Simon 2001). Further, Hubbard (2014) mention in his book that information have some benefits itself: to reduce uncertainty about decisions that have economic consequences, to affect other people, and information sometimes has its own market value.

Long-term benefits are influenced by organisational factors such as the usage of ERP, organisational learning, education and innovation. These factors positively influence benefits like improved productivity, better project management and external linkages. Particularly the organisational learning and organisational innovation help companies to exploit the potential of ERP implementation to achieve long-term benefits. (Teo *et al.* 2014)

O'Leary (2008) has found that intangible benefits vary across industry, while tangible benefits seems to be inherent to companies independent of industry. He reveals that with integrated infrastructure, the ERP could provide nonredundant data entry and faster processing of data resulting in better decision making.

Tangible benefits are designed to compare the costs of investment alternatives or attempt to provide procedures for quantifying benefits and risks. Most of the ERP investment benefits are measured in financial terms. Cost-benefit analysis (CBA), net present value (NPV), and return on investment (ROI) are mainly used techniques to evaluate the investments. Such techniques need monetary data for evaluation. (Molina 2003)

Woolman (2014) finds that ERP system tangible benefits to the enterprise and its stakeholders can include increased profitability, reduced costs and greatly reduced management planning cycles.

Botchkarev & Andru (2011) defined intangibles as benefits which are difficult to measure and assign a monetary value. Murphy & Simon (2002) agree that quantifying ERP benefits are more challenging when assessing changes in business processes and information flows that influence decision support, but still intangibles should be included in investment project evaluation.

Swink & Schoenherr (2015) are suggesting that in order to measure intangible factors such as information flows, planning, decision making and relations, managers need to measure and track the impact of integration improvement and also to evaluate changes in the quality of planning and collaboration across company. Maiga *et al.* (2015) propose that managers should evaluate the impact of IT integration directly on cost and quality performance indirectly on organisation profitability. Kaplan & Norton (2001) found that intangible assets such as knowledge, design and service do not have direct impact on company profitability. The value is created by entire set of assets along with a strategy that links them together. In addition, it needs many linked organisational processes to transform intangible assets into valuable tangible products and services.

Molina (2003) classifies benefits into four broad categories: decrease effort and improve operating process performance, facilitate management support, gain competitive advantage and provide framework for business restructuring or transformation. Shang and Seddon (2000) classify benefits in their framework into 5 dimensions and 21 sub-dimensions. Their next study from business manager's perspective (Shang & Seddon 2002) adds more descriptions for benefits identification in Table 3.

Table 3. Descriptions of benefits in different dimensions

ERP benefits	Measures	Links with business benefits	How to identify these benefits?
Operational benefits	Tangible with measurable figures	Direct link with end-result in operations	Business managers asked about business value chain processes and business stakeholder support activities
Managerial benefits	Intangible	Reflected through using information and consequent benefit	Business managers asked about different kinds of resources affected and different levels of decision making
Strategic benefits	Intangible	Direct links with business expansion, and with product and marketing competition	Senior managers asked about achievement of the various strategic goals
IT infrastructure benefits	Tangible in IT cost	Indirect support for all kinds of business changes	IT managers asked about IT cost items and different types of business and technology changes
Organisational benefits	Intangible in IT capability Intangible	Indirectly driving positive outcomes in various parts of the business	Business managers asked about individual attitudes and interpersonal interactions

Source: Shang & Seddon (2002, p. 15), adopted by the author.

Table 3 presents that different benefits can be tangible and intangible. Murphy and Simon (2002:17) have related comments to Sheng and Seddon benefit framework that "regardless of tangible or intangible benefits, it is progressively more difficult to measure managerial, organisational and strategic benefits than infrastructure or operational benefits". Murphy and Simon (2002) also noticed that long term benefits like strategic and organisational are challenging to quantify and to evaluate financially, but short-term operational and IT infrastructure benefits can easily be quantified.

It can be agreed with Botchkarev and Andru (2011) that the border between intangibles and tangibles is fuzzy. In this study the focus is on measuring benefits and tangibility definition is a secondary subject. More important is benefit classification to understand benefits' expected behavior. Sari *et al*. (2012) have taken Shang and Seddon's framework, combined it with Ranti's (2008) 13 Generic IS business value categories and 73 sub-categories and developed list of ERP implementation benefits with 24 categories followed

by 73 sub-categories (Appendix 1). It will be the basis for this study's benefit classification.

As ERP implementation is a time consuming process and consists of different phases it is relevant to understand when benefits are emerging and what is expected benefit realisation time. Badewi & Shehab (2013) have made a model that combines benefits, costs and financial risks into a single equation. The model shows how ERP can affect the cashflows of the organisation across project's implementation time frame. In Figure 1, it is illustrated how the performance and business benefits decline, increase and stabilize in certain stages of ERP project.

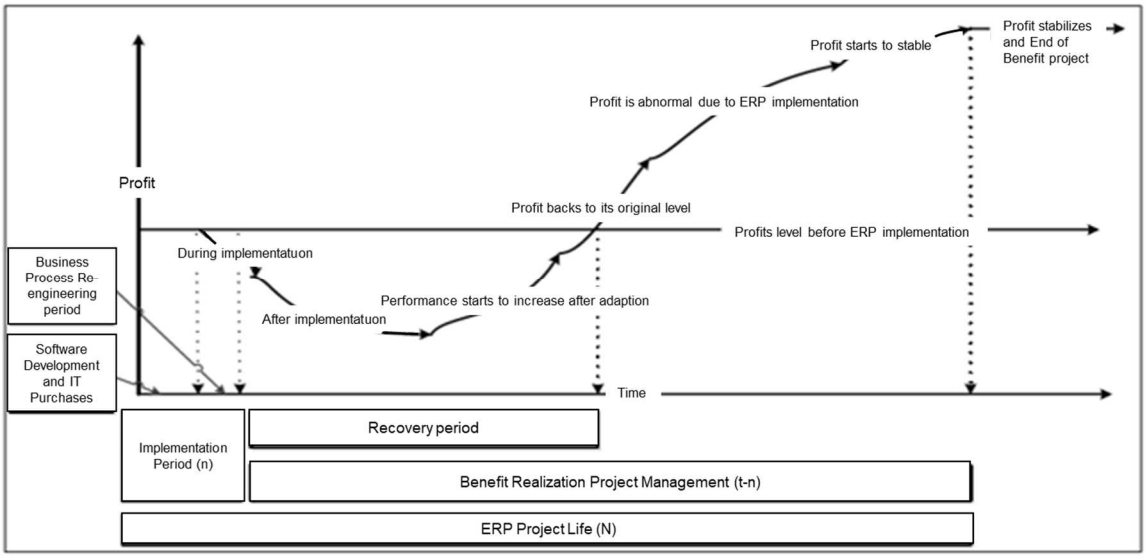

Figure 1. ERP Performance Lifecycle (Badewi & Shehab 2013, p. 209).

Figure 1 is presenting that there is time needed for organisation to reach value adding state and making the ERP implementation project into ERP benefit realisation project.

Velcu (2005) studied two groups of companies with successfully and less successfully adopted ERP systems. Beside the fact, that less successful ERP implementation hinders the exploitation of business processes and assets, they found that companies with successful ERP adoption have significantly better operational benefits in the first two years after implementation.

Based on the previously discussed studies, it is concluded that it takes time for an organisation to overcome the change resistance and fully adapt the ERP system. After

successful implementation the benefits are not realized right after the completion and it takes 1-2 years to achieve targeted performance. Time in the current study context is relevant from cash inflows and profitability measurement perspective and this introduces the next section focusing of the measurement of implementation benefits and profitability.

3. Methodology of ERP implementation

The following sections explain the business objectives, identification of ERP system benefits, project's costs and revenues, investment return assessment measures for the case study chosen for this thesis. As the case study, a wood supply organisation is used (a more detailed description of it provided in section 4), which should be accounted when setting the study's methodology.

3.1. Defining Objectives & Benefits

Researchers suggest starting a case study of ERP implementation with defining project objectives. Objectives should clearly state what organisation is going to achieve with the investment and what would drive project to a successful outcome. (Nafeeseh & Al-Mudimigh 2011; Ward *et al.* 2007)

Second step is to identify benefits that project objectives should deliver to organisation. When expected benefits are identified then two elements should be added: how the benefit will be measured and who is the benefit owner. (Ward *et al.* 2007)

According to Ward *et al*. (2007) in this way organisations build commitment to the project and can develop specific benefit realisation and organisational change plans. He also suggests structuring the benefits where organisation can: a) do new things or in a new way; b) do things better; c) stop doing things.

Ward *et al.* (2007) in their study do not give directions how to exactly define benefits from objectives. It seems that they expect the project manager and the management team to be fully aware of possible benefits rising from meeting the objectives. While their instructions are good as a starting point and support overall understanding of benefits, more detailed instructions are needed to know how to identify benefits. That gap is filled

by Murphy and Simon (2001) who have provided us with step by step guidelines how to identify and quantify intangible benefits. Their technique has four steps: 1) identify benefits using CSF and checklist of benefits; 2) make benefits measurable; 3) predict in physical terms; and 4) evaluate in cashflow terms. The guidelines in this section will be implemented in the empirical section of the thesis.

