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OLLI VIRTANEN
PERFORMANCE MEASUREMENT IN AGILE SOFTWARE
BUSINESS

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ABSTRACT

OLLI VIRTANEN: Performance Measurement in Agile Software Business

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Performance measurement has a significant role in agile software business. The academic literature of performance measurement is broad, but the most part of the research does not cover the perspectives of agile software business. Phenomena such as digitalization and globalization are reshaping many industries which makes software development more and more meaningful. Agile and lean models have become the major models of development and their use is growing all the time. The traditional ways of development are becoming inefficient in today's hectic market environment and that forces to reactive and proactive management in order to respond changes in the customers' needs.

This master's thesis analyzes performance measurement in the agile software business. The theoretical part covers the different control systems of companies, measurement activities in software business, and practical agile development indicators. The literature review enables to build the performance measurement framework which establishes the structured understanding of performance measurement and management. The empirical part consists of interviews and workshops which deepen the understanding of performance measurement in the agile software business environment. Different indicators are evaluated from the perspective of agile software development and their mutual relationships are investigated.

There have been achieved findings in the focus areas of this research. Agile industry has its own characteristics and the most meaningful of them are efficient and predictable process in deliveries and customer's continuous feedback during software development. Those characteristics impact to the performance measurement which needs to consider process and product perspectives. A process needs to be optimized in order to minimize waste and produce software with the best possible flow. A product needs to concentrate on customers' feedback and satisfaction with the aim of ensuring that all development work will be in demand after completion.

According to the results, metrics and indicator selection need to be done with the knowledge of organizational impacts and by respecting team level autonomy in agile models. Key performance indicators are followed by the management, but furthermore there should exist supportive metrics to team's independent improvement activities. Agile development enables the aggregation of metrics with the short development cycles and the clear structure of organization. Financial indicators usually have a dominating status at the management level, but also nonfinancial indicators should be analyzed. All metrics have to be implemented with the comprehensive understanding of process and business objectives.

TIIVISTELMÄ

OLLI VIRTANEN: Suorituskyvyn mittaaminen ketterässä ohjelmistoliiketoiminnassa

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Suorituskyvyn mittaamisella on merkittävä rooli ketterässä ohjelmistoliiketoiminnassa. Alan kirjallisuus käsittelee paljon suorituskyvyn mittaamista, mutta suurin osa tutkimuksesta ei käsittele ketterän ohjelmistoliiketoiminnan näkökulmia. Digitalisaation ja globalisaation kaltaiset ilmiöt muokkaavat monia toimialoja, mikä tekee ohjelmistoliiketoiminnasta entistä tärkeämpää. Ketterät- ja lean-menetelmät ovat kehittyneet alueidensa päämalleiksi ja niiden käyttö kasvaa jatkuvasti. Perinteiset menetelmät muuttuvat tehottomiksi nykyisessä hektisessä markkinaympäristössä, ja tämä pakottaa reaktiiviseen ja proaktiiviseen johtamiseen, jotta pystytään vastaamaan muuttuviin asiakatarpeisiin.

Tämä diplomityö analysoi ketterän ohjelmistoliiketoiminnan suorituskyvyn mittaamista. Teoreettinen osa käy läpi yritysten ohjausjärjestelmiä, erilaisia mittaustapoja ja ketterän ohjelmistokehityksen mittareita. Kirjallisuuskatsauksen ja teorian avulla muodostettiin suorituskyvyn mittaamisen viitekehys, joka luo kattavan ymmärryksen suorituskyvyn mittaamisesta ja sen johtamisesta. Empiirinen osio sisältää haastatteluja sekä työpajoja, joilla syvennetään käsitystä suorituskyvyn mittaamisesta ketterän ohjelmistokehityksen ympäristössä. Erilaisia mittareita analysoidaan ketterän ohjelmistoliiketoiminnan näkökulmasta ja niiden keskinäisiä riippuvuuksia tutkitaan.

Työn päätutkimuskohteissa saavutettiin tuloksia. Ketterällä kehittämisellä on sen omat ominaispiirteet, joista merkittävimmät ovat tehokas ja ennustettava prosessi sekä asiakkaan jatkuva palaute kehitystyössä. Nämä ominaispiirteet vaikuttavat suorituskyvyn mittaamiseen, jonka pitää huomioida sekä tuote- että prosessinäkökulmat. Prosessi pitää optimoida minimoimaan hukka ja tuottamaan ohjelmistoa parhaalla mahdollisella virtauksella. Tuotteen taas pitää keskittyä asiakkaan palautteeseen ja tyytyväisyyteen varmistaen, että kaikella kehitystyöllä on kysyntää sen valmistuessa.

Tulosten mukaan mittaristojen valinta pitää tehdä ymmärtäen organisatorisia vaikutuksia ja ketterien mallien autonomisia yksiköitä. Keskeiset suorituskyky mittarit tulee olla johdon seurannassa, mutta lisäksi pitää olla tukea antavia mittareita organisaation alempien tasojen itsenäiseen kehittymiseen. Ketterä kehitys mahdollistaa mittareiden tehokkaan aggregoinnin lyhyellä kehityssyklillä ja selkeällä organisaatorakenteella. Johto keskittyy yleensä seuraamaan taloudellisia mittareita, mutta myös ei-taloudellisia mittareita tulisi mitata. Kaikki mittaristot tulee ottaa käyttöön ymmärtäen liiketoiminnan prosesseja ja tavoitteita.

PREFACE

This thesis project started very systematically, but it turned out to be quite different than was planned in the beginning. I want to thank the examiner associate professor Teemu Laine for helping me to schedule and complete this work efficiently. Your comments and knowledge had a significant contribution to both this thesis and my understanding. For the part of the subscriber company, I truly appreciate my opportunity to do this project. Thank you Mika, Arto, and all of my colleagues for the support through the work and the long days of writing.

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LIST OF ABBREVIATIONS

KPI	Key Performance Indicator
MCS	Management Control System
PMS	Performance Measurement System
SAFe	Scaled Agile Framework

1. INTRODUCTION

This thesis is a master's degree work in industrial engineering and management. It is written for Tampere University of Technology and the subscriber company. The work was done as a development project in order to get more perspective to the subjects and to support decision making in the future.

1.1 Motivation and Background

Globalization evolves together with digitalization, and technology changes and emerges quickly (Minevich 2017). The competitive environment of different businesses is driven by customer's demand, and the best technical practices have an essential role when companies are trying to develop and implement new technologies (Atlassian 2016). That forces companies to react faster which requires flexibility and ability to lead a company proactively by using new methods and models. The software industry was growing very fast in 50' and 60', and there were created new models of development such as waterfall model (Leffingwell 2010, pp. 3-29). Later decades indicated a need to faster responsiveness which was not enabled with waterfall development and caused the creation of agile development models (Pollack 2015). After 90' agile development has become a new major model and it is refined all the time to be faster responsive by producing smaller batches reactively with continuous feedback loop (Leffingwell 2010, pp 3-29).

Different industries are trying to adapt agile models which is not happening straight forward or fast (Darrell et al. 2018). It can be even better to transform slower and use more controlled approach (Darrell et al. 2018). Denning (2017) analyzed the criticality of agile practices and noted the large need for agile models at operative and at strategic level. The author emphasized that agile working is not all in all, but managing agile working is the key to success. That makes the measurement and management of systems very essential. Metrics and performance measurement are important to be versatile and have both financial and nonfinancial management (Eccles 1991).

The academic literature has a broad discussion about performance measurement (e.g. Wouters and Wilderom 2008; Ramasubbu and Balan 2007; Lambert 1998). Different metrics and control systems have also been covered in the earlier literature (e.g. Siska 2015; Fisher 1995; Davila 2000). Nevertheless, agile software business and its performance measurement process has not been analyzed systematically. This work has been written in order to adapt performance measurement systematically to agile software business and analyzing its impacts, processes, indicators, and management.

Management control and decision making play the important role and creates an initial need for performance measurement. Performance is always dependent on industry needs, market environment, and other external factors. The software industry itself has the specific area of agile development which has turned out to be the most critical and useful for companies and industries. Nambisan and Wilemon (2000) investigated new product development and software development, and the authors discovered similarity in the area of management. In addition, the authors found that software development has more focus on process metrics, techniques, and methodologies whereas new product development is usually more interested in organizational factors which include communication, teamwork, cross-functional activities, performance and processes.

Agile development has several useful models like Scrum, DevOps, Kanban, Extreme Programming, and others, but their benefits can be totally utilized only by scaling them to all size organizations. Leffingwell (2018) created a model to scale agile development which is known as the Scaled Agile Framework (SAFe). It enables to use different agile methods efficiently and at all organizational levels. This thesis use the SAFe model as a basic framework for agile business and its analysis. Nevertheless, the SAFe is not a static model and it can be adapted to different purposes and organizations.

1.2 Objectives and Scope

This work concentrates on understand factors behind performance measurement in agile software business. Performance measurement has background factors which need to be taken into account when implementing or planning a new measurement system and its indicators. The factors can be identified internally and externally, and their nature can differ in various contexts. The target industry of this work is agile software business where reactivity and responsiveness play a big role. The area is not well covered in the earlier research. Performance measurement has metrics which have to be analyzed systematically by understanding contexts, relationships, and threats of surrounding environment. Performance measurement is not only decisions of what metrics to use but about leading organization with the metrics. This area can be called performance management, and organization's management level have a mission to follow measures and execute actions when they are necessary.

The research objective is to build the systematic and structured understanding of performance measurement and its impacts in the agile software business. The goal is to cover several areas such as impacting background factors, forming the metrics, and managing a system.

Those objectives are discovered with the research questions of this thesis:

- What kind of factors impact the performance measurement of agile software business?
- Which indicators and metrics should be used to measure agile software development?
- How should performance measurement systems be managed in agile software industry?

The research is conducted with literature analysis and empirical research. Other special questions of related concepts may rise along the research, and they are covered in the discussion section. The SAFe works as a guideline and example for organizational framework. The research starts from general level concepts and sharpen towards the characteristics of agile software business. Background factors, indicators, and management are discussed very broadly in the other contexts and those are acting as a reference material for the upcoming context of agile software business. Metrics are one key area of the research and there are several issues about them to discover. Those include the amount of indicators, their impact as a whole, metrics' management, indicators' relevance, and the overall impact of performance measurement process.

1.3 Structure of the thesis

This work has several sections. After the introduction, the second section is theoretical background which is a literature review of academic articles and other publications. The sources are chosen from the different areas of performance measurement related topics and the literature review covers academic background behind performance measurement. That section is divided to four parts. The first part introduces and explains different techniques to have a control in the organization. It starts from defining management control in general and then moves on to performance measurement and the use of accounting information in strategy and management. The second part limits inspection only to the software industry and explains the fundamentals of performance measurement and its impacts to businesses. After that, different strategies for control and measurement are analyzed. The third part of the theory deepens measurement to practical indicators and limits the inspection to business of agile software development which will be under analysis in the empirical section of the work. The fourth section summarizes the earlier theory and analyses background factors behind performance measurement.

After the theoretical background, the third section introduces the research methodology and data collection of the work. The main research methods of this work are interviews and workshops. The fourth section applies the background literature and builds the performance measurement framework. The framework has structured understanding of different factors in performance measurement, used metrics, and management. Theoretical knowledge and the created framework are used to form the interview questions.

The fifth section presents the results of the interviews. The interview questions were related to the framework of the section four, so the results are likewise presented under the framework's structure which enables to get perspective to them in the respective order. After results, the sixth section have discussion between the background literature and the empirical findings. In the first three parts of discussion, the results of the interviews and the workshops are compared to the theoretical knowledge in order to build the practical understanding with comprehensive model. The fourth part has the special questions which have risen during the research process. They are likewise inspected by comparing the theoretical and the empirical material. At the end in the section, there is synthesized the empirical and literature material and highlighted the most important aspects of the work.

The seventh section concludes the work with several viewpoints. There are at first analyzed the achievement of objectives and after that considered contribution to the existing literature. The third part is managerial implications which summarizes the most important findings from the perspective of business management. The fourth part criticizes methodology and the generalization of the results. The last part proposes some topics to be covered in the future research in order to continue this work.

2. THEORETICAL BACKGROUND

The theoretical background covers the literature review of this work and presents different frameworks and models to support the analysis. The background starts from the general level control of management and deepens to software industry. Performance measurement is described as a part of control and the theory proceeds to performance measurement process and indicators in agile software business. At the end, the theory analyzes external factors, which affect measurement, and also conclude some earlier theory.

2.1 Management Control and Decision Making

2.1.1 Management control and measurement systems

The management control system (MCS) is a tool to help companies to select and keep the desired direction of actions (Fisher 1995). By that, Fisher (1995) meant management has tools and procedures to tell people in a company how to achieve defined objectives. Also Siska (2015) perceived MCS like that as a group of control and metrics which are useful for management in order to lead a company towards its earlier chosen objectives. Control and management can be defined even more theoretically. Fisher (1995) examined complex organizations and management control in them. Control was defined as actions supposed to influence people's behavior the way which increases probability of those activities to lead towards the goals of organization (Fisher 1995). In that definition, control does not ensure anything but will likely to have desired impact in an organization.

Management control has many appearances in companies and can be organized various ways. Davila (2000) examined new product development and its management. According to the research, product development has usually significant role in companies and needs to be managed efficiently. MCSs play meaningful role in that. Malmi and Brown (2008) introduced a framework which describes an organization-wide control system where management control has several roles and practices. The framework is presented in the Figure 1.

Cultural Controls						
Clans		Values			Symbols	
Planning		Cybernetic Controls				Reward and Compensation
Long Range Planning	Action Planning	Budgets	Financial Measurement System	Nonfinancial Measurement System	Hybrid Measurement System	
Administrative Controls						
Governance Structure		Organization Structure			Policies and Procedures	

Figure 1. The components of a management control system (adapted from Malmi and Brown 2008)

Malmi and Brown's (2008) framework includes all different aspects of control: cultural, planning, cybernetic, reward and compensation, and administrative. At first, culture means both the formal and informal control. On a formal side, there are official values and procedures to act. On the other side, there are informal social norms which are impacting to organization and people's behavior. The second aspect is planning which means activities done in different functional areas in order to have influence to actions with future impact. The third one, cybernetic control defines quantitative means to control organization. It includes financial measures and budgeting as well as nonfinancial measures. The last mentioned has taken more and more importance in organizations (Shenhar et al. 2001). The fourth control measure in Malmi and Brown's (2008) framework is reward and compensation programs which usually use some measurable factor's to lead organization's activities. The last one is administrative controls. Organizations are divided to practical groups to cooperate together with the common goals. It needs control over units as well as the policies and structure of management.