3.2. Measuring benefits

Murphy and Simon (2001, p. 7) suggest that intangible benefits can be converted into monetary terms through the ability to 1) maintain and increase sales, 2) increase prices, 3) reduce costs, and 4) create new business. More clarity for this subject can be taken from Kaplan & Norton (2001) who explain how improvements in intangible assets could become valuable quantifiable outcome by putting the assets into organisational process context. For example, in the wood supply context:

- Investment in people education lead to improvements in service quality
- Better service quality leads to higher forest owner satisfaction
- Higher forest owner satisfaction leads to increased loyalty and repeat business transactions
- Repeat business transactions deliver higher volumes and increased sales

To overcome the difficulty of benefit quantification Murphy and Simon (2001) suggest three methods: 1) market survey, 2) ERP management estimates, and 3) comparative case study with a similar business. Ward *et al.* (2007) brings out five ways how to convert measures into actual numbers: 1) pilot, 2) reference sites, 3) external benchmarking, 4) modelling or simulation and 5) detailed internal evidence. Evidently, these methods have a certain overlap and interconnections.

Considering given instructions from authors (Kaplan & Norton 2001; Murphy & Simon 2001; Nafeeseh & Al-Mudimigh 2011; Ward *et al.* 2007) we can combine the suggested methods into a four-step system to be implemented in this study:

Step 1. Define project objectives that should lead project to a successful outcome.

Step 2. Convert objectives into measurable benefits using business process context.

2.1 Identify benefits by using CSF and checklist of benefits.

2.2 Structure benefits in a way of:

doing new things, b) doing things better, c) stop doing things.

Step 3. Predict benefits' impact to process outcome in physical terms

Step 4. Calculate benefits' value to organisation and estimate benefit realisation period.

3.3. Financial measures

Most common ERP project financial measures are net present value (NPV), internal rate of return (IRR) and payback period (PB) which are also commonly referred to as return of investment or investment profitability measures.

3.3.1. Net present value

Net present value is the difference between an investment's present value and its cost. In other words, net present value is a measure of how much value is created or added today by undertaking an investment. (Ross *et al.* 2002)

To calculate NPV in Equation 1, expected future cash flows are estimated that are rising from benefits. Then, future cash flows are discounted to estimate present value. NPV is then the difference between the cost of the investment and the present value of the future cash flows. An investment should be accepted if the net present value is positive and rejected if it is negative. (Ross *et al.* 2002)

$$\mathrm{NPV} = \sum_{t=1}^{n} \frac{\mathrm{CF_t}}{(1+\mathrm{r})^t} - \mathrm{IO}$$

where CF – cashflow,
r – discount rate,
t – number of time period,
IO – initial outlay.

Equation 1. The calculation of the net present value (Ross *et al.* 2002), composed by author.

Before determining the NPV of the cash flows we need to set a discount rate. For this purpose, we use organisation weighted average of cost of capital (WACC), the average

rate that organisation must pay to borrow money from creditors and raise equity from stockholders.

3.3.2. Internal rate of return

The IRR on an investment is the required return that results in a zero NPV when it is used as the discount rate. Based on the IRR rule, an investment is acceptable if the IRR exceeds the required return. It should be rejected otherwise. (Ross *et al.* 2002)

To find the break-even discount rate in Equation 2, the NPV is set equal to zero (NPV = 0):

$$IO = \sum_{t=1}^{n} \frac{CF_t}{(1 + IRR)^t}$$

Equation 2. The calculation of internal rate of return (Ross *et al.* 2002), composed by author.

3.3.3. Discounted payback period

Payback is amount of time required for investment to return enough cash flows to recover its initial cost. To get the discounted payback (DPB), we calculate discounted cash flows and cumulative discounted cash flows in Equation 3. (Jan 2019)

$$Discounted\ Payback\ Period = A + \frac{B}{C}$$

where, A – Last period with a negative discounted cumulative cash flow,
B – Absolute value of discounted cash flow at the end of the period A,
C – Discounted cash flow during the period A.

Equation 3. The calculation of discounted payback period (Jan 2019).

Based on the discounted payback rule, an investment is acceptable if its discounted payback is less than prespecified number of years. (Ross *et al.* 2002)

4. Study design on the example of a wood supply organisation

4.1. Characteristics of wood supply process

Wood supply process is mainly about gathering and delivering wood to customers. It starts with customer demand for different wood products. Customer demand info is used for purchasing wood from forest owners. Production consists of wood harvesting and forwarding operations. After wood is forwarded from forest to roadside then transport logistics will be made. Wood is delivered and sold to customer which is the end of the process.

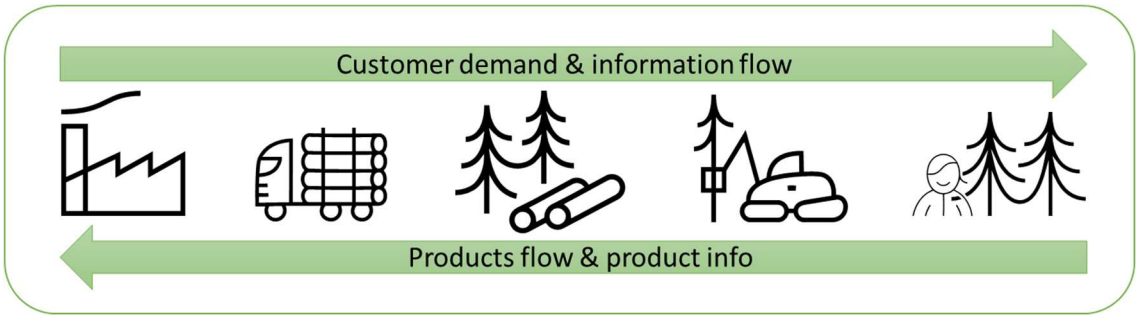

Figure 2. Wood supply process (source: author)

Figure 2 presents the information and products flow direction in wood supply chain. Wood supply organisation main customers are corporate paper- and sawmills who need different products from forest. Wood supply chain consists of different organisations who provide services and cooperation in harvesting, forwarding and logistics areas. Many organisations own machinery and provide full service to sell wood at the mill gate while some suppliers sell only standing forest and its wood supply organisation responsibility to provide all services to forest owner. Wood supply organisation role is to manage the supply chain in the most efficient way and to provide information at the right time to the participants on various stages in the supply chain.

There are many requirements for ERP system to meet the information need and to manage the wood supply chain efficiently. ERP system needs to cover whole wood supply process with core functionalities of planning, purchase, production operations, stocks, logistics, sales, finance and controlling (FICO). Additional functionalities for customer relation management (CRM), documents e-archive and reporting tools are also in this system

scope. The ERP system should be integrated with several public, forestry specific and corporate systems and it should have the ability to share the information with the supply chain participants and third parties.

Main mission for this ERP project is to renew ERP platform which will enable to meet the business and system development requirements to improve the supply chain efficiency. Even though, this project will impact the wood supply organisation business partners, it is relatively hard to evaluate and assimilate the impact on different types of organisations. Therefore, in this study the focus is only on a wood supply organisation internal business benefits.

People involved in this research are wood supply managers, procurement specialists, purchasers and controllers (hereafter as Team). Unstructured interviews have been conducted during the meetings with the Team. Total of 10,5 hours was spent on the meetings to define the project objectives and 10 hours to identify and quantify the benefits.

4.2. Study design with steps

Four-step guidelines from chapter 3.2 are used to start the business case for wood supply organisation. Step by step actions how to identify and measure benefits are described in Figure 2.

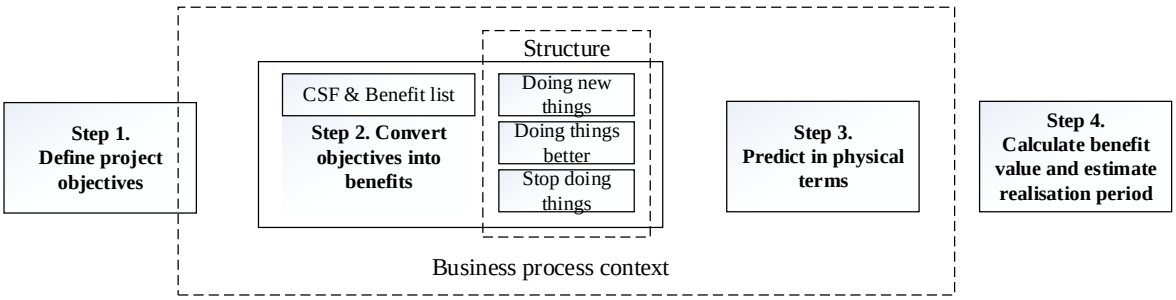

Figure 2. Guideline for identifying and measuring ERP benefits (Source: elaborated by the author, based on Kaplan & Norton 2001; Murphy & Simon 2001; Nafeeseh & Al-Mudimigh 2011; Ward *et al*. 2007)

Explanation for the guideline and usage in practice for the wood supply case is given in next sub-chapters.