As Malmi and Brown's (2008) framework shows, there are various measures and control systems within the organization and those parts certainly need links between them in order to work efficiently. Fisher's (1995) investigation of complex control systems in organizations highlighted that all parts of systems need to be connected with functional links so that control fills its mission. The author divided control to groups of management, corporate and operational control which all have different purposes. The management control is defined as control from higher managers to lower managers, whereas the operational control is between managers and employees. The corporate control is the highest strategic level control of board and shareholders.

Organizational objectives need to be defined the way which supports whole package of control (Malmi and Brown 2008). Without complete understanding how organization's goals and performance are connected, it is hard to lead optimally (Malmi and Brown 2008). Organizational systems and management need to be connected to control systems which should be designed to fit to certain organization (Fisher 1995). Understanding of MCS as package needs more research and focus on the behalf of research and business perspectives (Malmi and Brown 2008).

A management control system is the broader term of organizational management and there can be defined more narrow parts inside it. Siska (2015) summarized a performance measurement system (PMS) as a set of different diagnostics which are used to utilize accounting information for decision making. According to the author, many researchers describe PMS as a part of MCS. That can be seen from the Figure 1 where cybernetic control is defined as the measurable factors of financial, nonfinancial, and other performance measures which are together the subpart of control system. There exists conversation about definition and connection between MCS and PMS. Because performance measurement is usually used to exploit accounting information for organizational goal seeking, there is an overlap with MCS (Siska 2015). In some cases, they are even defined as synonyms (Siska 2015).

Ferreira and Otley (2009) defined performance management as a heading term for all the measures of organizational performance. According to this definition, it includes all aspects of management control which can be measured and used in order to manage performance. By other words, performance management is defined as leading the performance with measured data. Fisher (1995) defined performance measures as a cybernetic controls which are used as comparison between actual performance and some baseline. Then feedback provides information about all activities' performance when compared to the target. That enables the management of performance. Fisher (1995) mentioned some examples of financial and nonfinancial measures such as revenue, expenses, on time delivery, and scrap.

Performance measurement is significant function in leading business, but it should be taken to broader consideration also from other perspectives (Wouters and Wilderom 2008). Those sights would include PMS as a support for people who are under the monitoring and measurement (Wouters and Wilderom 2008). Davila (2000) examined drivers of management control and pointed out that management's desire is to go further than just basic financial indicators. The author noted that because of indirect observation, financial success follows certain nonfinancial indicators. There is a need to take into account different nonfinancial and financial measures to fill the information needs of organization (Davila 2000).

2.1.2 Decisions making with accounting information

Companies have a lot of accounting information available, but its use and analysis might be problematic. Lindholm et al. (2017) scrutinized management accounting and control in global operations. The authors noted that global organizations have several challenges relating to management accounting and MCSs because all the objectives of different organizational aspects can be hard to manage. MCSs are not operating in the isolation and that point need to be considered in their design (Malmi and Brown 2008). Lillis (2002) investigated the dimensions of manufacturing performance and discovered that the most part of the problems in accounting information use are caused by customer responsiveness. That means strategic orientation or commitment to quality are not seen as problem, but fast changing environment creates challenges (Lillis 2002).

Accounting information is definitely important part of PMS (Jordan and Messner 2012). It can be harder to define which parts belong only to MCS, but are too broad to take into account of performance management (Jordan and Messner 2012). Such larger entities can be accounting, strategic, or behavioral controls (Malmi and Brown 2008). Lindholm et al. (2017) considered accounting information as a whole aid of decision making. So they included all the aspects which support some part of decision analysis.

In the pure reporting part of accounting, it can be challenging to take into consideration different functional units, business lines, and operational groups (Lindholm et al. 2017). That means companies are usually divided such a way that they have different business objectives which increase complexity in producing useful information. In the article, Otley (1999) created a framework for performance management. The author noticed that management accounting is very often weighting financial and economic aspects of measurement, even if measurable things could be analyzed more nonfinancial way. Lambert (1998) pointed out that some very useful indicators of performance such as customer satisfaction can be challenging to measure. That means some assumptions and conclusions need to be done in order to find measurable factors.

One possible way to utilize accounting information is earned value management. In the article, Lipke et al. (2009) explained earned value management as a technique how to forecast final costs and manage the actual performance and gained value. The components of this prediction model are budget, total value to be earned, and timeline which are evaluated with planned value, actual costs, and earned value (Lipke et al. 2009). In the project environment, this approach can be used in order to integrate scope, schedule, and resource use (Sulaiman et al. 2006). Tsui (2013) introduced how earned value management can be improved as performance metrics in the software development. The author pointed out that software industry may show up problematic from the perspective of performance tracking because environments and skill sets can differ a lot. However, the methods of earned value management are quite exactly tracking the produced value within timeframe,

but it needs some effort and measures to be followed (Tsui 2013). In agile software development, earned value management does not change or decrease team's work and velocity so earned value management could be implemented easier to different environments (Sulaiman et al. 2006).

2.1.3 Business environment and strategic aspects

As earlier described, measurements are methods to control and lead companies so measuring functions are guiding organizations to some direction. Otley (1999) mentioned in the research that sufficient knowledge is required in developing control and measurement systems, otherwise an organization will fail. Business needs and strategy affect measurement and suitable indicators (Fisher 1995). Lindholm et al. (2017) stated that it is important to select key performance indicators (KPI) with the understanding of the big picture. The authors warned the incomplete knowledge of different aspects can lead to situation where different parts are not synced and that weakens the whole. The concept of big picture understanding is not straight forward. Various people's opinions differ in all cases so it is hard to create a model which satisfies everyone (Wouters and Roijmans 2011).

Managers are usually attracted mostly to their own area which drives them to optimize own units to gain desired goals. Banker et al. (2000) examined incentive programs with nonfinancial indicators and their impacts to business. The authors discovered the fact that if management of organization is interested to achieve certain indicators, they can usually lead the organization to meet the desirable goals. If a control system is connected with the incentive program, managers have a change to influence to the results (Fisher 1995). Lindholm et al. (2017) underlined that sub-optimization increases if different parts of a company have their own goals to be rewarded from. In general, incentives based on financial indicators can jeopardize internal motivation of units, but still their impact is rather positive than negative (Jenkins et al. 1998).

There can be identified some external factors, but in many cases companies exclude them and act only to meet business goals as they have been defined (Fisher 1995). Wouters and Wilderom (2008) inspected formalization of PMSs in organizations and listed that various articles demonstrate the defensive behavior for desired objectives. The authors stated organization units are trying to reach their goals even by weighting resources with inefficient way just to make sure they are meeting all the objectives. This kind of behavior is unfavorable in the future because it is causing imbalance and wrongly negotiated targets to the system (Wouters and Wilderom 2008). In the research, Lillis (2002) noticed multiple dimensions of performance measures are sensitive for problems if they are tried to diversify for separate functional units. That means different units must be noticed and measurement designed very sophisticatedly.

Strategy leads company's operations. Fisher (1995) listed different contingent control variables which define companies' strategy and measurement:

1. External environment (uncertainty, dynamically, complexity)
2. Competitive strategy and mission (cost leadership vs. differentiation, defender vs. prospector, build vs. hold vs. harvest vs. divest)
3. Technology (batch size, process, research and development)
4. Unit, firm, and industry variables (size, diversification, structure, industry)
5. Knowledge and observability factors (knowledge, observability, input output process)

The first category of Fisher's (1995) list includes external forces such as customers, suppliers, and other stakeholder. The second part includes different strategy options how a company can be placed on the field of competition. Those depends quite much about a portfolio of products and the strategy of a company. Miller (1988) investigated strategy options and noted that innovative and fast changing environment usually required good cooperation within organization whereas stable environment can better be managed by cost leadership. The third and the fourth aspects are technology and industry which have an impact how products are actually produced and what kind of methods are used. The last factor defines how knowledge and performance can be transferred and observed. This collection of Fisher (1995) combines different authors and serve as a guideline when defining organization's strategy and performance measure.

Miller (1988) investigated influencers between strategy, structure, and environment. The author explored that companies should create bridges and complementarities between them. External environment is contingent for companies and it has both opportunities and threats (Daft et al. 1988). Strategy and management need to respond to external changes and keep company's direction when external changes happen (Miller 1988). Daft et al. (1988) discovered that companies should have deepest screening to uncertain parts of strategy. The authors' data also showed that more successful companies tend to measure and report their activities more often. That can be seen as interesting fact when considering performance measurement system.

When trying to implement sustainable model to measure and control organization, there will appear problems within strategy approach, big picture understanding, and different stakeholders (Shenhar et al. 2001). Kaplan and Norton (1992) discovered a model to combine strategy and organizational control. This strategy framework is known as the Balanced Scorecard and presented in the Figure 2. It offers information how to deal with different aspects including financial measures, customer satisfaction, internal business, and innovation and learning.

Financial Perspective		Customer Perspective	
GOALS	MEASURES	GOALS	MEASURES
Survive	Cash flow and short term liquidity	New products	Percent of sales from new products
Succeed	Sales growth and operating income	Preferred supplier	Share of key accounts' purchases
Prosper	Increased market share and ROE	Customer partnership	Number of cooperative efforts

Internal business perspective		Innovation and learning perspective	
GOALS	MEASURES	GOALS	MEASURES
Technology capability	Production geometry vs. competition	Technology leadership	Time to develop next generation
Production excellence	Cycle time, unit cost, and yield	Production learning	Process time to maturity
Product introduction	Actual introduction schedule vs. plan	Time to market	Product introduction vs. competition

Figure 2. The Balanced Scorecard (adapted from Kaplan and Norton 1992)

The Balanced Scorecard contains knowledge of connections between different stakeholders. Kaplan and Norton (1992) wanted to create a model which sums the different perspectives of organizational measurement. In their view, management should always check all the standpoints of decision especially when doing new implementations.

The Balanced Scorecard is important because it offers links between the different points of view in strategy and measurement (Otley 1999). Wouters and Wilderom (2008) highlighted that organizations can have centralized scorecards, but they should still enable and support working in different units. After all, the framework has good impact to enable operational activities, but offering tools also to long term sustainability (Otley 1999).

Fisher (1995) summarized that control system design is influenced by different uncertainties such as business unit strategy, technology changes, and environmental uncertainty which are all dependent on the location. Global companies and organizations face challenges when trying to embed and handle their local networks because various units have different geographic objectives, resources, and business goals (Meyer et al. 2011). In the research, Lindholm et al. (2017) pointed out that for example deliveries and services can

clash if financial reporting is not enhancing the cooperation between them. As functional needs, globalization is usually supposed to decrease importance of local context, but actually it is increasing that (Meyer et al. 2011).

Meyer et al. (2011) discovered the opportunities and problems in global business decisions. According to them, there is a trade-off within business opportunities and operational challenges when considering subsidiaries' strategies. Lindholm et al. (2017) mentioned that organizational units might have different responsibilities, roles, and aims. That of course explains the need for a sophisticated system when measuring different unit and common goals for them. In order to keep international focus, strategy can be defined various ways (Meyer et al. 2011). Considering this point, two different investment types can be defined which are foreign direct investment and portfolio investment (Meyer et al. 2011). The former one have goals and measures separated and the another one have more interaction and common goals. Diversification decisions tend to have impact to both practitioners and policy makers (Meyer et al. 2011).

2.2 Performance Measurement in Software Industry

2.2.1 Software business as an industry

In software business perspective, performance measurement and management control might need a bit different approach. Nambisan and Wilemon (2000) compared similarities between new product development and software development. The authors concluded that both have many similarities and can be managed using quite same practices. In the article, Nambisan and Wilemon (2000) also listed teamwork management, accelerated product development, and development process maturity as the most important aspects of development work. Those all seem to be important factors when designing the implementation of performance measurement. Davila (2000) investigated drivers related to management control in the organizations. The author discovered in the research that control systems are relevant tool to decrease uncertainty in companies where MCS can be defined with different financial and nonfinancial drivers.

The measurement and control of projects are broadly discussed in research (e.g. Wateridge 1998; Shenhar et al. 2001; Atkinson 1999). Project success and control have been understood within a project triangle of scope, budget, and schedule for a very long time, but recent studies have shown its insufficiency (Ralph and Kelly 2014). Those factors are still of course the important parts of project evaluation, but they are not all in all (Ralph and Kelly 2014). Wateridge (1998) concluded that background factors are dependent on the industry. The author told the triangle perspective of project measurement can be sufficient for example for contractors, but in the information system and technology projects there need to be taken more factors into account.

In the article, Atkinson (1999) listed success criteria of project management and created the Square Route model which includes project management triangle, which is many times called iron triangle, and other criteria. This framework is presented in the Figure 3.

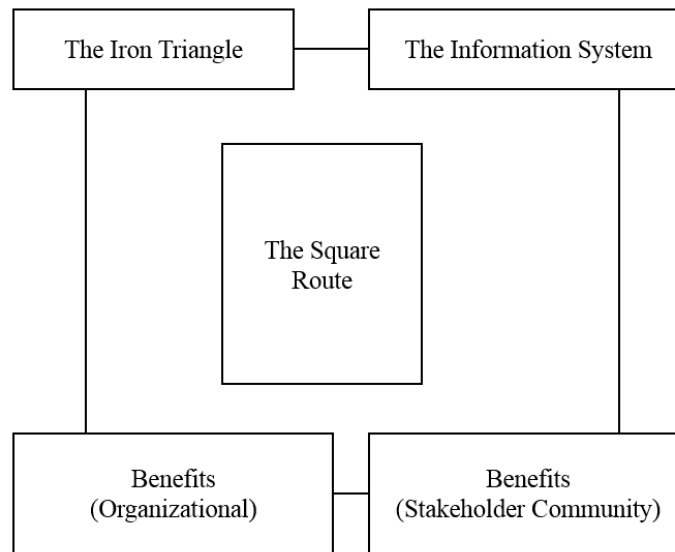


Figure 3. *The Square Route model to measure projects' success (adapted from Atkinson 1999)*

Atkinson (1999) stated that last 50 years the iron triangle of project management has dominated the success criteria, but those three factors are actually too much estimates in order to evaluate success efficiently. The Square Route model of the Figure 3 presents the framework where three other entities are information system, organizational benefits, and stakeholder benefits. The information system perspective includes software maintainability and reliability parts. The organizational and the stakeholder benefits are referencing to the important side of customer satisfaction with organizational learning and efficiency improvement. This approach is actually sharing some components quite similar than in the Balanced Scorecard framework by Kaplan and Norton (1992) which was presented earlier.

Software development has quite many specific aspects within the topics of performance management. Blackburn et al. (1996) evaluated software developers' speed and productivity and the authors noted the fact that time delays usually decrease the profits. In software industry, it is essential to keep time-to-market before the technology expires (Harter et al. 2000). Ralph and Kelly (2014) highlighted the fact that project and software engineering are not the same, and more specifically software engineering is not possible to lead with the old project triangle approach. The authors underline today's software development's difference comparing to older project based development. Productivity and quality need to be considered during the whole lifetime of products (Krishnan et al. 2000).

Capability of lead people and resources in projects will have a huge impact to end products' quality which means software development need better and better designed control systems (Krishnan et al. 2000).

When companies are defining and developing a framework for performance measurement, it is essential to include components such as strategy, objectives and plans, targets, rewards, and feedback (Otley 1999). From that point of view, strategy and operational work are going together. Shenhar et al. (2001) emphasized difference in operationally and strategically led projects' success. The authors summarized that operationally led projects fail more often than strategically led projects because operational level just tries to get things done within limits while strategic managed projects focus on actual business results and value creation (Shenhar et al. 2001). Otley (1999) added that in case accounting information, economic perspective, and control systems are utilized in creation of performance measurement framework, there should be also seen business as a whole by considering aspects of behavioral, cultural, and managerial contexts (Otley 1999).

In project organizations, teams are the meaningful part of strategy and they need to be noticed appropriately. Meyer (1994) stated that many organizations, which have cross-functional teams, are not considering their role enough at the management level. They should focus on to minimize unexpected situations by enhancing working environments for teams (Meyer 1994). It leads to very fragmented companies if all the projects are believed to have their own measures and management without implementing an organization-level coordinating system (Shenhar et al. 2001). Also Fisher (1995) pointed out that several control factors need to be considered in designing measurement system.

From the different perspectives, PMS design is not a simple process. Ferreira and Otley (2009) investigated the design of PMSs and analyzed top-down approach compared to bottom-up. According to the authors, top-down approach can be found extremely difficult for management to coordinate. The authors also added that in lean and low hierarchy organizations bottom-up is much more efficient way to design and implement control systems. When creating a new system, the joint ownership of experimentation is useful way to do changes (Wouters and Roijmans 2011). In the article, Wouters and Roijmans (2011) listed the roles of accounting information in the operational issues. The authors' view was that rather than using accounting information as control from senior management to employees, there should be more usable information for operational managers because they have the actual view of operational issues. Wouters and Roijmans (2011) continued in their article that when systems have been defined and designed, they need to be tested within several rounds. When there has been used the knowledge from the experimentation level, it tends to have positive impact for the system implementation (Wouters and Roijmans 2011).

Nowadays industries face a need for different measures in order that business requirements can be understood (Wouters and Wilderom 2008). Hanssen (2012) examined software ecosystem development which has changed a lot during last years. The author summarized the development of software ecosystem as following description from creative chaos to fragmented ecosystem. At first, software business seemed to be creative chaos which was not coordinated well. When activities and amount of customers increased, it became impossible to operate without control. Waterfall model gave more systematic way to develop software and information technology products by moving ahead step by step. More complex products and faster changing environment created the need to get feedback and coordination in shorter cycles. Agile software development rose and became the key of success in many environments. From agile perspective, industry moves towards more fragmented ecosystem where many players and stakeholders exist. After all, technical and social ecosystems have been drivers for big changes within software business (Hanssen 2012).

As described, new requirements for example quality, lead time, and flexibility have launched quite many new aspects of software business (Wouters and Wilderom 2008). Shenhar et al. (2001) mentioned that it is ironic to have different opinions about project success which are not considered as competitive advantage or market responsiveness. Traditionally performance metrics has considered low costs, high utilization rate of capacity, and people efficiency as a way to success (Wouters and Wilderom 2008). This has been changing at the same time when agile development and whole fragmented ecosystem is evolving (Ramasubbu and Balan 2007).

Currently dominating agile development is very practical from the perspective of performance measurement (Leffingwell 2007, pp. 311-326). Actually it can be easier to measure than its predecessor waterfall model (Leffingwell 2018, pp. 435-455). Agile and fragmented models demand the understanding of entities such as programs and portfolios. Laine et al. (2016) emphasized that program thinking and continuous cooperation between different parts is essential to single project execution and support. After all, the needs of a software company depends a lot about which strategy associates to it (Said et al. 2003). Innovation and quality orientated business models require the management of lead times, regulation impacts, and financial factors (Said et al. 2003).

2.2.2 Value and success in software development

Many years, value has been broadly discussed from the perspective how it can be delivered and produced in companies (Bryant et al. 2004). Shenhar et al. (2001) emphasized the fact of understanding long term benefits and companies' business requirements. The authors concluded, if management is only having thoughts about getting the work done, it can lead to bad results. In the software industry, Alahyari et al. (2017) defined that a company should always have a target in maximizing the value creation with given resources.

Sometimes companies need to decide how to handle different requirements. Atkinson (1999) summarized that in 21th century onwards, projects should be able to meet at least the time objectives to avoid problems in business. That seems to be related to which industry a company is operating (Alahyari et al. 2017). Paetsch et al. (2003) described agile methods of software business where customer expectations and needs are transmitted to support and guide development process. When selecting the metrics for value creation, it would be good to have some connection to economical view as well (Hartmann and Dymond 2006).

Customer view can be seen as a very important factor to achieve business goals, but in some cases customer may want to have something which can increase costs too much (Krishnan et al. 2000). For example different environments can turn out to be unprofitable for both vendor and customer (Krishnan et al. 2000). This fact need to be considered when designing and measuring value creation. Hartmann and Dymond (2006) summarized the need of tools to be simple and supportive for the actual operations in order to be useful. Furthermore, the authors pointed out that value metrics should encourage organization to develop and implement sustainable solutions and also enhance accountable measurement of value. This way companies can produce business value quickly and efficiently (Hartmann and Dymond 2006).

A lot of research has been done in order to explain project business success as well as success in information systems, but still there seems to be a lack of understanding all the viewpoints of success in software engineering (Ralph and Kelly 2014). Also in pure project standpoint, there is the lack of knowledge. If a project is implemented within a given timeframe, budget, specification, and quality, but it does not enhance customer experience or organization's effectiveness. In this condition, Atkinson (1999) asked is it still well managed project.

Wateridge (1998) mentioned that the specification with project factors is not the whole idea how to design metrics. The author said there should be considered the success criteria and what is tried to reach within the project. Shenhar et al. (2001) added the fact that success means different things for different people. On the broader basis, success is not straight forward to define. Atkinson (1999) emphasized, if project's progress is measured for example with earned value and costs incurred, it is not the same than success incurred. This critique was for earned value management (e.g. Lipke et al. 2009; Sulaiman et al. 2006). Atkinson (1999) added that of course some projects need to be measured with the basic metrics, but some metrics can be more useful and more important than others.

In the article, Shenhar et al. (1997) listed and analyzed factors of projects' success. The authors defined four aspects depending to which part of time horizon they are related. Model with project efficiency, impact on customer, business success, and preparing for the future is presented in the Figure 4.

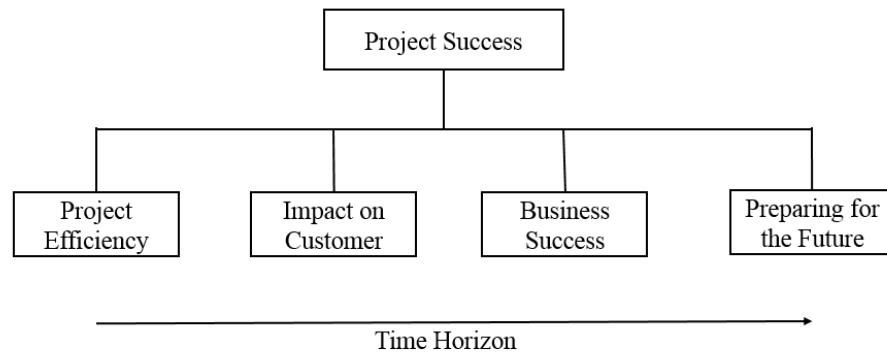


Figure 4. *The four dimensions of project success (adapted from Shenhar et al. 1997)*

The first dimension of the Figure 4 describes short term goals which can be compared to project triangle objectives. The next level take customer perspective, needs, and experience into account. The third step includes direct impacts to organization such as the financial aims of product and gained market share. The last one looks to the future and evaluates what kind of learning and developing have been achieved within the project.

After the model described in the previous chapter, Shenhar et al. (2001) did another research on management role in the project success and how to implement measures efficiently. Next Figure 5 deepens the model with a technological perspective.

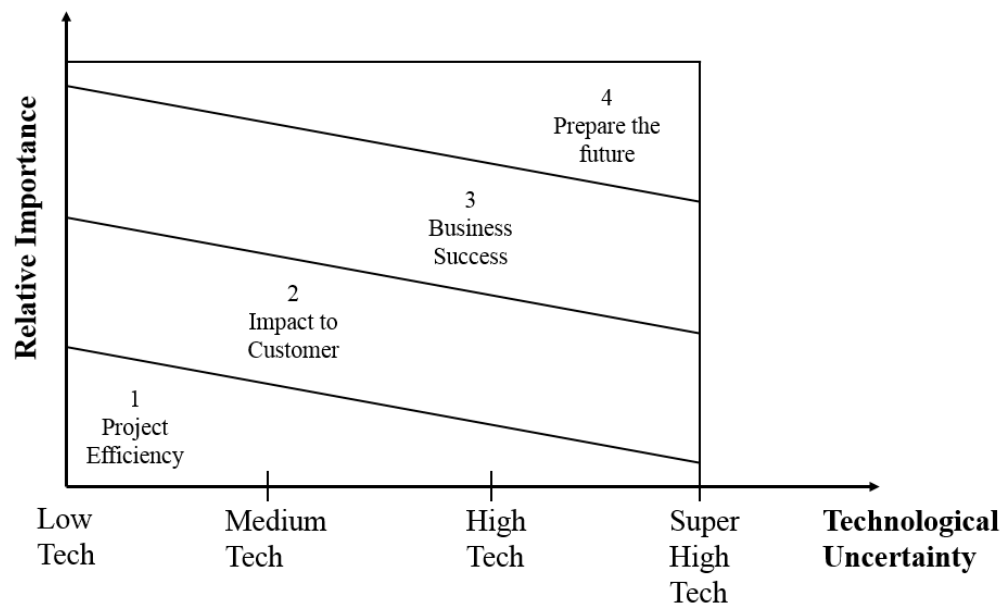


Figure 5. *The dimensions of projects' success (adapted from Shenhar et al. 2001)*

Shenhar et al. (2001) described that when technological uncertainty increases, the project's basic efficiency metrics lose relevance. This model shows that from technological perspective, customer and business impacts are important in all cases. Ralph and Kelly (2014) analyzed this model. The authors underlined the importance of an industry and project type evaluation which specifies what is meant by success. Shenhar's et al. (2001)

model highlights the impact on customer as the second dimension. Ralph and Kelly (2014) found this deficient because that should include other possible stakeholders as well.

In the article, Ralph and Kelly (2014) suggested to extend the framework to deal with the two frameworks by Shenhar et al. (1997 and 2001). This new framework is presented in the Figure 6.

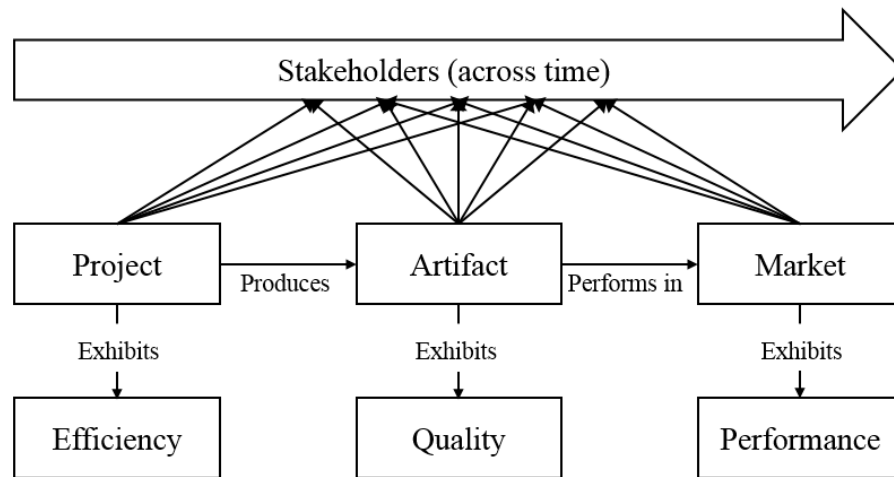


Figure 6. The framework for software engineering success (adapted from Ralph and Kelly 2014)

In this model, it can be seen that the stakeholders and keys to success will change during the lifecycle, and artifact aspects show how measurement cannot be done only by focusing on a single perspective (Ralph and Kelly 2014). The dimensions of success can be defined internally or externally which makes project's efficiency and quality artifacts internal factors and market performance external factor (Ralph and Kelly 2014).

2.2.3 Enabling and coercive management systems

Performance management systems can have either enabling or coercive nature. Adler and Borys (1996) examined formalization and compared enabling and coercive bureaucracy. The authors underline that enabling formal systems gives users an opportunity to fix situation in the case of something is out of control. Wouters and Wilderom (2008) highlighted employees' experience and professionalism when planning new performance measurement techniques. That leads to more enabling culture and build experiment system efficiently (Wouters and Wilderom 2008). Performance systems' enabling nature increases the local and global transparency of a company (Adler and Borys 1996). Usually, when organization is creating and implementing new measurement systems, they are felt coercive (Jordan and Messner 2012). Jordan and Messner (2012) mentioned it can change after a system is working, but usually there is a resistance for change. The authors

also state the fact of organization's incomplete harmony which means even if organization is creating very transparent and enabling system, it can be seen differently. The important issue of a system is that management does not stuck too much to monitoring, but instead supports the lower levels of a company (Adler and Borys 1996).

In Adler and Borys's (1996) article, the authors built the framework to describe the levels of control systems' formalization and type. This matrix is showed in the Figure 7.

		Type of Formalization	
		Enabling	Coercive
Degree of Formalization	Low	Organic	Autocratic
	High	Enabling Bureaucracy	Mechanistic

Figure 7. The typology of organization's formalization (adapted from Adler and Borys 1996)

The model includes organic, autocratic, enabling bureaucracy, and mechanistic parts. Adler and Borys (1996) explained that in the real world those degree of formalization and type of formalization variables are of course continuous. The authors' implication indicates the negative results, if using coercive control, because employees cannot perform a mix of routine and nonroutine tasks so well. On the other hand, coercive approach is sometimes used in order to keep structure and routines very clear (Adler and Borys 1996).