4.2.1 Defining objectives

Objectives can be taken as important business process improvements. Realizing them would provide significant benefits and drive to successful ERP implementation. Objectives are defined in a way where: ERP supports wood supply organisation business strategy, important “as-is“ practice is supported, currently missing functionalities are added, business re-engineering and automatisation could be done, and where future requirements “to-be“ are also considered. Process-wise approach is used to identify the objectives, so the owner of the process and benefit are in place. Main processes where objectives are described are wood purchase, production, logistics, sales and FICO. Team has assigned 59 objectives to the ERP project (see Appendix 2).

4.2.2. Converting objectives to benefits

Within this study we have gathered information about organisational, individual, supply chain integration, system and vendor success factors and benefits. We have found source for benefits from Sari *et al*. (2012) study where catalogue of ERP implementation benefits is provided.

To convert objectives into measurable benefits two things are considered in process context: 1) objective direct or closest impact on process and 2) objective as benefit enabler. Benefits are identified though discussion with the Team and by using CSF information and the benefits lists. Each identified benefit is then classified by benefit catalogue. Benefit structure of *doing new thing*, *doing things better* and *stop doing things* is added to define process change.

4.2.3. Predict benefit impact

The principal methods of quantification is found in the chapter 3.2. In this section, the methods suitability for the current wood supply case is discussed.

Market survey is not used for this study because ERP benefits are focusing on the wood supply organisation only. Benchmarking needs understanding for comparative case background, objectives and business environment specifics, so it takes a lot of effort in order to make accurate comparison for ERP project. Pilot implementation could be very

complex in case of ERP system and it is not reasonable to start such process to prove certain benefits in ERP implementation pre-study phase. Modelling and simulation need experts or software and once again it raises the question of need to use them for benefit proofing in ERP project. In this study management estimates and detailed internal data is used for quantification. Combination of management estimation and internal data is the most reasonable way to quantify and to valuate benefits for this wood supply case. Estimation suits because of the strategic nature of current project and objectives. Management team can predict the outcome based on their knowledge and experience as they have insight of process bottlenecks. Internal data can be collected from current system as a base for a Team to evaluate the future value of the benefits.

Different data is available from previous business transactions like average wood and service prices and volumes. Process specific metrics and key performance indicators (KPIs) like document count, reject log percentage and forwarding costs are found in reports. Team predicted that from different functionality improvement, service quality increase, data quality increase and process automatisation, it is possible to reduce total work time of certain tasks for purchasers by 11.5%, for assistants 14.5%, for harbor terminal employees 12.5% and for forest masters 3.5%. It is also predicted that total annual sales are increased by 5.5% from improving reporting quality and info availability (see Appendix 3). It was agreed with Team to predict benefits' most realistic impact to organisation. This way the risk of overestimating cash flows is decreased. In this step benefits' measurement info is added that can be monitored during implementation and post implementation period to follow benefit realisation.

4.2.4. Calculation of benefit value

Team prediction of benefit impact to the process outcome is the basis for value calculation. For example, it is predicted that through purchase process improvement forest purchase volume is increased by 5% which is realized when the wood is sold to the customer. If the volume is multiplied by average sales price and by rate of profit, then the benefit value is generated.

Benefit measurements are used to calculate yearly cash flow. Estimated benefit realisation time bases on literature findings in chapter 1.4. (p. 16). Benefit realisation time is also

depending of ERP vendor vision of the implementation plan and related to project timeline. Current project is estimated to be finished in five years for three countries. Benefits are expected to be realized two years after implementation period (see Appendix 4). Five years total benefit value is calculated accordingly to benefit yearly realisation.

5. Results and discussion

5.1. Benefits' classification and quantification

As a result of the meetings and interviews, 59 benefits are identified. Benefits are categorized into four dimensions by their impact on process – operational, managerial, strategical and organisational dimension. Benefits are listed in 27 of 73 sub-categories and 11 of 24 categories (Appendix 1). Only dimension that is not marked is IT-infrastructure. This is an expected result as objectives are defined from business managers perspective where improvements are done through technology not on technology itself. If thinking on ERP project main goal of renewing system platform, then indirectly IT-infrastructure dimension could also be marked because new technology will probably increase business flexibility. Taking the fact that there are more benefits in the process context and technological benefits are not identified, then actual categorisation variation could be much wider.

From organisational change point of view, new ERP system should enable to *do things better* on 58% of benefit cases, *do new things* or *a new way* on 32% and on 10% of benefit cases we could *stop doing things*. This describes where the project objectives are aiming at and the nature of benefit low tangibility because we could not measure directly the impact of new functionality or functionality improvement.

Quantification of the benefits is a great challenge to the management team. Only a few objectives are referring to possible outcome and most of the benefit measures are found in a relation to process and to other benefits. As a summary (Appendix 3), 47% of total benefits are quantified. Other 53% could not be quantified because: 1) objectives are in the same process context causing benefit overlap, 2) objective is a base for other objective and its benefit to emerge, 3) mandatory functions doesn't bring new benefits, and 4)

insufficient proof to estimate objective impact on process. From not quantified benefits, 84% serve a supportive role which are mainly managerial benefits.

Eckartz *et al*. (2009) has a similar result where organisational and IT-infrastructure benefits have supporting role in ERP implementation. Their hypotheses of dependencies between benefit categories are not complete so managerial benefits could be added for future research. This shows that quantifiable outcome is related to different processes and dependent of one to several other benefits, making quantification complicated.

Taking process metrics and KPIs, the quantified benefit value to organisation is calculated. Total value of 3.2 million EUR is measured over five years period. Overview of benefits' values by the classification is given in the next sub-chapter to describe benefits' impact to the wood supply organisation.

5.1.1. Operational benefits

Operational dimension is about automatisation benefits from savings in labor and time. Operational benefits should be mostly or fully tangible and quantifiable (Murphy & Simon 2002) and in this case quantification percentage is 80% which proves the statement. Having 47% of listed benefits, it is the biggest contributor to cash flow - 76% from total revenue is expected after implementation. Operational benefits of cycle time reduction, cost reduction, data quality and customer service improvement should deliver over 2.4 million EUR (see Table 4).

Table 4. Operational benefits' classification and value

Operational dimension categories	Benefit count	Total value
Cost reduction	**6**	**517 639 €**
Reducing cost of communication	1	28 435 €
Reducing cost of delivery	1	46 224 €
Reducing cost of services	3	160 500 €
Reducing returning cost for incorrect delivery	1	282 480 €
Customer services improvement	**2**	**192 600 €**
Reducing order cancellation	2	192 600 €
Cycle time reduction	**15**	**1 474 680 €**
Accelerating order checking process	2	3 159 €
Accelerating process of data preparation	3	34 491 €
Accelerating production process	2	1 253 428 €

Accelerating transaction process	5	97 771 €
Acceleration process of stock procurement	3	85 832 €
Data quality improvement	**5**	**285 904 €**
Increasing accuracy of data	1	- €
Reducing risk of price miscalculation	3	285 904 €
Reducing risk of incorrect data	1	- €
Grand Total	**28**	**2 470 823 €**

There is type of service cost reduction benefit that rises from increasing resources planning quality and as there is no good match found in the benefit catalogue, the *Cost of services* is suggested as additional sub-category in cost reduction category.

Most of the value is in operational dimension but there are not many hints if the benefit quantification outcome will be operational or other dimension. Still, based on this study and other authors covered in this research, we can suggest for project managers to start benefit quantification from operational benefits when possible to get quick insight on revenues.

5.1.2. Strategic benefits

Strategic dimension benefits expected incoming cash flow in Table 5 is 728 thousand EUR, making it 23% of total revenues.

Table 5. Strategic benefits' classification and value

Strategic dimension categories	Benefit count	Total value
Support current and future business growth plan	**11**	**728 028 €**
Accelerating the execution of new business opportunities	1	44 940 €
Increasing customer trust	1	- €
Increasing quality of better supplier/vendor management	2	321 000 €
Increasing quality of services	4	- €
Increasing revenue caused by increasing business capacity	2	321 000 €
Increasing revenue caused by increasing report quality	1	41 088 €
Support external linkages	**4**	**- €**
Complying with regulations	4	- €
Grand Total	**15**	**728 028 €**

25% of total benefits listed in strategic dimension are occurring in two categories:

1) Support current and future business growth plan – by Murphy and Simon (2002) this category should be fully quantifiable but we could quantify only 36% of benefits. 64% are found to be supportive for the other dimension benefit.
2) Support external linkages – in low tangibility category (Murphy & Simon 2002) the benefits are seen in complying with regulations. These are mainly occurring in FICO process and could not be measured. We could only observe the completion of the objective during ERP implementation and simple yes/no can be answered to the question if the benefit has been achieved after implementation.

5.1.3. Managerial benefits

This dimension is about making better decisions from using real-time information and increasing the accuracy of analysis and planning. 79% of managerial benefits are supporting many other benefits that are emerging in operational and strategical dimensions. Most of the benefits realisation is observable and not measurable. 21% could be quantified into ~38 thousand EUR worth of risk reduction (see Table 6).