Wouters and Roijmans (2011) argued that a performance management system needs to support people's work which is under its measurement activity. The measurement of work is many times felt uncomfortable, but employees are feeling better if the performance metrics are also supporting or helping the part of their work activities (Adler and Borys 1996). On the other hand, if it seems to control or even critique their work, it is felt to be very harmful and disturbing (Adler and Borys 1996). Companies are able to evolve when their success can be monitored and utilized for the future's use, and then accumulated knowledge develops an organization (Wouters and Wilderom 2008).

Mutual respect and trust are the significant factor of success in the area of performance measurement (Wouters and Roijmans 2011). Wouters and Roijmans (2011) emphasized the importance of transparency between managers and employees in order that workers

are really committed to their effort and releasing their knowledge for the use of measurement. Employees need to feel that their real effort will be collected within measures (Wouters and Wilderom 2008). Otherwise they feel inconvenient because of their sense that unfair measuring activities display them less productive than they are (Wouters and Wilderom 2008). The mutual sense of performance measurement is also substantial part of lower managers' work. Adler and Borys (1996) diagnosed that operational managers and employees should feel the support of measurements. Their opinion is that higher management can trust to measurement results only if operational managers are really committed to measuring activities. Managers' feel of adequate flexibility in the systems enables them to better manage their work, and also prevent the undesirable situation where departments might fight against each other to get better results (Adler and Borys 1996).

All the performance measurements have someone who receives the results. Westfall (2014) considered software measurement fundamentals and analyzed what different people are expecting from measurements. The author summarized functional managers are mostly interested about the return on investment whereas project managers are more interested the project efficiency and control measures. From the employees' side, software practitioners want to make informed decisions, specialists are respecting quantitative information, and users and customers need good user experience with low cost during the lifetime of product. Furthermore, Westfall (2014) highlighted a need for customer if there is no one interested about the measurement then measurement process should be suspended.

It is expected that if measurement shows something is wrong, it should also give some information how to repair it (Meyer 1994). Within a software industry, agile and waterfall methods share some similarities which are analyzed by Kupiainen et al. (2015). The authors listed common tasks of both perspectives which are planning, progress tracking, improvements of quality, fixing problems, and motivating people. Those seem to be in the both but their processing and management is different. Measurements' customers define what they are expecting to get. Meyer (1994) listed four steps how to define expectations. The first one is to create the metrics of factors which are obviously important from the customer perspective. Secondly, illustrating the process cross-functionally to produce, and after that recognizing the most important process factors. The last step is to design metrics of tracking desired issues.

2.3 Indicators in Agile Software Development

2.3.1 Measurement system and metrics

As described earlier, PMS is highly dependent on the environment. When the focus is in the agile software development, measuring metrics is easier to create than in traditional

waterfall model (Leffingwell 2018, pp. 435-455). Westfall (2014) summarized process measurement as the whole entity of different pieces in development process. Agile process has limited time boxes and requirements which make it very measurable (Leffingwell 2018, pp. 435-455). Blackburn et al. (1996) stated the fastest companies usually have the smallest teams. According to Leffingwell (2018, pp. 435-455), ability to produce working software components very quickly is one key component of agile development. Performance measurement is critical for agile environment because management is often skeptical about the benefits of agile development instead of traditional waterfall approach (Leffingwell 2007, pp. 311-326).

Agile environment usually has small teams which are divided to different programs (Leffingwell 2018, pp. 1-13). When there is a need to control programs, organization needs to pay attention to form value orientated program objectives (Laine et al. 2016). Before that, value need to be recognized from the perspective of leading lifetime value including all the stakeholders, and this information can be shifted to manageable events and to actual program objectives (Laine et al. 2016). Jordan and Messner (2012) highlighted the importance to notice the incompleteness of a measurement system design by taking managers along the process. A measurement system needs to take into account different parts and objectives between and above single projects (Laine et al. 2016). In other words, program measurement need to serve as the common sense of performance measurement within the program which includes different aspects of financial and nonfinancial indicators with connections between different levels and phases (Laine et al. 2016). The final goal is to design and to create a system which include multiple factors of development process, output, and value creation (Fisher 1995).

Usually information is used in performance measurement by splitting and assembling accounting information to the set of indicators (Lindholm et al. 2017). The performance measurement metrics need to observe all the different aspects in order to gain the goals (Jordan and Messner 2012). Jordan and Messner (2012) scrutinized performance indicators from the view of coverage. The authors stated that too much flexibility in indicators and metrics often leads to problems if they should serve as a control mechanism.

The number of indicators in metrics is essential. Ferreira and Otley (2009) examined the design and use of performance management systems, and the authors explored that too many KPIs are decreasing their impact because management's attention have limits. Also Meyer (1994) stated that amount of indicators should be only handful in order to manage their use and monitor efficiently. A company only achieves the things which are measured, but studies show that the broad set of indicators is not functional.

2.3.2 Indicators in agile development

The last years during digitalization, information technology solutions have become one of the most meaningful success components (Harter et al. 2000). The recognition, measurement, and production of value aspects have become the essential part of success and companies need to focus on it more and more (Alahyari et al. 2017). In agile development, human capital can be seen as the most meaningful asset of a company so everything need to be implemented with the respect to people (Blackburn et al. 1996). Lambert (1998) emphasized the importance of customers' satisfaction. The author noted in research that investments to customer satisfaction are usually seen only as costs, even when they are actually investments to quality and success in the future. Harter's et al. (2000) research have an interesting result that process maturity can decrease cycle time and effort.

Belekoukias et al. (2014) summarized the most crucial components of lean business. The authors found defects, costs, lead time, and value as the most important factors of lean-ness. And from another view, Harter et al. (2000) listed quality, effort, and cycle time as the most important factors. Those views by Belekoukias et al. (2014) and Harter et al. (2000) are actually very close each other. Harter et al. (2000) pointed out that time-to-market is fundamental in the fast moving software industry, but still its improvements cannot be done with the expense of other factors like quality and costs. Blackburn et al. (1996) underlined the speed and productivity are not the same in the development because they are depending on how much effort is used. On the other hand, both speed and productivity can be improved with similar ways to act and they should not be seen as trade-offs (Blackburn et al. 1996).

The major question in the quality improvement can be defined as, is it possible to improve quality and at the same time have no impact to costs and cycle time (Harter et al. 2000). It is trivial that if amount of testing decreases, solutions can be produced faster. But according to Krishnan et al. (2000), software producers are often trying to remove defects in the first place, instead of speeding up the development and at the same time removing defects with continuous testing. In any case, quality is more appreciated than delays in markets so better to be delayed than deliver bad quality (Harter et al. 2000). However, quality is very hard to define for different stakeholders for example the perspectives of usability, efficiency, reliability, maintainability (Wateridge 1998).

At strategic level, there can be identified indicators such as satisfaction of customers, revenue predictability, and profit margin (Westfall 2014). Kupiainen et al. (2015) did qualitative analysis about the importance of different metrics. The authors found that the most crucial components of agile software development are customer satisfaction, technical debt, build status, and progress as working code. In addition to agile components, also the basic project components, cost, scope, and time can be seen meaningful (Atkinson 1999). But they are not enough to measure project's whole success so Atkinson

(1999) took information systems, organizational benefits, and stakeholder benefits into account.

2.3.3 Indicator categories

Traditionally organizations have used mostly financial measures in their PMSs, but the most recent impression of supportive and comprehensive metrics include nonfinancial indicators (Brignall 2007). Within the models of program perspective, it has been accepted for long that it is useful to have nonfinancial indicators along with financial indicators (Laine et al. 2016). However, there seems to be a lack of conception within business phenomenon in agile program context and it is not having enough attention in empirical use (Laine et al. 2016). Fisher (1995) noted in the article that the business needs of nonfinancial metrics should be more evaluated together with financial indicators. The author's intention is that research is weighted too much to financial budgeting and standard cost systems.

Nonfinancial metrics have been research more in recent studies. Pure financial measures were good option in industrial era when fixed costs and volumes were greater in companies (Shenhar et al. 2001). Bryant et al. (2004) considered nonfinancial measures as a metrics to evaluate the business value of a company. The authors found that both customer satisfaction and product introductions were enhanced when using also nonfinancial indicators. In the article, Ferreira and Otley (2009) found that some nonfinancial and financial metrics can be absolutely useful at various organizational levels. The authors underlined that their use need to be synchronized in different cases. When using nonfinancial indicators, companies need to consider their business and objectives of measurement, and then implement suitable indicators (Said et al. 2003).

Cohen et al. (2012) identified nonfinancial indicators in a large group of companies' reports. The authors' leading indicators consisted of market share, quality rankings, customer satisfaction, employee satisfaction, people turnover, and innovation. In the research, the mostly used by companies were market share and innovation. After them quality rankings, but specifically software industry had customer satisfaction in very highly valued. Turnover of employees was the least used. Cohen et al. (2012) also found out that the success factors change between the industries depending what kind of success industry is pursuing. Also incentive programs can have nonfinancial indicators. When considering nonfinancial incentive programs and their impact to business success, they have positive impact to economic performance (Said et al. 2003).

Performance indicators can be categorized many ways. One possible approach is to compare process and product indicators and they can be used to different purposes (Westfall 2014). Krzeminska and Eckert (2016) summarized the difference of process and product indicators and their measurement. The authors mentioned product approach is more revenue orientated while process perspective gives more significance to process efficiency

and cost savings. The process perspective is interesting in agile software development where process is continuous (Leffingwell 2010, pp. 3-29).

Paetsch et al. (2003) defined that agile methods aim to maximum customer satisfaction. The authors mentioned agile development very people-orientated and that is why it is focusing on process rather than product perspective. In their paper, Ramasubbu and Balan (2007) scrutinized decentralized software development and its project performance. The authors used quality and size of code as indicators for output during the defined timeframe. Westfall (2014) divided indicators to process and product measures with following way. Product measures are size, complexity, defect density, problem report backlog, test coverage, requirements volatility, reliability, availability, maintainability, and performance. Process measures are costs, first-pass yield, cycle time, defect detection, defect containment, defect removal effectiveness, customer satisfaction, and responsiveness to problems.

2.3.4 SAFe metrics

The Scaled Agile Framework (SAFe) is a freely available model which can be used to control and scale agile software development (Leffingwell 2018). The framework combines the best practices of agile and lean product development with system thinking and team management (Leffingwell 2018, pp. 1-13). The SAFe has been released in 2013 and it has spread very broadly and is used in several companies (Laanti 2014). The SAFe model can be adapted to different business contexts.

The SAFe can be scaled to the organization's size and purposes. There exist the four levels of organization which are team, program, large solution, and portfolio levels (Leffingwell 2018, pp. 1-13). The framework has the collection of guidelines which help to success in the agile development (Leffingwell 2018, pp. 1-13). From the performance measurement perspective, the SAFe offers own metrics which are used in the development. For each level of development, the SAFe includes metrics as a tools which are connected and can be used together (Leffingwell 2018, pp. 435-455).

The whole framework of the SAFe is defined by its core values which are built-in quality, alignment, transparency, and program execution (Leffingwell 2018, pp. 21-26). By built-in quality, Leffingwell (2018, pp. 21-26) meant quality must be enabled to create within development work, instead of doing quality assurance and trying to increase quality later on. Alignment works as a key of having all people behind own development work. There is the idea of decentralized decision making and team autonomy. Teams can work independently which also points out the importance of performance measurement. That is a way to see how different parts of organization are doing. But if indicators are not sufficient and reasonable, there will be given the wrong picture of actual performance. Transparency in the SAFe means visibility for every levels in organization. All people of organization should be meaningful how progress is measured and what how to enhance

performance. The last value of the SAFe is program execution. That means agile working has the higher levels in the organization.

Earlier in this work, the Balanced Scorecard approach by Kaplan and Norton (1992) was introduced. The SAFe has adapted model which has also four perspectives to measure performance (Leffingwell 2007, pp. 311-326). Those four quadrants of business performance measurement are meant to support all important areas of business as in the traditional Balanced Scorecard (Leffingwell 2007, pp. 311-326). The Enterprise Balanced Scorecard is introduced in the Figure 8.

<p>EFFICIENCY</p> <p>Sample Measures:</p> <ul style="list-style-type: none"> • Contribution margin and work in progress • Organizational stability • Team velocity vs. capacity 	<p>VALUE DELIVERY</p> <p>Sample Measures:</p> <ul style="list-style-type: none"> • Number of releases • Value feature points delivered • Release date percentage • Architectural refactors
<p>QUALITY</p> <p>Sample Measures:</p> <ul style="list-style-type: none"> • Defects • Support calls • Support satisfaction • Product satisfaction • Escalation rate percentage 	<p>AGILITY</p> <p>Sample Measures:</p> <ul style="list-style-type: none"> • Product ownership • Release planning and tracking • Teamwork • Development practices

Figure 8. *The Enterprise Balanced Scorecard (adapted from Leffingwell 2018, pp. 435-455)*

The Enterprise Balanced Scorecard have four areas which are efficiency, value delivery, quality, and agility. Leffingwell (2007, pp. 311-326) described those sections as follows:

1. Efficiency is the factor to measure how organizations' are meeting their objectives and financial targets. Examples can be margin if there exist clear revenue stream, or velocity versus capacity which measures efficiency to utilize resources.
2. Quality contains satisfaction to products and services as well as software quality measures like defects or support calls. Measures need to be adjusted to the size of object.
3. Value delivery is specifically important target for agile development and measures the amount which is produced within the timeframe. That can be counted by the releases of software, but usually better indicator is the value of delivered feature points.
4. Agility measure is an indicator for organization's ability to improve its performance and reform. This factor is built in to agile methods of working and enables continuous improvement to increase all the time.

The Enterprise Balanced Scorecard approach is intended to use in measuring whole organization activities which have the substantial amount of workers (Leffingwell 2007, pp. 311-326). Those factors of it can be scrutinized in smaller parts at team level in order to utilize organizational measurement by implementing it to the lowest levels (Leffingwell 2007, pp. 311-326). The Balanced Scorecard tells the guidelines and indicators for comprehensive measuring which should be one of the main focus areas in agile and lean environment (Leffingwell 2018, pp. 435-455). Otley (1999) described in the performance management article that operative issues need to be understood as well as have a focus on strategy and its implementation.

Because the SAFe is scalable, there must be different indicators and measurement methods for different levels. Program metrics are more practical way to implement performance metrics for programs (Leffingwell 2018, pp. 435-455). The SAFe model's program performance metrics are showed in the Figure 9. Program metrics are basically summarizing performance objectives to practical rate card. Programs can be understood as the collection of teams on the same area.