Table 6. Managerial benefits' classification and value

Managerial dimension categories	Benefit count	Total value
Better decision making	**12**	**- €**
Accelerating decision making process	4	- €
Increasing accuracy of analysis	4	- €
Increasing accuracy of planning	4	- €
Better performance control	**1**	**21 400 €**
Reducing risk of forgery	1	21 400 €
Better resource management	**1**	**16 407 €**
Reducing risk of incorrect payment	1	16 407 €
Grand Total	**14**	**37 807 €**

This dimension has high 24% of total benefits listed but almost no impact on incoming cash flow – 1% of total revenues. In such case managerial benefits' value to the case study may be questionable, but for managers these are very important due to the positive impact on process steering capabilities and their supportive role for other dimensions' benefits.

5.1.4. Organisational benefits

There are two benefits in organisational dimension in Table 7. Non-measurable benefits are emerging from impact on employee's way of working.

Table 7. Organisational benefits' classification and value

Organisational dimension categories	Benefit count	Total value
Facilitate business learning and broaden employee skills	**1**	**- €**
Increasing internal services of personal feedback	1	- €
Support business organisational changes	**1**	**- €**
Matching employee's right and responsibility	1	- €
Grand Total	**2**	**- €**

New sub-category is suggested to this dimension. It is seen that *Increasing internal services of personal feedback* could affect positively many business areas. Organisational benefits' value lies in supporting operational benefits.

5.1.5 Summary of benefits

Structured benefits encouraged better discussion, brought more clarity to the Team and revealed what type of business changes are needed to deliver implementation benefits.

It can be said that even when in some cases the link between category and sub-category does not suit well on wood supply business and may prefer other type of combination between them, the Sari *et al.* (2012) list of benefits is a good source to start benefit identification for ERP project.

Sari *et al*. (2012) tested the catalogue applicability in Indonesia palm oil business organisation engaged in agricultural sector. Their analyses show benefits of ERP system in 5 dimensions, 19 categories and 41 sub-categories, where most of the benefits are gained in operational dimension. Comparing with current result of benefits' classification in 4 dimensions, 11 category, 27 sub-category and 47% benefits in operational dimension, we can claim that their proposed catalogue applicability is once more proved. Because Sari *et al.* (2012) study was conducted many years after the ERP implementation, we could predict higher benefit variation also for this project when it is finished.

5.2. Cash flow structure

To calculate main profitability measures of net present value (NPV), internal rate of return (IRR) and payback time (PB), typical cash flow components of inflows and outflows are needed.

5.2.1 Inflows

Benefits are grouped into three inflow components of cost avoidance, cost saving and increased revenues. Cost avoidance is about avoiding penalties, extra work and avoiding cash loss from bad business. In cost saving we are mainly reducing time of certain works and we can calculate the cost of the work time. Increased revenues are additional sales of wood from business growth, which are calculated as net cash flow (profit) from this activity. The incoming cash flows from additional revenues or decreased costs have total value of 3,2 million EUR (see Table 8).

Table 8. Annual incoming cash flow and total benefits value

Timeline	Year 0	Year 1	Year 2	Year 3	Year 4	Total
Cost avoidance	- €	- €	301 690 €	446 502 €	543 043 €	
Cost savings	- €	- €	239 197 €	354 380 €	431 218 €	
Increased revenues	- €	- €	215 100 €	318 348 €	387 180 €	
Annual total inflow	- €	- €	755 987 €	1 119 230 €	1 361 441 €	3 236 658 €

Year 0 is when the ERP implementation starts. In Year 1 the system is ready to use for first country and implementation roll-out continues to second country. Year 2 inflow consists first country benefits that are realized after one year of adaption period and at the same time the system roll-out continues to third country. In Year 3 the benefits of first and second country are being realized. In Year 4 the third country benefits are added to inflow with first two countries, reaching to the of benefit realisation period.

5.2.1. Outflows

ERP investment project has three main cost components: IT infrastructure costs, labour and vendor service costs. IT infrastructure is about software licences, annual maintenance, hardware purchase and servers purchasing, hosting and installation. Labour

includes operating expenses, salaries and wages for IT and business unit employees who do the in-house development, testing and maintenance. Vendor is providing consultation services of installation, configuration, software customisation and integrations to other systems. Vendor responsibility is also IT and end-user personnel training. Table 9 is presenting estimated yearly cost of each component of ERP implementation and total outflow of over 2.7 million EUR€.

Table 9. Annual cash outflows from initial investment and consecutive operation cost

Timeline	Year 0	Year 1	Year 2	Year 3	Year 4	Total
IT infrastructure	- 131 851 €	- 253 227 €	- 253 227 €	- 253 227 €	- 253 227 €	
Labour	- 230 400 €	- 192 000 €	- 153 600 €	- 115 200 €	- 76 800 €	
Vendor services	- 612 200 €	- 110 775 €	- 73 500 €	- 36 750 €	- 18 375 €	
Annual total outflow	- 974 451 €	- 556 002 €	- 480 327 €	- 405 177 €	- 348 402 €	- 2 764 359 €

41% of total project spending is made during project start in Year 0. Most of the costs comes from vendor services. Vendor service cost depends on work amount needed for software development, tailoring, integrations and country specific adjustments. After the system is fully implemented in Year 2, it is estimated that vendor costs are reduced significantly. Labour costs are reduced year by year as not so many employees are needed after system implementation in a country. IT infrastructure cost difference in Year 0 and rest of the years comes from the number of purchased software licences.

5.3. Profitability of ERP implementation

Annual cash flow is the basis for profitability calculation. To get the discounted cash flow, the discount rate is set and wood supply organisation WACC 5% is used. Main profitability measures are presented in Table 10.

Table 10. ERP implementation profitability measures

Timeline	Year 0	Year 1	Year 2	Year 3	Year 4	Total
Annual total inflow	- €	- €	755 987 €	1 119 230 €	1 361 441 €	3 236 658 €
Annual total outflow	- 974 451 €	- 556 002 €	- 480 327 €	- 405 177 €	- 348 402 €	- 2 764 359 €
Total cash flow	- 974 451 €	- 556 002 €	275 660 €	714 053 €	1 013 039 €	472 299 €
Discounted cash flow	- 974 451 €	- 529 526 €	250 032 €	616 826 €	833 430 €	196 311 €
Cumulative NPV	- 974 451 €	- 1 503 977 €	- 1 253 945 €	- 637 119 €	196 311 €	
NPV	196 311 €					
IRR	4%					
DPB (years)	3.8					

Total inflow is bigger than outflow and after discounting the net present value is approximately 196 thousand EUR. If the NPV is positive, then investment should be accepted. Discounted payback time, calculated from discounted cashflow and cumulative NPV, shows positive value in Year 3 and the investment return point is 3.8 years. IRR in this case is 4%, which is lower compared to required rate of usual investment projects, but it is acceptable for wood supply organisation chosen for the current study. The reason is that the current project is about renewing ERP system so there could be phase 2 for ERP and business development which enables greater benefits from e-services and process harmonisation. Second reason is that the wood supply organisation purpose is firstly to supply internal customers and by updating the system, it could be done in sustainable way.

All though base scenario shows the acceptability of the ERP implementation in terms of profitability, to foresee other possible scenarios the financial measures are calculated in terms of 80% and 120% of benefits value in Table 11.

Table 11. Profitability scenarios on benefit value of 80%, 100% and 120%.

Scenario 80%		Current case scenario		Scenario 120%	
NPV	-358 209 €	NPV	196 311 €	NPV	750 830 €
IRR	-8%	IRR	4%	IRR	15%
DPB (years)	4.7	DPB (years)	3.8	DPB (years)	3.3

There is a possibility that Team estimation has been too moderate because of uncertainty of process changes and actual benefits' impact on process outcome is higher. Taking the estimation as 120%, the present value of the investment would be 750 thousand EUR. The return rate jumps from 4% to 15%, which makes big difference when making investment decision. Together with nearly three years payback time, it would be perfect investment project for a wood supply organisation.

In a large-scale project, it is possible that some objectives aren't fully completed or achieved at all and benefits will not realize 100%. Team may have overestimated some of the benefits because of low insight on process changes and their emotional willingness to have greater impact. So actual value could be 80% from current estimation. Then NVP drops and IRR turns negative, payback time is increasing near to five years and the investment is not acceptable anymore.

To overcome the worst-case scenario, we could study the benefits of customers, suppliers and other stakeholders. Identifying and measuring stakeholder benefits may have great impact on case study profitability. Adding stakeholder benefits as incoming cash flow to profitability calculation we could get positive outcome.

Conclusions

The aim for this study was to investigate ERP implementation benefits to calculate investment return in a wood supply organisation. In the relevant scientific literature, many articles are found regarding ERP implementation, critical success factors and benefits. Based on literature the ERP system is defined and ERP implementation methodology is composed. There are only a few guidelines that discuss how to measure ERP benefits. To fill the gap in the literature, the four-step guideline is compiled and practiced in this study. Following the guideline, the management team assigned 59 ERP implementation objectives, identified and classified benefits for a wood supply organisation. 47% of total benefits are quantified and their value to organisation is calculated. It is concluded that benefit quantification is complicated because benefits are dependent of one to several other benefits from different processes. By benefit classification the biggest contributors to cash flow are operational benefits that are making 75% of total revenue. Managerial benefits are the biggest supporters for other benefits to emerge.