Functionality	PI 1	PI 2	PI 3
Program velocity			
Predictability measure			
# Features planned			
# Features accepted			
# Enabler features planned			
# Enabler features accepted			
# Stories planned			
# Stories accepted			
Quality			
Unit test coverage %			
Defects			
Total tests			
% automated			
# NFR tests			

Figure 9. The program performance metrics (adapted from Leffingwell 2018, pp. 435-455)

In the SAFe methodology, indicators can be divided to agile project metrics and agile process metrics (Leffingwell 2007, pp. 311-326). The Figure 9 shows project metrics which can be incorporated with the respective indicators of process metrics. Leffingwell (2007, pp. 311-326) presented the idea where project metrics are tracked in independent projects which are executed one by one. Independent metrics can be aggregated to process

metrics which are then representing the continuous development. Main topics of the Figure 9 are velocity, predictability, defects, and testing. Those can quite broadly be used in order to reflect various aspects of organization's performance on practical level.

2.4 Agile Performance Measurement and Environment

2.4.1 Business environment and external factors

Performance measurement systems have external factors which are analyzed in the academic literature (e.g. Fisher 1995; Miller 1988; Daft et al. 1988). Based on those researches, company's environment can be defined with elements of industrial characteristics, competition and markets, social and political circumstances, and technological environment. Those external factors form the initial background for performance measurement and analysis. PMS need to be created, used, and managed by understanding the background. As the results of well utilized performance measurement, organization will end up to better situation in organizational, financial, and business contexts. This process is presented in the Figure 10.

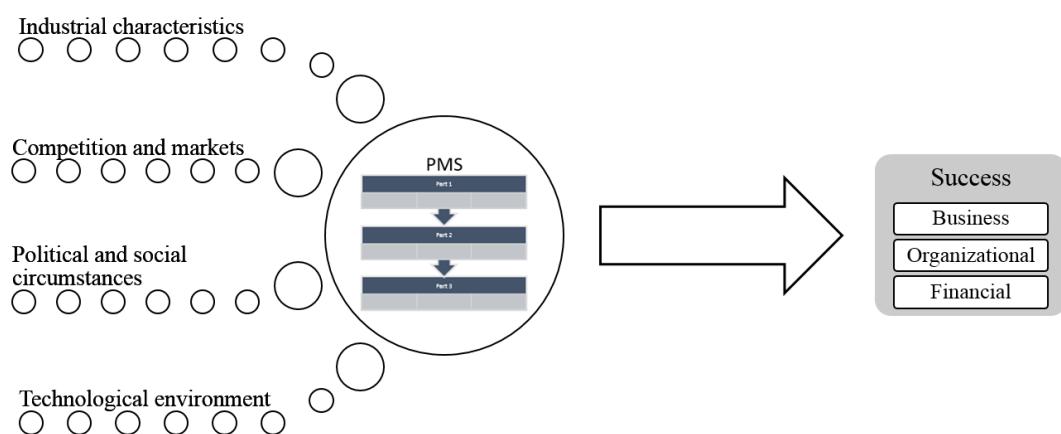


Figure 10. *The external factors of performance measurement and objectives*

In the middle of Figure 10, performance measurement is described as a step by step model which is created and managed in order to enhance organization's performance. In order to accomplish comprehensive performance measurement, correct metrics are not all in all, but the system needs to be created and managed correctly. Alahyari et al. (2017) stated, companies in the software industry need to maximize the value produced in their actions. On the other hand, Ralph and Kelly (2014) found the insufficiently defined viewpoints of success in many contexts. Obviously there is a need for an organized approach to performance measurement.

2.4.2 Objectives and management

The framework of Malmi and Brown (2008) showed the aspects of organizational control. When evaluating a system for agile performance measurement system, there is a meaningful focus also on the cultural and value parts. Leffingwell (2018, pp. 1-13) emphasized that agile organizations should have a strong culture which encourages to flexible working. Malmi and Brown's (2008) framework has certain parts which define the environment and objectives for the activities. Strategy level aspects give the guidelines for measurement. Shenhar et al. (2001) noted, strategically led project environments are more successful because of their ability to look forward. Strategy includes creation of culture and long terms planning as well as administrative controls in Malmi and Brown's (2008) framework.

As mentioned earlier, performance measurement needs to have supportive aspects for people whose performance is under monitoring (Wouters and Wilderom 2008). In the business that means used indicators need to measure essential impacts which are the key factors for business' success. Managers lead organization to the direction enabled with indicators. Banker et al. (2000) found the fact that management have the power to guide organization towards desired objectives. That makes indicators very important aspect from the view point of strategy. Chosen indicators define what organization wants to accomplish. In Malmi and Brown's (2008) framework, cybernetic controls as financial and nonfinancial measures serve as indicators to measure the desired key components of performance.

Adler and Borys (1996) compared enabling and coercive control systems. A coercive system has certain advantages in some cases where routines and tasks are heavily standardized. Nevertheless, if the perspective is an agile software development, it is clear that enabling control systems are required in order to success in the markets. That is highlighted with Adler and Borys' (1996) notice that an enabling system gives employees opportunity to fix problems when they occur. In the technology orientated software development that is the minimum requirement.

2.4.3 Factors and indicators

Agile software business has specific issues which need to be managed in order to be successful in the quickly changing markets. For agile organizations, speed is important aspect according to (Leffingwell 2007, pp. 311-326). That makes team size small in order to enable fast actions. Also Blackburn et al. (1996) stated that the fastest organizations usually have the smallest teams. So speed tends to be one key element of agile development. There need to be researched which is the best way to measure it in agile context.

Another crucial aspect of agile software development is customer satisfaction and its management. This is important aspect for all levels of technology (Shenhar et al. 2001).

Customers are defining the future demand for companies' products, so their opinions must be respected. On the other side, Krishnan et al. (2000) pointed out the irrelevance of some opinions. The authors mentioned, sometimes customer desires can be too expensive to carry out. So customer satisfaction need to be managed by clarifying and defining crucial value requirements. This creates the question which is correct way to measure customer satisfaction the way that can be analyzed also from the perspective of effectiveness.

Project environment is usually hard to predict. Lipke et al. (2009) summarized that there need to be better ways to track achieved success. The authors mentioned earned value management as a one standpoint trying to predict obtained value. As the Figure 9 shows, Leffingwell's (2018, pp. 435-455) SAFe has predictability as a very important factor for the agile development. When environment is changing faster and faster, there need to be ability to plan and execute steps efficiently.

Lillis (2002) found that hectic environment changes cause problems for the quality. According to the author, quality must be in the core of commitment. Quality improvements tends to increase used efforts because all new implementation need definition, testing, and the other areas of work. The earlier introduced project triangle seems to keep its importance when considering the balance of used effort in the form of costs and working hours. Efficiency during the projects cannot be decreased as a tradeoff for other requirements.

3. RESEARCH METHODOLOGY

This research was conducted for the subscriber company which produces different information technology services and products globally. The target organization of the research is the business unit which focuses on serve the financial industry needs of information technology services. The topics, methods, and models were discussed together with the instructor from the university and the people from the subscriber company. The objectives of the work were chosen in order to fulfill the business goals of the subscriber company and the academic objectives of the university.

3.1 Research Strategy

The nature of this work is qualitative analysis of performance measurement as a process. The thesis was carried out as an action research where the researcher participated actively to the discussions and the workshops of related topics. As the main method of data gathering, the several interviews were arranged in order to collect detailed information about the specific subjects. The action research fulfills the four common themes which are research in actions, participating role of a researcher, an iterative nature, and general level implications (Saunders et al. 2009, pp. 147-148). The researcher was a member of the project group and had several formal and informal conversations which deepened the knowledge of the topics.

Qualitative data is defined as all non-numeric data which need to be understood in order to make it useful (Saunders et al. 2009, pp. 480-482). The essential objective of this research is to reflect research material about performance measurement to the agile software development context when the most part of source material in performance measurement covers other contexts. Qualitative data is based on non-standardized data, expressions, and conceptualization analysis (Saunders et al. 2009, pp. 480-482). Performance measurement has various subparts which include its background factors, indicators, system, and management. The topics are covered by collecting qualitative material and analyzing it. The data collection is done with multi-method approach which allows to use several different methods to collect qualitative data.

The performance measurement framework was built in this work. The used research approach for that is abductive research which differs from inductive and deductive approach mostly by the role of a framework (Dubois and Gadde 2002). The framework of the work was formed interactively during the research process. At first, the model was structured with the knowledge gathered from the background literature. Different phases and perspectives are collected under the model which have been used in order to create research

questions. Later, the empirical findings are used to specify framework to the targeted industry of agile software business.

3.2 Research Process

This research was totally six months long which included the first month of preparation and the last month of finishing the report. The first month was used mainly to conversations in the organization and investigating the specific needs for the analysis. The last month of the time was spent to evaluate the report and planning next steps. Hence, the actual research process took four months.

The research started by collecting articles and source material. The material was analyzed and summarized to the notes. The sources were chosen by analyzing their authors and publications which were only included if they have subjectively academic or other way reliable reputation. When initial theoretical background was formed, the first drafts of the performance measurement framework were created. This work had two main methods to gather data which were interviews and workshops. The different areas of performance measurement were covered during the interviews and the workshops. Their goal was to deepen the understanding of factors which are related to performance measurement. The material was designed and discussed the way which is presented in the upcoming performance measurement framework.

The next phase of the research process was to arrange the interviews and participate to the workshops which gave more understanding of performance measurement and its related issues. The framework and the literature review were iterated and recreated many times when new information and understanding were gained. When the research proceeded, there were more and more analysis done and the focus moved all the time from the literature to the analysis of the empirical material. When all the interviews were done, they were analyzed and summarized in order to get understanding of different perspectives. Those key areas of the interviews are described later. When actual writing process went ahead, there were also all the workshops done and their analyses were carried out.

The last parts were writing and analyzing the material. Collected data was handled by identifying different opinions and perspectives. In the last phases, there was not many new sources found, but analysis and writing was continued. The Figure 11 shows the visual presentation of the process and its found references, used time, and written text.

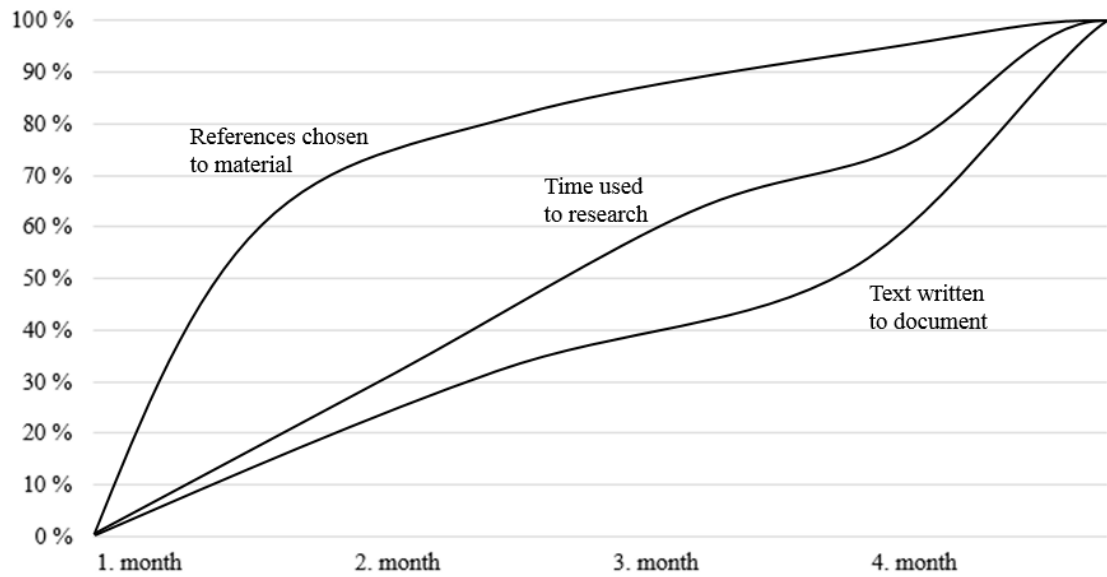


Figure 11. *The research process described by the amount of references, used time, and written text*

The research process started from the literature background and proceeded to the empirical analysis. That can be seen from the Figure 11 which shows how the references were collected mostly in the earlier phases of the research whereas text was written mostly in the later phases.

3.3 Interviews

During the material collection, there were six interviews arranged. They were conducted as semi-structured theme interviews. Those were done for the personnel of different positions related to performance measurement. The lengths of the interviews were between 45 minutes and 75 minutes. Following Table 1 presents details of interviews.

Table 1. *The interviewed people and the perspectives*

Position of interviewee	Perspectives of interview
Specialist of agile development	<ul style="list-style-type: none"> • Project management • Agile environment • Customer perspective
Specialist of quality control	<ul style="list-style-type: none"> • Value creation • Quality aspects • Organizational levels
Specialist of agile and lean methodologies	<ul style="list-style-type: none"> • Agile production • Organizational management • Scaling of measurements
Specialist of financial administration	<ul style="list-style-type: none"> • Financial objectives • Managerial perspective • Stakeholders of measurement
Portfolio manager	<ul style="list-style-type: none"> • Performance indicators • Organizational impacts • Tracking of performance
Agile coach	<ul style="list-style-type: none"> • Agile characteristics • Performance management • Critical indicators

The interviews had different approaches and perspectives to performance measurement. The discussed topics depended about the interviewees' areas of specialty. The interviews dealt different perspectives of the previously introduced framework, but they had different focus areas depending the position of an interviewee. The general structure of the interviews is presented in the Appendix A.

3.4 Workshops

The participant-observer workshops were related to discussing and planning performance measurement, indicators, and management. The lengths of the workshops were changing between 30 minutes and 60 minutes, and there were attending from five to nine people. The researcher participated to meetings and was mainly studying and observing, but did not actively discuss or share opinions. The researcher participated to eight workshops which covered the different perspectives and themes of performance measurement. The themes and the amounts of participants are presented in the Table 2.

Table 2. *The themes of the workshops*

Theme of workshop	Amount of participants
Data gathering	6
Defect reporting	5
Measurement metrics	9
Reporting activities	7
Reporting activities	6
Measurement metrics	8
Data collection	8
Reporting activities	7

The workshops were practical and mostly focused on to define metrics and management for performance measurement. They did not have specific structure or case working, but they were intended to gather and share opinions of performance indicators, measurement process, and management. The researcher observed and took notations in order to build more comprehensive understanding of performance measurement.

4. PERFORMANCE MEASUREMENT FRAMEWORK

Performance measurement is the broad topic in the academic literature as can be seen from the theoretical background of this work. Its flow can be described as in the theory part from the broader definition of control to the more detailed indicators of a certain industry. In this work, performance measurement and management start by defining management control in a company. That includes different aspects such as values, culture, planning, incentives, organizational structure, and cybernetic controls. Those aspects are discussed in Malmi and Brown's (2008) framework. When proceeding from general level control aspects to performance measurement, there are seen different perspectives and reasons to execute certain measurements. From performance measurement, it is natural to move to indicators which are actually tracked in order to get desired results. Metrics and systematic measurements need to support company's goals. After the indicators are defined, there is a need to manage and lead a system optimally. Information utilization and use are processes which have multiple things to pay attention.