Main ERP profitability measures of net present value, internal rate of return and payback time are calculated based on project's costs and revenues during the five years period. Cash flow inflows of 3.2 million EUR and outflows of 2.7 million EUR is calculated. Most realistic scenario by the wood supply organisation's management team estimate has NPV 196 thousand EUR, IRR 4% and payback time 3.8 years. While optimistic scenario of 120% is considered as the perfect ERP system investment, then the pessimistic scenario of 80% could end up cancelling the project, but solution can be found by adding the stakeholders benefits which could make the project acceptable again for wood supply organisation.

This study can be used by project managers as stylized example, but the exact calculation mechanisms nor the results might not be fully transferrable to organisations functional in different industries. In this study management team measured objective direct or closest impact to process by identifying one main benefit but there are side benefits that are not listed and measured. Objective impact is measured for wood supply organisation only and stakeholders are left out for estimation accuracy purposes. Another study for stakeholder benefits could be conducted. This study can serve as base for further research to identify

and measure stakeholder's benefits in a wood supply chain. Methodological guidelines suggested for ERP implementation in this study can be used for every software system implementation evaluation.

References

Ağaoğlu, M., Yurtkoru, E. S., & Ekmekçi, A. K. (2015). The Effect of ERP Implementation CSFs on Business Performance: An Empirical Study on Users' Perception. *Procedia - Social and Behavioral Sciences*, *210*, 35–42. https://doi.org/10.1016/j.sbspro.2015.11.326

Alalwan, J. (2010). Can IT Resources Lead to Sustainable Competitive Advantage? *Proceedings of the Southern Association for Information Systems Conference*, 231–236. Retrieved from https://aisel.aisnet.org/cgi/viewcontent.cgi?article=1040&context=sais2010

Alshawi, S., Irani, Z., & Baldwin, L. (2003). Benchmarking information technology investment and benefits extraction. *Benchmarking: An International Journal*, *10*(4), 414–423. https://doi.org/10.1108/14635770310485015

Badewi, A., & Shehab, E. (2013). Cost, Benefit, and Financial Risk (COBEFR) of ERP Implementation. *Proceedings of the 11th International Conference on Manufacturing Research (ICMR2013)*, (September 19th-20th), 207–212. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2605551

Bobek, S., Rohadia, S., & Sternad, S. (2016). *ERP Solutions Acceptance in Different Business Environments*. *5*(2), 103–108. Retrieved from http://www.internationaljournalcorner.com/index.php/ijird_ojs/article/view/136052

Bokovec, K., Damij, T., Rajkovic, T., & Rajkovic, V. (2010). Evaluating ERP projects with global efficiency factors. *Frontiers in Artificial Intelligence and Applications*, *212*, 395–406. https://doi.org/10.3233/978-1-60750-577-8-395

Botchkarev, A., & Andru, P. (2011). A return on investment as a metric for evaluating information systems: Taxonomy and application. *Interdisciplinary Journal of Information, Knowledge, and Management*, *6*, 245–269. https://doi.org/10.28945/1535

Candra, S. (2013). ERP Implementation Success and Knowledge Capability. *Procedia - Social and Behavioral Sciences*, *65*(ICIBSoS), 141–149. https://doi.org/10.1016/j.sbspro.2012.11.103

DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean Model of Information System Success. *Journal of Management Information Systems*, *19*(4), 9–30.

https://doi.org/10.1080/07421222.2003.11045748

Eckartz, S., Daneva, M., Wieringa, R., & van Hillergersberg, J. (2009). A Conceptual Framework for ERP Benefit Classification: A Literature Review. In *CTIT Technical Report Series. No. 09-04*. Retrieved from https://ris.utwente.nl/ws/portalfiles/portal/5115585/TechnicalReportBenefitFramework.pdf

Hubbard, D. W. (2014). *How to Measure Anything: Finding the Value of Intangibles in Business*. https://doi.org/10.1002/9781118983836

Ince, H., Imamoglu, S. Z., Keskin, H., Akgun, A., & Efe, M. N. (2013). The Impact of ERP Systems and Supply Chain Management Practices on Firm Performance: Case of Turkish Companies. *Procedia - Social and Behavioral Sciences*, *99*, 1124–1133. https://doi.org/10.1016/j.sbspro.2013.10.586

Jan, I. (2019). Discounted payback period. Retrieved May 16, 2019, from https://xplaind.com/572953/discounted-payback-period

Jeyaraj, A., & Sethi, V. (2010). Implementation of Information Systems Infrastructures for Supply Chain Visibility. *Proceedings of the Southern Association for Information Systems Conference*, *14.*, 75–79. Retrieved from http://aisel.aisnet.org/sais2010/14

Johansson, B., Karlsson, L., Laine, E., & Wiksell, V. (2016). After a Successful Business Case of ERP - What Happens then? *Procedia Computer Science*, *100*, 383–392. https://doi.org/10.1016/j.procs.2016.09.173

Kaplan, R. S., & Norton, D. P. (2001). Transforming the BSC from performance measurement to strategic management: part I. *Accounting Horizons*, *15*(1), 87–104. https://doi.org/10.2308/acch.2001.15.1.87

Kimberling, E. (2006). In Search of Business Value : How To Achieve the Benefits of ERP Technology. *Panorama Consulting Group, LLC*, pp. 1–8. Retrieved from http://hosteddocs.ittoolbox.com/EK41806.pdf

Krivtsov, A. I., Polinova, L. V., Ivankina, M. S., Chubarkova, E. V., & Prokubovskaya, A. O. (2016). Corporate information management system and its influence on increase of changes productivity. *International Journal of Environmental and Science Education*, *11*(15), 7627–7636. Retrieved from https://files.eric.ed.gov/fulltext/EJ1117313.pdf

Kumar, A., & Gupta, P. C. (2013). Identification and Analysis of Failure Attributes for an ERP System. *Procedia - Social and Behavioral Sciences*, *65*(ICIBSoS), 986–991. https://doi.org/10.1016/j.sbspro.2012.11.231

Lee, R. C. (2012). Does the Success of Information Systems Really Matters to Firm Performance? *IBusiness*, *04*(02), 98–107. https://doi.org/10.4236/ib.2012.42012

Leuschner, R., Rogers, D. S., & Charvet, F. F. (2013). A meta-analysis of supply chain integration and firm performance. *Journal of Supply Chain Management*, *49*(2), 34–57. https://doi.org/10.1111/jscm.12013

Maiga, A. S., Nilsson, A., & Ax, C. (2015). Relationships between internal and external information systems integration, cost and quality performance, and firm profitability. *International Journal of Production Economics*, *169*, 422–434. https://doi.org/10.1016/j.ijpe.2015.08.030

Marinagi, C., Trivellas, P., & Sakas, D. P. (2014). The Impact of Information Technology on the Development of Supply Chain Competitive Advantage. *Procedia - Social and Behavioral Sciences*, *147*, 586–591. https://doi.org/10.1016/j.sbspro.2014.07.161

Matende, S., & Ogao, P. (2014). Enterprise Resource Planning (ERP) System Implementation: A Case for User Participation. *Procedia Technology*, *9*, 518–526. https://doi.org/10.1016/j.protcy.2013.12.058

Mitra, P., & Mishra, S. (2016). Behavioral aspects of ERP implementation: A conceptual review. *Interdisciplinary Journal of Information, Knowledge, and Management*, *11*, 17–30.

Molina, E. S. (2003). *Evaluating IT Investments A Business Process Simulation Approach* (Kungl Tekniska Högskolan). Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.203.4541&rep=rep1&type=pdf

Murni, F., Suhaimi, A., & Budiarto, R. (2011). Measuring The Tangibles and Intangibles Value of an ERP Investment. *Proceedings of the 3rd International Conference on Computing and Informatics, ICOCI*, (123), 61–66. Retrieved from https://pdfs.semanticscholar.org/b9e8/6478759cb9eb7fb910ac4c87a13339bc0755.pdf

Murphy, K. E., & Simon, S. J. (2001). Using cost benefit analysis for enterprise resource planning project evaluation: a case for including intangibles. *Proceedings of the 34th*

Annual Hawaii International Conference on System Sciences, *00*(c), 11. https://doi.org/10.1109/HICSS.2001.927131

Murphy, K. E., & Simon, S. J. (2002). Intangible benefits valuation in ERP projects. *Information Systems Journal*, *12*(4), 301–320. https://doi.org/10.1046/j.1365-2575.2002.00131.x

Nafeeseh, R. A., & Al-Mudimigh, A. S. (2011). Justifying ERP Investment: The Role and Impacts of Business Case A Literature Survey. *IJCSNS International Journal of Computer Science and Network Security*, *Vol.11*(1), 185–193. Retrieved from http://paper.ijcsns.org/07_book/201101/20110128.pdf

Nofal, M. I., & Yusof, Z. M. (2014). Integration of Business Intelligence and Enterprise Resource Planning within Organizations. *Procedia Technology*, *11*(Iceei), 658–665. https://doi.org/10.1016/j.protcy.2013.12.242

O'Leary, D. E. (2004). Enterprise Resource Planning (ERP) Systems: An Empirical Analysis of Benefits. *Journal of Emerging Technologies in Accounting*, *1*(1), 63–72. https://doi.org/10.2308/jeta.2004.1.1.63

Orougi, S. (2015). Recent advances in enterprise resource planning. *Accounting*, *1*, 37–42. https://doi.org/10.5267/j.ac.2015.11.004

Pérez-Méndez, J. A., & Machado-Cabezas, Á. (2015). Relationship between management information systems and corporate performance. *Revista de Contabilidad*, *18*(1), 32–43. https://doi.org/10.1016/j.rcsar.2014.02.001

Power, D. (2005). Supply chain management integration and implementation: a literature review. *Supply Chain Management: An International Journal*, *10*(4), 252–263. https://doi.org/10.1108/13598540510612721

Rajan, C. A., & Baral, R. (2015). Adoption of ERP system: An empirical study of factors influencing the usage of ERP and its impact on end user. *IIMB Management Review*, *27*(2), 105–117. https://doi.org/10.1016/j.iimb.2015.04.008

Ranti, B. (2008). The Generic IS/IT Business Value Category : Cases in Indonesia. *Konferensi Dan Temu Nasional TIK Untuk Indonesia*, 1–6. Retrieved from https://www.slideshare.net/yaqinov/fullpaper170-benny-ranti

Rashid, M. A., Hossain, L., & Patrick, J. D. (2002). The evolution of ERP systems: A historical perspective. In *Enterprise Resource Planning* (pp. 1–16). https://doi.org/10.4018/978-1-931777-06-3.ch001

Ross, S. A., Westerfield, R. W., & Jordan, B. D. (2002). *Fundamentals of Corporate Finance* (Sixth, Vol. 1). The McGraw−Hill Companies.

Rouhani, S., & Zare Ravasan, A. (2012). ERP success prediction: An artificial neural network approach. *Scientia Iranica*, *20*(3), 992–1001. https://doi.org/10.1016/j.scient.2012.12.006

Sari, N., Hidayanto, A., & Handayani, P. (2012). Toward Catalog of Enterprise Resource Planning (ERP) Implementation Benefits for Measuring ERP Success. *The Journal of Human Resources Management Research*, *2012*, 1–16. https://doi.org/10.5171/2012.869362

Shang, S., & Seddon, P. B. (2000). A Comprehensive Framework for Classifying the Benefits of ERP Systems. *AMCIS 2ooo Proceedings. Paper 39*, 1005–1014. Retrieved from http://aisel.aisnet.org/amcis2000/39

Shang, S., & Seddon, P. B. (2002). Assessing and managing the benefits of enterprise systems: the business manager's perspective. *Information Systems Journal*, *12*(4), 271–299. https://doi.org/10.1046/j.1365-2575.2002.00132.x

Swink, M., & Schoenherr, T. (2015). The Effects of Cross-Functional Integration on Profitability, Process Efficiency, and Asset Productivity. *Journal of Business Logistics*, *36*(1), 69–87. https://doi.org/10.1111/jbl.12070

Tams, S. (2010). Information Systems Development Risk, Success, and Firm Performance: the Missing Link. *SAIS 2010 Proceedings. 40.*, 130–135. Retrieved from https://aisel.aisnet.org/sais2010/40

Teo, L. K. Y., Singh, M., & Cooper, V. (2014). A Contingent Model for Evaluating Enterprise Systems' Benefits Using Competing Value Approach. *25th Australasian Conference on Information Systems*, 1–10. Retrieved from https://openrepository.aut.ac.nz/handle/10292/8070

Themistocleous, M., Irani, Z., & Love, P. E. D. (2004). Evaluating the integration of supply chain information systems: A case study. *European Journal of Operational Research*, *159*(2), 393–405. https://doi.org/10.1016/j.ejor.2003.08.023

Uçaktürk, A., & Villard, M. (2013). The Effects of Management Information and ERP Systems on Strategic Knowledge Management and Decision-making. *Procedia - Social and Behavioral Sciences*, *99*, 1035–1043. https://doi.org/10.1016/j.sbspro.2013.10.577

Velcu, O. (2005). Impact of the Quality of ERP Implementations on Business Value. *Electronic Journal of Information Systems Evaluation*, *8*(3), 229–238. Retrieved from http://www.ejise.com/issue/download.html?idArticle=569

Ward, J., Daniel, E., & Peppard, J. (2007). Building Better Business Cases for IT Investments. *MIS Quarterly Executive*, *7*. Retrieved from https://pdfs.semanticscholar.org/990c/22c22576e1783e5b06cdee377581eda614ee.pdf

Wei, C.-C., Chien, C.-F., & Wang, M.-J. J. (2005). An AHP-based approach to ERP system selection. *International Journal of Production Economics*, *96*(1), 47–62. https://doi.org/10.1016/j.ijpe.2004.03.004

Woolman, T. A. (2014). Guiding Principles for Successful Enterprise Performance Solution System Implementations. *International Journal of Business and Management*, *9*(10), 143–148. https://doi.org/10.5539/ijbm.v9n10p143

Young, R. (2006). What is the ROI for IT Project Governance? Establishing a benchmark. *2006 IT Governance International Conference*, (June), 11. Retrieved from https://www.researchgate.net/publication/266872806_What_is_the_ROI_for_IT_Project_Governance_Establishing_a_benchmark

Zhang, Z., Lee, M. K. O., Huang, P., Zhang, L., & Huang, X. (2005). A framework of ERP systems implementation success in China: An empirical study. *International Journal of Production Economics*, *98*(1), 56–80. https://doi.org/10.1016/j.ijpe.2004.09.004

Appendices

Appendix 1. Benefit catalogue and business case results

Dimensions	Benefit Categories	Benefit Sub-Categories	Sari et al. (2012)	Wood supply case
Operational	Cost reduction	**Reducing Cost of**		
		communication	*	*
		travelling		
		staff/operator/employee		
		meeting		
		service failure		
		delivery	*	*
		training cost per employee		
		returning cost for incorrect delivery		*
		money		
		office supplies and printing	*	
		subscription cost of certain reading materials or		
		subscription cost per employee		
		space rental		
		device rental		
		inventory	*	
		research failure		
		service (suggested by author)		*
		Avoiding Cost (ACO) of		
		reserved fund		
		maintenance		
		lost and delay	*	
	Cycle time reduction	**Accelerating Process of**		
		production		*
		stock procurement		*
		report making	*	
		data preparation	*	*
		order checking	*	*
		debt payment		
		transaction	*	*
	Productivity improvement	**Increasing Productivity caused by**		
		restructuring job function	*	

		accelerating mastering product knowledge		
		ease of analysis	*	
		increasing employee satisfaction	*	
	Data quality improvement	**Reducing Risk of**		
		price miscalculation	*	*
		data lost	*	
		incorrect data	*	*
		Increasing Accuracy of		
		data	*	*
	Customer services improvement	**Increasing External Services of**		
		reducing order cancellation	*	*
		customer's problems		
		personalized services		
		customer satisfaction	*	
Managerial	Better resource management	**Reducing Risk of**		
		unrecoverable claim		
		inventory lost	*	
		rejected goods		
		penalty		
		losing potential employee		
		incorrect payment	*	*
		asset mismanagement	*	
	Better decision making	**Accelerating Process of**		
		decision making	*	*
		Increasing Accuracy of		
		analysis	*	*
		planning	*	*
		decision	*	
	Better performance control	**Reducing Risk of**		
		forgery	*	*
		administration fraud	*	
Strategical	Support current and future business growth plan	**Increasing Revenue caused by**		
		increasing business capacity	*	*
		increasing report quality	*	*
		increasing customer trust	*	*
		Increasing Quality of		
		better supplier/vendor management		*
		work result	*	
		services	*	*
		products	*	
		Increasing Competitive Advantage caused by		

		accelerating the execution of new business opportunities	*	*
	Support business alliances	**Increasing Competitive Advantage caused by** forming business alliances		
	Support business innovation		*	
	Support cost leadership	**Accelerating Cash-in caused by** accelerating billing dispatching **Increasing Revenue caused by** increasing other incomes **Increasing Accuracy of** billing **Increasing Competitive Advantage caused by** increasing switching cost	*	
	Support external linkages	**Increasing Image caused by** increasing service quality offering substantial discounts complying with regulations using branded systems	*	*
	Enables worldwide expansion	**Increasing Revenue caused by** widening market segment **Increasing External Services of** adding point of services		
	Enables e-business			
IT-infrastructure	Increased business flexibility			
	IT cost reduction			
	Increased IT Infrastructure capability		*	
Organisational	Support business organisational changes	**Increasing Internal Services of** shared services matching employee's right and responsibility employee services	*	*
	Facilitate business learning and broaden and employee skills	**Increasing Internal Services of** personal feedback (suggested by author) proper schedule and training material	*	*
	Empowerment			
	Changed culture with a common vision		*	

	Changed employee behavior with a sifted focus		*	
	Better employee morale and satisfaction		*	