Companies operate in different environments and industry specific perspectives are essential for models with the aim of success. In this work, the industry view is placed to software industry and more specifically to agile software business. That creates fundamental assumptions to system management. Therefore, performance indicators and measurement is defined in order to fill the certain needs of agile software development.

The framework for performance measurement can be defined various ways as indicators or different approaches. Different perspectives are described in the theory part. Performance measurement is not just a stable framework, but environment can change and performance measurement activities need to be adjusted. On the other hand, this can be enabled only by designing a system such a way it can be reactive and dynamic to lead and measure. According to the theoretical part of this work, a performance measurement system is analyzed as a result of three main parts:

- Defining the fundamentals of measurement from the perspective of industry, business objectives, and organizational goals.
- Identifying drivers for measurement and then choosing indicators which are relevant, descriptive, and accurate.
- Managing a measurement system and following performance.

The idea of the framework is comprised to the need of effectively and systematically build a measurement system which is accurate and meaningful for both management and work-

ers. Organizational objectives and value aspects are grounding a system which also emphasizes the first research question of work. It is followed by value identification process which starts by recognizing value producing drivers. Then moving to indicators which can be used in order to measure the key areas of business. Metrics definitions are trying to answer to the second research question. When a measurement system is formed with indicators, it needs to be managed and used supportive way in a company. Produced measurement data offers valuable information for many internal and external stakeholders. One of the key success factors for measurement is the realization of measurement's supportive role. Management role and activities are considering the issues which are defined in the third research questions.

The performance measurement framework is presented in the Figure 12. It has three main components which are connected to each other.

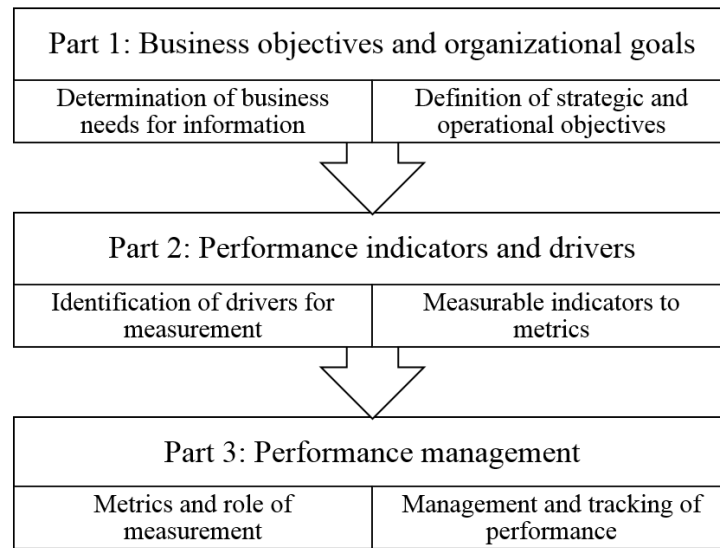


Figure 12. *The performance measurement framework*

The framework reflects the steps which are needed in order to respond in the Figure 10 mentioned external factors such as industrial, competitive, social and political, and technological changes. The following parts are explaining the parts 1, 2, and 3 of the framework.

4.1 Business Objectives and Organizational Goals

Performance measurement starts by defining environmental issues and business needs which measurement is based on. This definition is divided to understand environmental and business needs and secondly to identify the strategic perspective of measurement. The first issues are industrial, competitive, social and political, and technological perspectives which are meaningful for business. Industrial and competitive environments

have some uncertainty and complexity because there are other companies and stakeholders having an impact. Technological environments like software industry are usually highly uncertain environments to operate. Technological environment needs flexible and dynamic processes which respect the importance of research and development practices. Companies can implement tests with different innovations and that is the way to find good opportunities.

From the political and social parts of environment, companies need to do some background work in order to have a view to changes for example regulations which can impact to their business positively or negatively. Political changes can be predictive or surprising, but they require some preparation. If a company predicts some specific issues which later take place in the market, it can obviously outperform its competitors. On the other hand, social factors offer some pressure to companies. In software business, social and human factors are playing quite meaningful role. Companies' assets are basically their human resources and people are the crucial part of business, so their respect is important.

In the earlier listed Fisher's (1995) strategic factors, knowledge transfer was considered on the side of environmental variables. Knowledge transfer plays the role in all businesses, but especially in the software development. Systems can be very complex and their adoption is not easy for new developers. That needs to be taken into account when organizations' are reshaping themselves. It need to be secured that necessary skills are represented in all units. Software products are many times tried to differentiate quite a lot from other substitutes which makes it difficult to change people without losing some crucial knowledge. Highly technological industries have also very important aspects of knowledge and information transfer. The Figure 5 presents the important aspects of technological uncertainty which are affecting organization's performance measurement. Future's focus need to be understood and handled properly.

Industrial perspective is important for agile software development. Fast changing environment forces to agile working which requires the use of scalable agile models. Earlier introduced the SAFe is one approach to solve this problem. It divides organization to different levels which are closely connected and working together (Leffingwell 2018, pp. 1-13). The goal of agile development is to decrease wasted time, bring customer view closer to development work, and require shorter cycle times for implemented features. It enables efficient tracking and measurement for development work when information is shared transparently within organization's portfolio, program, and team levels. Leffingwell (2018, pp. 1-13) underlined working software as the main component of success evaluation. Software industry is heavily forming itself towards more and more flexible working. Some projects can be developed as traditional waterfall projects, but it requires the high level of knowledge for requirements and how to form the actual solution. In hectic environment, it is very hard to predict needs correctly in the beginning. As mentioned, software industry is changing environment which makes it hard to predict necessary requirements in early stages when problems have not been found.

When identifying strategic needs, companies need to evaluate their strategy and its impacts to performance measurement. From the strategic perspective, the SAFe focuses on to maximize the value produced for the customer with given resources and schedule (Leffingwell 2010, pp. 3-29). This approach differs very much from the traditional way of thinking where requirements are fixed, but resources and schedule serve as variables. Agile value-driven approach keeps resources and schedule varying, but have costs fixed. Those fixed factors set the limits for work which aims to maximize done features, releases, and business value produced.

The strategic positioning of a company can be done many ways. One approach is to use the Balanced Scorecard which is presented in the Figure 2. This perspective can be compared to the SAFe's Enterprise Balanced Scorecard in the Figure 8. The Balanced scorecard has been introduced as the general framework, but when applying it to agile software development and the SAFe model, the actual strategic needs of agile environment can be understood. The scorecards of Kaplan and Norton (1992) and Leffingwell (2018, pp. 435-455) are presented in the Figure 13.

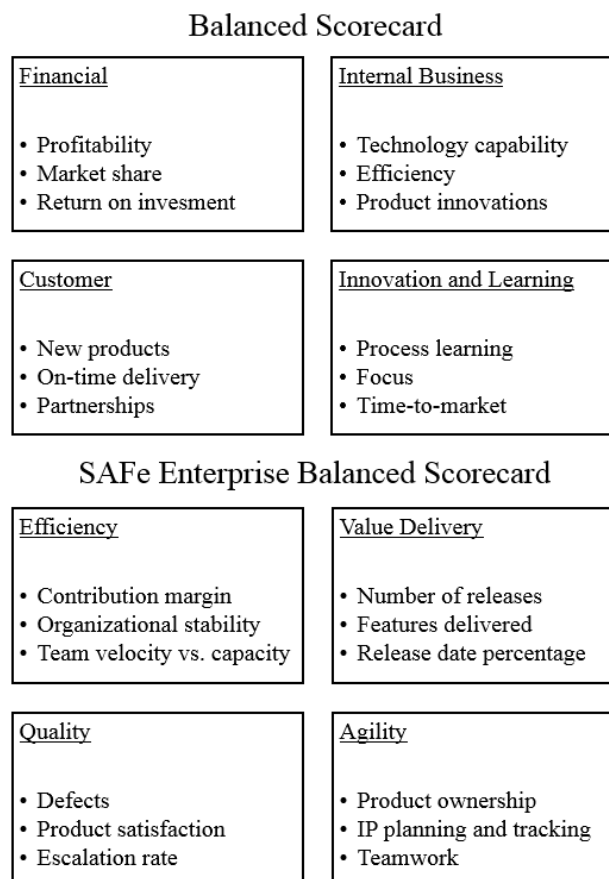


Figure 13. *The comparison of the scorecards (adapted from Kaplan and Norton 1992; Leffingwell 2018, pp. 435-455)*

The traditional Balanced Scorecard starts by taking into account the financial perspective of business owners. That shows appropriate indicators how organization is performing

for its owners. Financial perspective highlights performance by measuring financial values such as profitability which tells how the costs have been in order to do all required work. This same methodology does not exist in the SAFe's Balanced Scorecard because the SAFe methodology defines costs as fixed values. Given resources generate value and make it very measurable to see how much was spent. That does not mean the SAFe excludes financial measures, but rather measure them different way. Margin and return on investment are appropriate measures there as well, but management of projects is not done with them.

In the SAFe's Balanced Scorecard the value delivery and the quality sections are both customer orientated, whereas the traditional Balanced Scorecard have customer's perspective as a own part. The traditional Balanced Scorecard defines it essential to see what customers think about a company. Predicting customers' satisfaction and its factors is important for business and Kaplan and Norton (1992) highlighted time-to-market and product quality as crucial factors for customer's view. The SAFe methodology notes those, but divides them to two categories. One is to deliver value for customer which includes time-to-market aspects, but also the releases of software and measured business value for customer. This focuses on software business perspective as agile method to separate implementation and releases. Implementation work can be done all the time and in certain time periods do the releases. A quality part is crucial in order to satisfy customer and increase their desire to buy more. Bad quality removes the achievements of efficient development process. Customer satisfaction and working software serves as a main goal for all the work in agile development.

The innovation and learning of the traditional Balanced Scorecard is actually quite close of agile mindset. In the SAFe model, innovative learning and self-development belong to the core of values. Leffingwell (2018, pp. 27-33) introduced the SAFe's house of lean which describes value driven development. It includes aspects of respect for people and culture, flow, innovation, and relentless improvement. Those describe very well the ideas of agility and continuous learning. The same idea is innovation and learning of the traditional Balanced Scorecard where learning and time-to-market is developed.

From the strategic points of view, the roles and goals of performance measurement process must be understood. The essential part of definition is to see how value and success are created in business. Shenhar's et al. (1997) model is presented in the Figure 4 and it forms the dimensions of success in the project environment. The authors' implication was that project success will reform within time from process execution to its product's performance in markets. Projects cause costs when are ongoing which can be seen as a very easy indicator to measure projects' efficiency. It is not clear, does that indicate their produced value or success. When projects go further, there is a change that cost criticality varies and then more costs does not always mean inefficiency.

4.2 Performance Indicators and Drivers

After organizational and strategic factors are identified, the focus will move to drivers and indicators. The background work during the part 1 of the framework needs to be done in order to understand fundamental external factors which affect the selection of performance indicators and overall to measurement system. Indicators cannot be selected straight without the sight of background drivers and indicators' measurability. The first step in this stage is to identify drivers for measurement. Traditionally project environment management has been done through the project triangle of cost, schedule, and scope, but Ralph and Kelly (2014) summarized that the perspective has turned out to be insufficient. There is a lot of other factors within different industries. Different frameworks can offer the useful knowledge of factors which are impacting to development in information technology solutions.

One framework for the industry of information technology is earlier presented Atkinson's (1999) Square Route model which includes the project triangle, specific factors of information systems, organizational benefits, and stakeholder community benefits. In the framework, the project triangle is defined as cost, time, and quality. The scope and the quality can be seen quite equivalent in software development. That is underlined in Leffingwell's (2018, pp. 435-455) citation from agile manifesto: "Working software is the primary measure of progress." In that perspective, the scope means the quality of changes. Otherwise software is useless and not working. The information system part of the Square Route model means certain factors which are specific for software engineering like maintainability, reliability, and information use. Software cannot be done without having thoughts as well in the future and how to maintain and update it. The benefit sections of model are divided to internal and stakeholder benefits. Organizational benefits are learning and improved efficiency which were also discussed earlier when analyzing the strategic background of measurement. Internal and strategic factors can also be combined in strategic targets. Those goals are set from higher levels and they can be measured as contractual criteria within customer contract or they can be set as strategic goal in order to success in the future. Latter definition can be done only if management has very good knowledge and experience which factors are the most important for organization. The last section is stakeholder benefits and reasons why to cooperate within a company. There are economic and environmental factors.

Frameworks have certain ways to look upon issues, but they need to fit to companies in order to enable successful use. From the frameworks, there have to be moved to actual implementation which reshapes models. The way of use or interpret can be changed so it brings models closer to a certain company. It is a way to consider how models can be implemented. Same methodology applies for drivers and indicators. Analyzing them will move focus closer actual work and enables the efficient use of indicators.

Value aspects are analyzed, turned to drivers, and to measurable indicators. One way for this is to adapt the model which is used in value categorization in Alahyari's et al. (2017) article. The authors used the model to identify value aspects and categorizing them to broader units. This methodology is presented in the Figure 14.

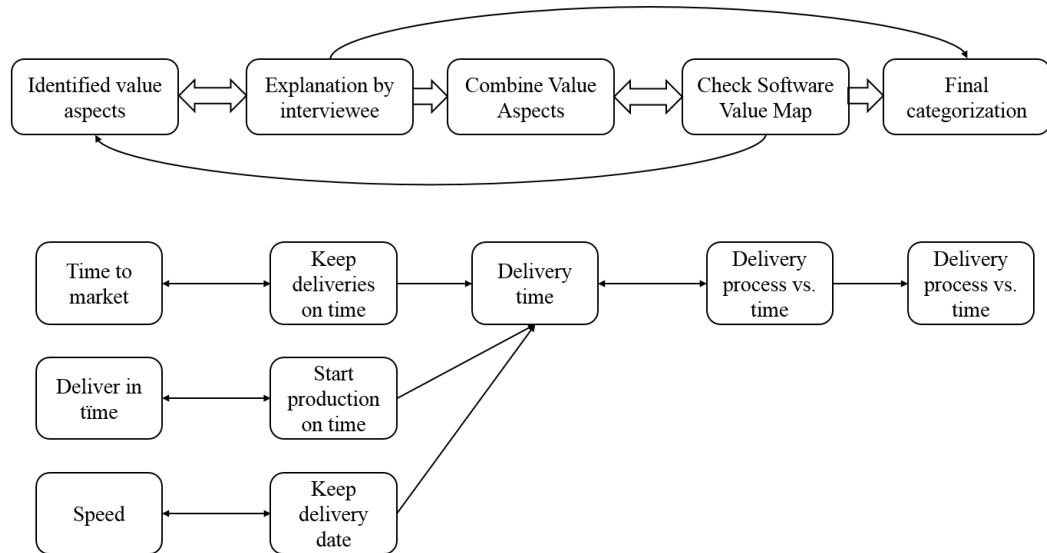


Figure 14. *The categorization of value aspects (adapted from Alahyari et al. 2017)*

Drivers work as a ground for the indicators so they need to be actual success criteria which brings together the most important aspects of business. Different sources define success different ways. In agile software development, meaningful perspectives are project management, process efficiency factors, and lean and agile factors which determine the progress and performance of software development work. The following Figure 15 presents the summary of factors within the important areas of agile and lean software development. Those factors were collected from several researches (Westfall 2014; Harter et al. 2000; Belekoukias et al. 2014; Kupiainen et al. 2015; Leffingwell 2018, pp. 435-455). The summary is created in order to fill need to combine normal project and process factors to agile factors. That is the way to analyze agile software development metrics and find drivers for indicators.