Appendix 2. ERP implementation objectives and benefits in wood supply case

Process	Process Objective/Improvement	Objective Benefit/Enabler	Sub-categories/Process Benefit	Benefit nr
Purchase	Overview of all resources	Improved decisions by info availability	Increasing revenue caused by increasing business capacity	B1
Purchase	Inquiry and feedback	Increasing supplier satisfaction and loyalty	Reducing cost of communication	B2
Purchase	Connection with public databases	Controlling business legitimacy	Reducing risk of forgery	B3
Purchase	Volumes are inserted into system by supplier	Improved purchase planning	Accelerating process of data preparation	B4
Purchase	Fast and accurate information exchange with vendors	Improved decisions by info availability	Accelerating the execution of new business opportunities	B5
Purchase	Accurate pricelists based on product value	Sustainable wood price levels	Reducing risk of price miscalculation	B6
Purchase	Targeted offers according to customer needs and forest type	Increasing personalized services	Increasing revenue caused by increasing business capacity	B7
Purchase	Offer registration and feedback statistics	Increasing service quality	Reducing order cancellation	B8
Purchase	Average prices calculation	Predicting price trends	Reducing risk of price miscalculation	B9
Purchase	Offer and contract signing on site	Convenient offering and contracting	Reducing order cancellation	B10
Purchase	Different contract forms	Clear terms for each contract type	Increasing quality of services	B11
Purchase	Measurement deed signing in system by all parties	Digital signing service	Accelerating transaction process	B12

Purchase	Primary origin control is done by system	Reducing risk of forgery	Accelerating order checking process	B13
Purchase	Precise measurement data fast movement and sharing with vendors	Increasing service quality	Acceleration process of stock procurement process	B14
Purchase	Invoice and payment statuses are visible to vendors	Increasing service quality	Acceleration process of stock procurement process	B15
Purchase	Purchaser dashboard	Overview of business status	Accelerating decision making process	B16
Purchase	Week done (task prior)	Daily task lists and reminders	Increasing accuracy of planning	B17
Purchase	Agreement and contract operative statuses are visible to team and vendors	Increasing reporting quality	Increasing quality of better supplier/vendor management	B18
Production	Cost, working time, seasons and efficiency overview	Increasing reporting quality	Increasing accuracy of analysis	B19
Production	Site, work & resource overview	Increasing planning quality	Reducing cost of services	B20
Production	Valuable log feedback and work order correction on site	Increasing data availability	Reducing returning cost for incorrect delivery	B21
Production	Map application	Increasing planning quality	Reducing cost of services	B22
Production	Harvester, forwarder and team connection for communication	Improved communication	Accelerating decision making process	B23
Production	GPS location and tracking	Improved machinery surveillance	Increasing quality of services	B24
Production	Data export to system	Increasing data quality	Reducing risk of incorrect data	B25
Production	Service works surveillance	Increasing service quality	Accelerating production process	B26
Production	Site budget vs actual	Increasing reporting quality	Increasing accuracy of analysis	B27
Production	Info transparency and fast exchange with forest owner	Increasing reporting quality	Increasing customer trust	B28

Production	Connecting data and generating act	Improving data preparation	Accelerating transaction process	B29
Logistics	Operational data is in system	Increasing data availability	Accelerating decision making process	B30
Logistics	Action plan and delivery plan	Increasing planning quality	Reducing cost of services	B31
Logistics	Transport estimations are visible in system	Increasing data availability	Increasing quality of better supplier/vendor management	B32
Logistics	Overview of wood stocks & levels	Accelerating decision making process	Reducing cost of delivery	B33
Logistics	Origin documents are linked with E-waybill	Accelerating transaction process	Accelerating process of data preparation	B34
Logistics	Elvis integration	Complying with regulations	Complying with regulations	B35
Logistics	Whole terminal process is in system (claims, reception, quality measurement, rotation)	Increasing data quality	Acceleration process of stock procurement process	B36
Logistics	Service quality evaluation	Increasing service quality	Increasing quality of services	B37
Logistics	Goals tracking	Increasing reporting quality	Accelerating production process	B38
Sales	Customer needs and are inserted and understandable in one way	Increasing data availability	Increasing accuracy of planning	B39
Sales	Input of customer reception, gate and quality info	Increasing data availability	Increasing accuracy of planning	B40
Sales	Agreement and contract operative statuses are visible to team and customers	Increasing reporting quality	Increasing revenue caused by increasing report quality	B41
FICO	Flexible assortments and usage	Increasing accuracy of data	Accelerating order checking process	B42
Sales	Contract forms for different goods	Clear terms for each contract type	Increasing quality of services	B43
Sales	Integration of credit limit system	Complying with regulations	Reducing risk of incorrect payment	B44

Sales	Measurement data import	Improving data preparation	Accelerating process of data preparation	B45
Sales	Sales order and deed automated generation	Process automatisation	Accelerating transaction process	B46
Sales	Calculation of logs net cost and cost trends	Increasing reporting quality	Reducing risk of price miscalculation	B47
Sales	Salesman dashboard	Overview of business status	Accelerating decision making process	B48
FICO	One measurement unit system for goods and for goals input and follow up	Increasing accuracy of data	Increasing accuracy of data	B49
FICO	Output of working capital components planning (stock, AP, AR, profit account)	Increasing planning quality	Increasing accuracy of analysis	B50
FICO	Different layers of reports (RF, goals, estimation etc.)	Increasing reporting quality	Increasing accuracy of analysis	B51
FICO	Real time stock volume and value	Increasing data availability	Increasing accuracy of planning	B52
FICO	Document archive automation	Process automatisation	Accelerating transaction process	B53
FICO	Open archive for documents	Complying with regulations	Complying with regulations	B54
FICO	Automated random audit selection	Complying with regulations	Complying with regulations	B55
FICO	Audit result registration, connection and history preservation on selection, notifications	Increasing data availability	Matching employee’s right and responsibility	B56
FICO	Cost tree report with goals monitoring	Increasing accuracy of analysis	Increasing internal services of personal feedback	B57
FICO	Self-billing	Accelerating billing dispatching	Accelerating transaction process	B58
FICO	E-billing	Complying with regulations	Complying with regulations	B59

Appendix 3. Team estimation for benefit impact on process and benefit measures.

Benefit nr	Sub-categories/Process Benefit	Prediction in physical terms	Benefit measure	Measure structure
B1	Increasing revenue caused by increasing business capacity	Sales is increased 2%	Roundwood sales (€)	Quantifiable
B2	Reducing cost of communication	Purchasers work time is reduced 3%	Phone calls to supplier (h)	Quantifiable
B3	Reducing risk of forgery	Forgery cost is avoided	Forgery cost (€)	Quantifiable
B4	Accelerating process of data preparation	Purchaser's work time is reduced 2,85%	Supplier estimation input (h)	Quantifiable
B5	Accelerating the execution of new business opportunities	Export sales is increased by 10%	Project sales (€)	Quantifiable
B6	Reducing risk of price miscalculation	Price miscalculation is reduced by 5%	Purchase price goals (€)	Quantifiable
B7	Increasing revenue caused by increasing business capacity	Supports B1	Targeted offers volume (m3)	Measurable
B8	Reducing order cancellation	Sales is increased 1,2%	Offers won/lose (m3)	Quantifiable
B9	Reducing risk of price miscalculation	Supports B6	Segment average prices (€)	Measurable
B10	Reducing order cancellation	Supports B8	Offers won/lose (m3)	Measurable
B11	Increasing quality of services	Supports B1	Contract form types (pcs)	Observable
B12	Accelerating transaction process	Reducing purchasers work time 2% and assistants work time 5%	Measurement deeds signed in system (pcs)	Quantifiable
B13	Accelerating order checking process	Reducing purchasers work time 0,65%	Count of KHA checks (pcs)	Quantifiable

B14	Acceleration process of stock procurement process	Reducing purchasers work time 1%	Supplier satisfaction index	Quantifiable
B15	Acceleration process of stock procurement process	Reducing purchasers work time 1%	Supplier satisfaction index	Quantifiable
B16	Accelerating decision making process	Supports B18 and B6	-	Observable
B17	Increasing accuracy of planning	Supports B18 and B6	-	Observable
B18	Increasing quality of better supplier/vendor management	Sales is increased 2%	Contract fulfillment %	Quantifiable
B19	Increasing accuracy of analysis	Supports B26	-	Observable
B20	Reducing cost of services	Production prices are reduced for 10% volume	Production price goal (€)	Quantifiable
B21	Reducing returning cost for incorrect delivery	Reject volume is reduced 0,5%	Reject %	Quantifiable
B22	Reducing cost of services	Forwarding distance is reduced for 10% cutting sites	Forwarding price goal (€)	Quantifiable
B23	Accelerating decision making process	Supports B26	-	Observable
B24	Increasing quality of services	Supports B26	Vendor quality index	Measurable
B25	Reducing risk of incorrect data	Supports B26 & B39	-	Observable
B26	Accelerating production process	Production efficiency is increased 5%	Production efficiency %	Quantifiable
B27	Increasing accuracy of analysis	Supports B26	Site production budget (€)	Measurable
B28	Increasing customer trust	Supports B1	Supplier satisfaction index	Observable
B29	Accelerating transaction process	Forest masters and purchasers work time is reduced 3,5%	Service deeds generated (pcs)	Quantifiable

B30	Accelerating decision making process	Supports B31	-	Observable
B31	Reducing cost of services	Transportation prices are reduced for 10% volume	Transport price goal (€)	Quantifiable
B32	Increasing quality of better supplier/vendor management	Supports B31	-	Observable
B33	Reducing cost of delivery		Transport price goal (€)	Quantifiable
B34	Accelerating process of data preparation	Assistants work time is reduced 1,7%	Origin document count (pcs)	Quantifiable
B35	Complying with regulations	-	-	Observable
B36	Acceleration process of stock procurement process	Terminal work time is reduced 12,5%	Daily average income (m3)	Quantifiable
B37	Increasing quality of services	Supports B38	Vendor quality index	Measurable
B38	Accelerating production process	Transportation efficiency is increased 5%	Transport efficiency %	Quantifiable
B39	Increasing accuracy of planning	Supports B41	-	Observable
B40	Increasing accuracy of planning	Supports B41	-	Observable
B41	Increasing revenue caused by increasing report quality	Sales bonus earnings are increased 20%	Sales bonuses (€)	Quantifiable
B42	Accelerating order checking process	Supports B47	-	Observable
B43	Increasing quality of services	Supports B1 and B41	Customer satisfaction index	Measurable
B44	Reducing risk of incorrect payment	Sales overdue invoices risks are reduced	Invoice average overdue (€)	Quantifiable
B45	Accelerating process of data preparation	Supports B46	-	Observable

B46	Accelerating transaction process	Assistants work time is reduced 5%	Sales orders count (pcs)	Quantifiable
B47	Reducing risk of price miscalculation	Price miscalculation is reduced by 5%	External sales price goals (€)	Measurable
B48	Accelerating decision making process	Supports B41	-	Observable
B49	Increasing accuracy of data	-	-	Observable
B50	Increasing accuracy of analysis	-	-	Observable
B51	Increasing accuracy of analysis	Supports B50	-	Observable
B52	Increasing accuracy of planning	Supports B50, B47, B41, B18, B5	-	Observable
B53	Accelerating transaction process	Reducing purchasers work time 1% and assistant's work time 2,5%	Documents in archive (pcs)	Quantifiable
B54	Complying with regulations	Supports B53	-	Observable
B55	Complying with regulations	Supports B56	-	Observable
B56	Matching employee's right and responsibility	-	-	Observable
B57	Increasing internal services of personal feedback	Supports B47, B31, B26, B20, B6	-	Observable
B58	Accelerating transaction process	Assistant's work time is reduced 0,3%	Invoice count (pcs)	Quantifiable
B59	Complying with regulations	-	-	Observable

Appendix 4. County (C) level benefit value estimation and benefit realisation period

Benefit nr	Prediction in physical terms	C1 value	C1 period	C2 value	C2 period	C3 value	C3 period	Total Value
B1	Sales is increased 2%	75 000 €	Y1	36 000 €	Y2	24 000 €	Y3	321 000 €
B2	Purchasers work time is reduced 3%	5 315 €	Y1	2 551 €	Y2	1 701 €	Y3	28 435 €
B3	Forgery cost is avoided	5 000 €	Y1	2 400 €	Y2	1 600 €	Y3	21 400 €
B4	Purchaser's work time is reduced 2,85%	4 724 €	Y1	2 268 €	Y2	1 512 €	Y3	25 276 €
B5	Export sales is increased by 10%	10 500 €	Y1	5 040 €	Y2	3 360 €	Y3	44 940 €
B6	Price miscalculation is reduced by 5%	50 000 €	Y1	24 000 €	Y2	16 000 €	Y3	267 500 €
B7	Supports B1	- €	Y2	- €	Y2	- €	Y3	- €
B8	Sales is increased 1,2%	45 000 €	Y1	21 600 €	Y2	14 400 €	Y3	192 600 €
B9	Supports B6	- €	Y1	- €	Y2	- €	Y3	- €
B10	Supports B8	- €	Y2	- €	Y2	- €	Y3	- €
B11	Supports B1	- €	Y1	- €	Y2	- €	Y3	- €
B12	Reducing purchasers work time 2% and assistants work time 5%	10 000 €	Y1	4 800 €	Y2	3 200 €	Y3	48 150 €
B13	Reducing purchasers work time 0,65%	591 €	Y1	283 €	Y2	189 €	Y3	3 159 €
B14	Reducing purchasers work time 1%	1 772 €	Y1	850 €	Y2	567 €	Y3	9 478 €
B15	Reducing purchasers work time 1%	1 772 €	Y1	850 €	Y2	567 €	Y3	9 478 €
B16	Supports B18 and B6	- €	Y1	- €	Y2	- €	Y3	- €
B17	Supports B18 and B6	- €	Y1	- €	Y2	- €	Y3	- €
B18	Sales is increased 2%	75 000 €	Y1	36 000 €	Y2	24 000 €	Y3	321 000 €

B19	Supports B26	- €	Y1	- €	Y2	- €	Y3	- €
B20	Production prices are reduced for 10% volume	12 000 €	Y1	5 760 €	Y2	3 840 €	Y3	64 200 €
B21	Reject volume is reduced 0,5%	52 800 €	Y1	25 344 €	Y2	16 896 €	Y3	282 480 €
B22	Forwarding distance is reduced for 10% cutting sites	6 000 €	Y1	2 880 €	Y2	1 920 €	Y3	32 100 €
B23	Supports B26	- €	Y2	- €	Y2	- €	Y3	- €
B24	Supports B26	- €	Y2	- €	Y2	- €	Y3	- €
B25	Supports B26 & B39	- €	Y2	- €	Y2	- €	Y3	- €
B26	Production efficiency is increased 5%	178 571 €	Y1	85 714 €	Y2	57 143 €	Y3	764 284 €
B27	Supports B26	- €	Y1	- €	Y2	- €	Y3	- €
B28	Supports B1	- €	Y2	- €	Y2	- €	Y3	- €
B29	Forest masters and purchasers work time is reduced 3,5%	3 543 €	Y1	1 701 €	Y2	1 134 €	Y3	18 957 €
B30	Supports B31	- €	Y1	- €	Y2	- €	Y3	- €
B31	Transportation prices are reduced for 10% volume	12 000 €	Y1	5 760 €	Y2	3 840 €	Y3	64 200 €
B32	Supports B31	- €	Y2	- €	Y2	- €	Y3	- €
B33		8 640 €	Y1	4 147 €	Y2	2 765 €	Y3	46 224 €
B34	Assistants work time is reduced 1,7%	1 722 €	Y1	827 €	Y2	551 €	Y3	9 215 €
B35	-	- €	Y1	- €	Y2	- €	Y3	- €
B36	Terminal work time is reduced 12,5%	12 500 €	Y1	6 000 €	Y2	4 000 €	Y3	66 875 €
B37	Supports B38	- €	Y2	- €	Y2	- €	Y3	- €
B38	Transportation efficiency is increased 5%	114 286 €	Y1	54 857 €	Y2	36 572 €	Y3	489 144 €
B39	Supports B41	- €	Y1	- €	Y2	- €	Y3	- €
B40	Supports B41	- €	Y1	- €	Y2	- €	Y3	- €

B41	Sales bonus earnings are increased 20%	9 600 €	Y1	4 608 €	Y2	3 072 €	Y3	41 088 €
B42	Supports B47	- €	Y1	- €	Y2	- €	Y3	- €
B43	Supports B1 and B41	- €	Y1	- €	Y2	- €	Y3	- €
B44	Sales overdue invoices risks are reduced	3 833 €	Y1	1 840 €	Y2	1 227 €	Y3	16 407 €
B45	Supports B46	- €	Y2	- €	Y2	- €	Y3	- €
B46	Assistants work time is reduced 5%	1 038 €	Y1	498 €	Y2	332 €	Y3	5 555 €
B47	Price miscalculation is reduced by 5%	3 440 €	Y1	1 651 €	Y2	1 101 €	Y3	18 404 €
B48	Supports B41	- €	Y1	- €	Y2	- €	Y3	- €
B49	-	- €	Y1	- €	Y2	- €	Y3	- €
B50	-	- €	Y1	- €	Y2	- €	Y3	- €
B51	Supports B50	- €	Y1	- €	Y2	- €	Y3	- €
B52	Supports B50, B47, B41, B18, B5	- €	Y1	- €	Y2	- €	Y3	- €
B53	Reducing purchasers work time 1% and assistant’s work time 2,5%	5 000 €	Y1	2 400 €	Y2	1 600 €	Y3	24 075 €
B54	Supports B53	- €	Y1	- €	Y2	- €	Y3	- €
B55	Supports B56	- €	Y1	- €	Y2	- €	Y3	- €
B56	-	- €	Y2	- €	Y2	- €	Y3	- €
B57	Supports B47, B31, B26, B20, B6	- €	Y1	- €	Y2	- €	Y3	- €
B58	Assistant’s work time is reduced 0,3%	295 €	Y3	142 €	Y3	94 €	Y3	1 033 €
B59	-	- €	Y3	- €	Y3	- €	Y3	- €

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