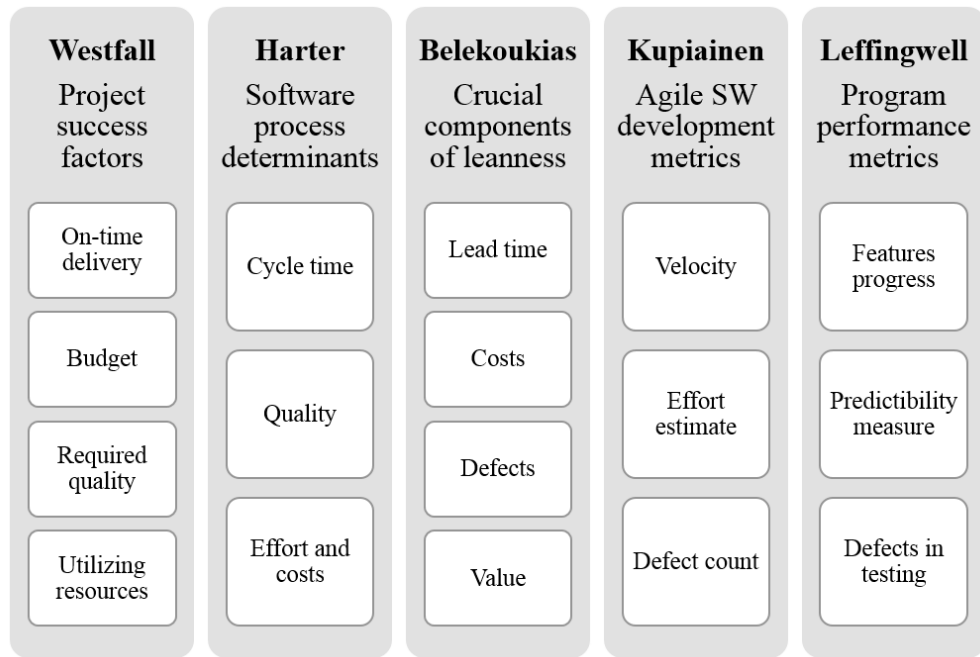


Figure 15. *The summary of the most important factors in software and process development*

Indicators are not existing in the isolation, but instead there need to be considered external factors for defining them. The presented Figure 15 shows that the most part of references has similar views of critical factors. Westfall (2014) mentioned delivery time, budget, and required quality as normal project triangle factors which are also the part of the effective utilization of resources. Harter et al. (2000) pointed out the traditional project triangle factors which highlight that even if they are not sufficient metrics alone, they have a broader role and can summarize the minimum needs of projects. Belekoukias et al. (2014) analyzed leanness which works very closely with agile software development and points out similar objectives and benefits. The author's opinion for critical factors of leanness determines value aspects and defect removal with cost and lead time aspects. Kupiainen et al. (2015) and Leffingwell (2018, pp. 435-455) referenced to agile development which seems to have important factors as developing speed and predictability.

With analyzed background and industry information, there can be identified meaningful drivers and measurable indicators. The Figure 16 allocates the drivers from the Figure 15.

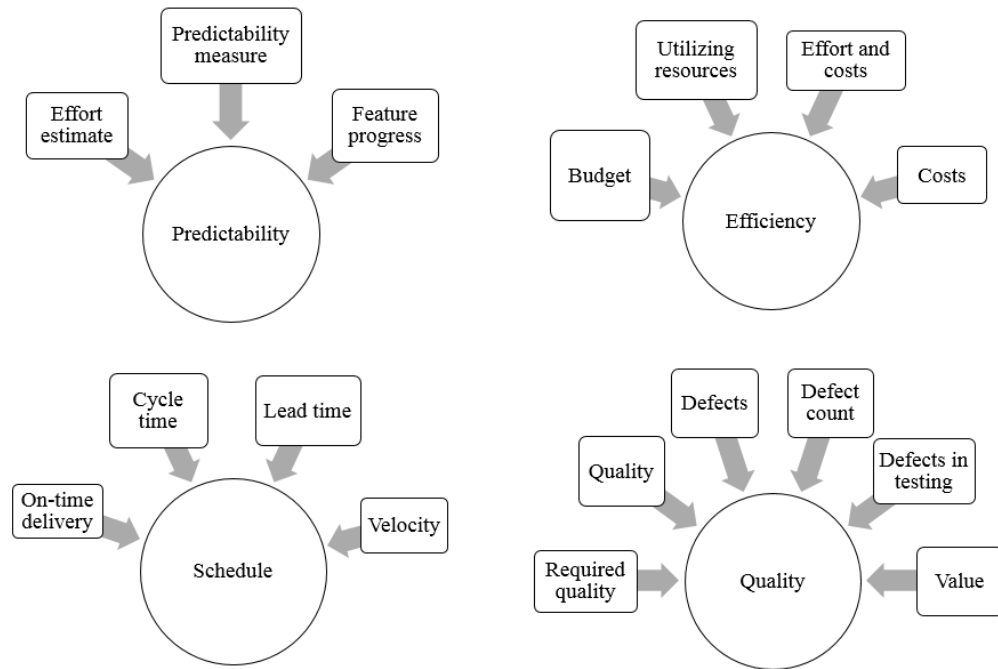


Figure 16. *The categorization of drivers and indicators*

Measurable indicators can be defined by analyzing different drivers. From the Figure 16, there can be seen four different value aspects as indicators. Those are predictability, efficiency, schedule, and quality.

Predictability is identified as an important indicator especially according to agile development and lean related research. It is essential in fast changing environments and requirements when work cannot wait over long time periods. Predictability is defined as a sum of effort estimation and feature progress so the easiest indicator for measurement is to define

- Planned amount of work / actual amount of work done.

Efficiency relates closely to traditional project management where success is measured as efficiency. This approach highlights costs and used resources in order to make results. It is important to see the difference between efficiency and productivity. Productivity can be defined the sum of all work within some timeframe, but that means productivity can be improved by increasing effort during time. In software business, effort is usually measured by used hours and prices which forms total costs. That is synonym for resources in the context. So efficiency can be defined by

- Amount of resources used / amount of work done.

Schedule is very crucial point in fast changing industries. Customer needs can be hectic and without ability to react opportunities can be lost. Agile working units are implemented in very short cycles. The cycles can be seen just as a review points, but delivery

time for a certain job is crucial in order to deliver value efficiently. Schedule component can be calculated as

- Delivery time of certain feature.

Quality is traditionally a factor which goes together with a scope. A scope can be delivered completely, but still be insufficient if quality is not expected. Quality is quite broad target to be defined unambiguously and there is no single definition. In software industry, there can be many perspectives to track quality. It can be independent from testing activities which means measuring it as subjective evaluation of added value. Another option is to define quality technically as a security factor for testing. In this case, it tells the coverage of testing activities and how well the testing will catch defects. One option to measure quality is

- Amount of errors / units tested.

Above mentioned definitions of indicators in agile software development are based on the background literature. Definitions and indicators are further discussed later in the empirical section, and they can be modified to different environments and cases. The later research of this work will go closer through actual indicators in agile environment.

4.3 Performance Management

After metrics are created and a company has been able to define objectives, drivers, and indicators, the last part of the process is to manage and track performance. That can be done by considering the desired level of control and planning a control system which is flexible enough to support organization. Organizational levels are connected and measurement is usually collected at the lowest level, but analysis and review is followed at management level. All measurement information must be collected for a reason and organization need to consider what is good way for information sharing and communication about performance measurement. When organization collect the measurement data, it need to be combined to respective units in order to get the overall picture of units. Data collection must be planned together with the data usage. That is the way to ensure all the needed data will be collected. When the data is analyzed, some divergences can be noticed. In those cases management level need to do some actions which will be based on results, but more importantly to the understanding of root causes and business factors. The effort used to manage, track, and analyze measurement is called performance management.

Adler and Borys (1996) analyzed the formalization levels of organizational control system. The authors' view was to divide performance measurement to the enabling and coercive points of view. Structured and stable organizations are able to use coercive perspective, but then all functions must be well defined and not much flexibility needed. For

enabling control, the authors summarized good sides that it supports the work better and makes it possible to fix problems. In agile software development where all the business is done in hectic environments and short cycles, coercive model is not workable. Agile models, such as Leffingwell's (2018) SAFe, are based on independent and active teams so the supportive role of measurement is highlighted. From the supportive role of performance management, it also matters who is receiving the results of measurements. Westfall (2014) defined different customers of measurements. As a summary of the theory, when moving inspection from upper levels to lowers, the focus moves from financial to functional measures. Information sharing is an essential factor in performance measurement. Results need to be informed in a way which is the most understandable and supportive for a target group. Information may be critical and confidential so another question is to provide results in a way which is needed and not too detailed.

The last step of performance management is about tracking key indicators and analyzing results. Management in companies does not have time to evaluate measures continuously, but the tracking period should be defined by respecting the schedules as well as the purposes of data usage. In that perspective, there is two factors to decide which are the amount of indicators and the frequency of tracking. Measurable factors can include a lot of different values and measures, but when they are tracked, it is essential to create the useful amount of factors to be included. This part is not straight forward and the amount of metrics depends also about the decision makers and their knowledge of measures. Frequency must be at level which brings information often enough in order to have time to react in case of challenges. That enables efficient managing of performance measurement.

5. RESULTS

This section presents the results of the empirical material which consists of the interviews and the workshops. Six interviews were carried out with the people from different positions. The structure of discussion was a bit different depending on the role of an interviewee. The researcher participated to the workshops in order to deepen the understanding of performance measurement process and systems. The workshop notes are the part of the empirical material. The results are divided under parts which are adapted from the performance measurement framework.

5.1 Business Objectives and Organizational Goals

5.1.1 Purpose for measurement

The need of performance measurement can be defined multiple ways which help organization to improve its actions. In the interviews, there was found two main categories which are enhanced by measurement results. Those needs are to improve organization's performance and to steer organization's actions. The improving perspective of measurements was highlighted mainly by people with the strong agile mindset.

From the improving point of view, the need for performance measurement is understood as utilizing data which gives real results and objectivity for measurements. Therefore performance measurement is not only opinions. Valid data can be used to predict future's needs, improve own performance, or improve the own level of operations. One interviewee pointed out that without measures there is no opportunity to identify baseline and need for improvements. One approach emphasized management role in the improvement actions. According to that, the main purpose of performance measurement is to receive information of organization's performance and forward this knowledge to management. This enables to see what and how to improve activities within the organization. Agile software development starts by trying to use resources as efficiently as possible. Performance indicators are setting guidelines for what are important areas of working. That enables to effective daily working which can be optimized and controlled. One of the interviewees summarized the viewpoint by:

“Performance measurement is the only way how organization can improve its actions.”

Management is steering organization to its desired direction. Two interviewees emphasized management as the main stakeholder of measurement. They also highlighted the need for targets which are analyzed with the measurement results. So before measuring performance, organization needs to analyze its target and direction where it wants to go.

After that analysis, measures can be put in place. Higher levels of organization have demand for measurements when they are steering to desired direction. Without the knowledge of current situation it is not possible to know where to go. However, measurements need always a goal to pursue, so measurements will lead to something. Results and their use were also mentioned in the interviews. Results can be something what was known before, but in some cases they can be something really unexpected and those are typically important findings. In the workshops, there were different perspectives to measurement purposes. The main components are to improve predictability and make management easier. Predictability is an essential factor especially in agile software development. In addition, measurement is important for quality management. It is essential to monitor quality and make sure errors are caught before they are delivered to customer.

As the interpretation of performance measurement results, measurements should never have an absolute value, but instead all the measured issues should be mapped to larger picture and context. It is possible that nowadays trends of big data and measuring are leading to too many metrics and measurements. If metrics do not have any objectives, they are unnecessary. One interviewee pointed that out by:

“Measurements should not be done just for measurements’ sake.”

Meaningful things must be identified when metrics are planned and measures put in place. Target setting can take place at first, then results and measurement process is analyzed and unnecessary metrics can be dropped away. When measurement is used correctly, it will give return for used resources. Some parts of measurements can be also duty for the company which means it needs to measure itself and share the information with certain stakeholders.

5.1.2 Stakeholders

Stakeholders can be found internally and externally in the companies. Companies have different structures. Organizational structure, external stakeholders, and an environment defines what kind of stakeholders and responsibilities there exist and need to be served. The interviewees had mostly the viewpoint that performance measurement will be done for the entire organization. One interviewee summarized internal stakeholders at three levels. The first level is delivery level which includes development teams in software industry. Those teams are producing value directly for the customer. The second one is tactical level which has middle management to monitor operational level work. The highest level is strategic level to represent top management in the company. All these stakeholder levels in the company have different KPIs and purposes and use for certain indicators. The Figure 17 presents the structure of organization and different needs for each organization level.

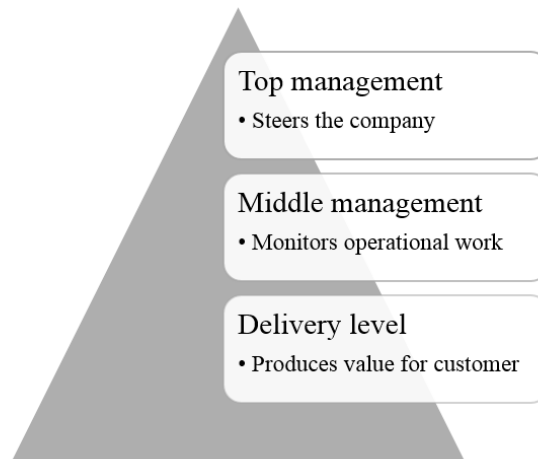


Figure 17. *The organizational levels and their interest to performance measurement*

Even when all levels have their own needs for the information, levels are closely connected. One of the interviewees explained how different layers use the data. At team level working, it is important to see how working could be improved or streamlined. Lowest level measures are very detailed so they need to be aggregated to upper levels in order to have a viewpoint from management to actual work. This presents the need for measurements practical parts and planning needs. Measurements need to be similar enough in different the parts of organization in order to enable ability to aggregate information.

Another standpoint of the interviews was that organization will benefit from measurements as a whole. The most part of the interviewees had opinion that whole organizational benefits will be achieved from reasonable performance measurements. This is especial for agile software development because transparency is the essential part of agile models. Employees in the company will care most about working environment and work life satisfaction. When considering lower levels in the organization, measurements can help to improve team work and efficiency. Positive feeling to work is usually increasing efficiency. Measurements are used by upper levels of business units and management. In addition, they are very useful for a software project and portfolio management where they have been measured from. Team levels have their own measures to improve their performance, but those are not same than organization's KPIs, which are followed mostly by management. From the financial perspective, the most important stakeholders of measurement are management people. From upper levels, the most necessary information will transfer to lower levels. Lower level people does not know everything, but they receive the necessary information which is needed in their work.

Customers and related stakeholders can also be interested in metrics. Usually at least big customers are interested of their contractors performance. Customers, who have a significant amount of company's sales, have usually leverage to get more information of company's measured metrics. Some measurement results can be communicated to external

stakeholders as well and transparency creates trust. One interviewee mentioned that some way everyone can be interested in measurement results both internally and externally. Indicators' nature defines how many stakeholders are interested about them and how the information can be shared. If some indicators have financial impacts, they are followed much more. That relates especially to incentive or sanctioned metrics. For the management of software business, return can be measured as profitability, whereas for customer it is not that straight forward. Customers want to have products and services which will fill the need for them. So indicators are meant for different stakeholders and their nature defines quite much how much different stakeholders are interested about them. Management should be interested in indicators always, even if they are not having direct financial impacts.

Other stakeholders can be for example third parties of projects and they may be measured similar way. That is the reason why they want to be familiar of their own ability to compete in markets. Some organizational indicators can be invisible for the public, but some specific people may be evaluating them. One stakeholder group is subcontractors who can be interested in metrics. Especially if metrics have a focus on subcontractors together with overall performance. In addition to different stakeholders in organization's and customer's side, there are other people who may be interested in measurement information. Those are for example owners and auditors. When measured information is shared, the transparency of information needs to be considered. Many stakeholders require information, but then an important factor is to decide how accurate information should be shared. Detailed calculations are done, but all the information is not needed for all stakeholders. In some cases, stakeholders can have a leverage to request information, but otherwise a company need to define its level of transparency in certain cases.

5.1.3 Agile software industry

The market environment of software industry is changing more and more hectic and harder to predict. That is the reason why many companies are forced to be more flexible. Traditional waterfall development is based more to milestones which does not consider the whole picture of development and produced value. If working is too much orientated to long steps of development, it creates challenges for management. Even if certain stage is measured, there is no connection to other stages. The most part of the interviewees were emphasizing the end-to-end perspective in agile development where small batches are produced continuously and their value and feedback are evaluated immediately. This point makes it easier to be flexible and was highlighted by all interviewees who are working directly in agile software deliveries. Nowadays markets are very hectic and there is a need for reactive management. It is essential to keep vision clear all the time because it is very hard to predict the future. Software industry has different ecosystems which set environment for the development. Teams and other parts in a delivery system are optimized to deliver efficiently and getting feedback all the time. The validation of feedback and

needs is essential with the aim of enabling management and reactive manner of development. Agile development has broad requirements for a system and people. The Figure 18 presents the summary of software industry and agile development characteristics.

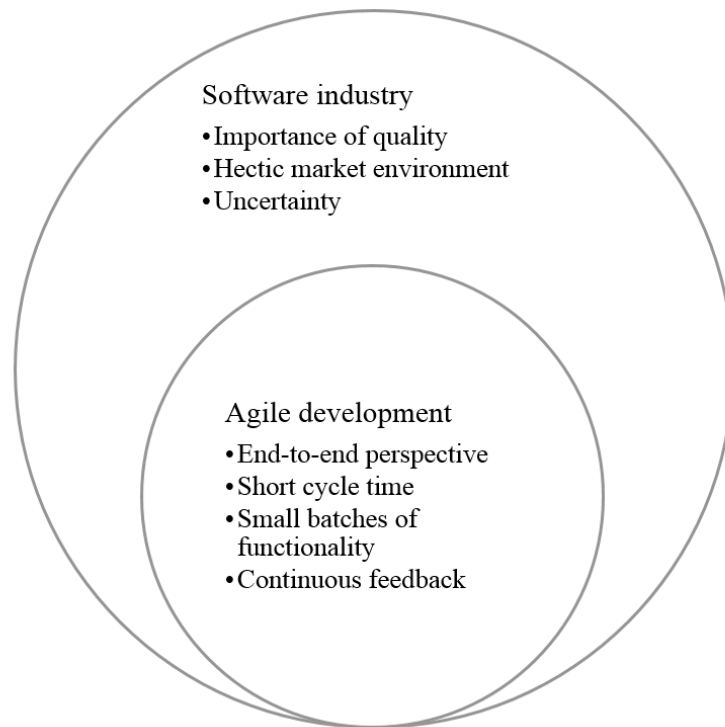


Figure 18. *The characteristics of software industry and agile development*

The operational level of a company usually have reactive manner, whereas strategic level should be proactive. The operational objective of measurement is usually to collect data from different levels of organization which can be aggregated to strategic level. Operations can be measured with large amount of performance indicators which are aggregated in an information system. Information can be used to make operational processes more effective and improving quality. All metrics have to be defined by considering is it possible to add value with them. Otherwise their measurement is not reasonable because they do not have a link to organization's goals and business objectives. One interviewee summarized that operational side of measurement is usually very practical and shows up in practical working. At strategic level, measures are more to wider perspective management.

Strategic management must be considered in metrics. The linkage between strategy and metrics is not always clear. Practical connections between strategy and implemented metrics at operational level should be communicated. That enables to get people behind management plans. One interviewee explained the strategy and logic of the SAFe agile methodology the way that strategy planning means the logic how to operate teams and portfolios with fixed costs. A variable factor is to measure how much output and value can be created with given resources. That leads to lean perspective where process is optimized

and waste removed. This methodology leads automatically to better financial results by operational excellence. Return on investment is produced differently in traditional and agile contexts. Agile context keeps the cycle very short which enables to get return for resource investments all the time. No work is done without immediate impact to products. That enhances the financial situation of a project organization when working capital, which is required to operate, is smaller. The requirements of software can be handled as inventories which makes traditional development to require more work before any income is received. If requirements expire, they cannot be used anymore which means waste in lean context. Therefore strategy is managed by operational excellence and the cost of delay.

New gain or profit will be created when measured information is used in decision making. Operational measurements can be used in strategy planning, vision and future plans under consideration. Companies' actions can support strategy and customer needs when development is done in short feedback loops. From strategic perspective, if there is invested to something, it is better to get return as soon as possible. Therefore there should be seen time perspective which enables to predict how long it will take to get return for investment. Prioritizing is important in the agile software business. In agile models like the SAFe, it have to be prioritized which work is the most important at certain moment. That enables to do meaningful work all the time. Quality is important part and customers will prefer products which fill their needs. Companies should actively improve own working and learn trends to be followed. Agile development is usually time and material based which means costs are fixed and delivered functionality is variable. That makes agile development very easy to forecast with financial metrics.

5.1.4 Benefits and disadvantages

Performance measurement has some benefits as well as disadvantages. Benefits are quite similar issues than those which are the needs for measurements. Two interviewees mentioned that the benefit of measurements is to get data. But they had different use for the data which were the same than two main reasons for measurements. The first is to get data where improvements can be based on. And the second is to get data for the management's use. One interviewee summarized that measurement has only positive effects when metrics are workable.

Measurement can turn to have bad impacts if measures are controlling work instead of just measuring it. This problem exists in all measurements. Too strict measures may have an impact to work. Then actions are done just for measurement but not for themselves. Another threat is if metrics are monitored only by their values. There can exist some root

causes for different results and those should not be excluded. If measurements are followed wrongly or if they are requiring too much effort, they will have bad impacts. As one interviewee mentioned:

“Measurements can be used wrongly in an organization.”

Measurement should have targets to tell where the company is and to which direction it can be led. Measurement is based on some actual metrics which need to be well defined and measurable. It is very essential to consider which metrics are important and how much effort need to be put to measurement activities. If some processes are handled manually without critical impacts, they must be evaluated again and dropped. The workshops also highlighted the need to be clearly stated what are actual indicators and how they are measured. Sometimes team is not able to affect all phases and their work can be delayed because of other reasons. Measurement results are usually a starting point for decisions and speculations. If decisions are based on results which are not evaluated, there is a threat to do actions with insufficient data. When the amount of data increases, the actions are usually more rationalized. Measured information is important to be evaluated with the reference data because all measurements have errors. Complexity can decrease the usefulness of output because there is a threat to get wrong information or interpretations. From metrics' standpoint, some indicators can be lagging and if time period between the measurement and decision making is too long, results may be expired. Another threat is that there can be too easy opportunities to modify measurement to desired direction. If teams see measurement very coercive way, they can act certain way that measurement will show positive results even if there is not done right things. In that case strategic objectives of certain indicators are not understood correctly.

5.2 Performance Indicators and Drivers

5.2.1 Main drivers for indicators

Indicators are defined in order to get desired results and they are based on some drivers. Indicators should measure some objectives which can be reached. It is important to perceive the overall picture of business goals. Indicators have different drivers and the interviewees also mentioned many of them. The most important drivers were depending quite much on the role of an interviewee. It is natural that people have different perspectives according to own position. The most important drivers for the indicators and their contexts are presented in the Figure 19.

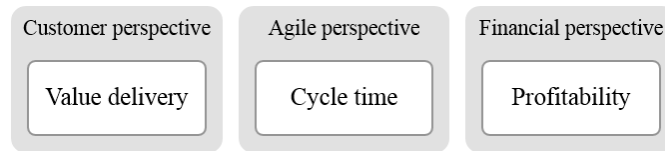


Figure 19. *The main drivers and their contexts*

The first main driver of operations is value delivered to customer. One interviewee emphasized that usually several components can be contributing to customer satisfaction and all used targets must be analyzed do they contribute to that final objective. Otherwise the parameters are not valid. Targets can be for example increases in productivity, increases in quality, or improvements in time-to-market. Therefore all the measured targets must have direct impact to the customer satisfaction.

Project business in software industry is based on project management. An interviewee emphasized related to financial perspectives that financial indicators of projects are always getting back to profitability at management level, even if some other measures are used at first. Profit objectives are important to set high enough because there is business risks in projects. On the other hand, business risks need to be negotiated with the customers because the revenue of a company is expense for another company. That is why it is important to set objectives from the perspective of many stakeholders.

In agile perspective, cycle time is the most important factor. An interviewee explained that organization need to maximize its value creation, and therefore be able to produce good quality continuously. The main idea is to get the process working as fluently as possible and at the same time receive continuous feedback and make sure the end product is desirable. Hence short cycle time with continuous feedback will enable other important targets which are quality and value creation. Also in the workshops, cycle time was found to be a very essential factor. It enables to track ongoing work in progress which can then ensure sizing of different software components in agile development. If features or other parts are too large, they are not going fluently through delivery process. Agile deliveries should have always workable delivery pipe, and also produce some value, as one interviewee summarized:

“Operational excellence and added value are two main components of agile delivery.”

Another interviewee emphasized cycle time as the most significant driver of agile software development because agile working is mainly based for the flow of work. That is the way how cycle time monitoring enables weighted shortest job first -principle which means optimizing value and speed in deliveries. The cost of delay defines issues to do at first without waiting time, and so business critical parts will be done inside the delivery pipe. In agile software development, flexibility creates the need for prioritizing system. In some cases it is not enough to stick too much to certain goals, but instead have the list

of critical things which are done in any case. Secondary objectives can be moved to the next cycle of development if needed. Achieved business value can describe the objectives' importance, and it can be compared to done investments.

According to the workshops, quality is essential from the many different perspectives. Defect metrics enable to track how much defects are created and also make sure they are not going to production. In portfolio metrics, it is important that all the defects have identifiers which enable to connect them to correct units. Quality can be measured at portfolio level by measuring total amount of defects, but one option is also get the updated amount of open defects which tells the current amount of technical debt. Testing function is basically the main auditing for the quality and it is better to catch defects before they have proceeded to production. When a defect is found, they need to be allocated to someone who will do the investigation. This allocation process is crucial to do correctly so that investigator is able to send error to correct unit and feature.

In addition to exact drivers, there is usually good to have broader guideline to drive measures. The SAFe methodology is an example baseline for measurement. It enables agile working methods by most important measures such as velocity and predictability. They improve the forecasting and predictions as well as reactive manner to work. One interviewee pointed out the SAFe as guideline and besides that quality aspects can be maintained by investing to test automation and the monitoring of defects. Another interviewee compared agile and waterfall development and expressed they are very different, but their actual indicators will sharpen depending on environment and culture. According to the same interviewee, most important component of agile development is continuous deliveries and the releases of software. In addition, one interviewee highlighted team satisfaction as an indicator which can be used in all organization. It creates a background for improvements and innovative culture which is important to have in the middle of changing environment. Nowadays almost all the businesses have demand for good flexibility and reactive manner, so the role of agile measurement is growing.

5.2.2 Value and success

Value, success, and quality are all worth of pursuing, but they are hard to define. Value can be defined subjectively or objectively. Some issues may be required in order to continue business so their value is objective, on the other hand some issues and their priority can be defined, but their rejection does not take down a company. Measurement should always be objective, but in some cases it is not possible to find objective value. That is the point how the value of product can be defined by its demand. Continuous feedback is required in order to produce right things. Value may lead to success if its production is under control. One interviewee mentioned that financial results must be achieved in any case. But as the interviewee added, on the other hand process to achieve those results can change. That is why measuring results is not only issue to be done. Good results can be repeated when their background is known. Success can be seen as the amount which is

delivered to the customer. But customer's satisfaction defines the amount of software used.

Quality is bad if software passes through testing with defects. Defective code may cause very bad impacts in systems, and after that problems are more expensive to fix. Finding and fixing costs are not only expenses. There can occur serious problems related to company's brand and imago as well and bad impacts will cumulate if situation is going further. Quality has various viewpoints. On the one hand it means working code and software, but on the other hand it is customer satisfaction to the things delivered. In agile models, the idea is that quality is not added to product at the end, but instead it is guiding the work all the time within the project.

The interviewees analyzed value, success, and quality differently. Some definitions by the interviewees are presented in the Figure 20.

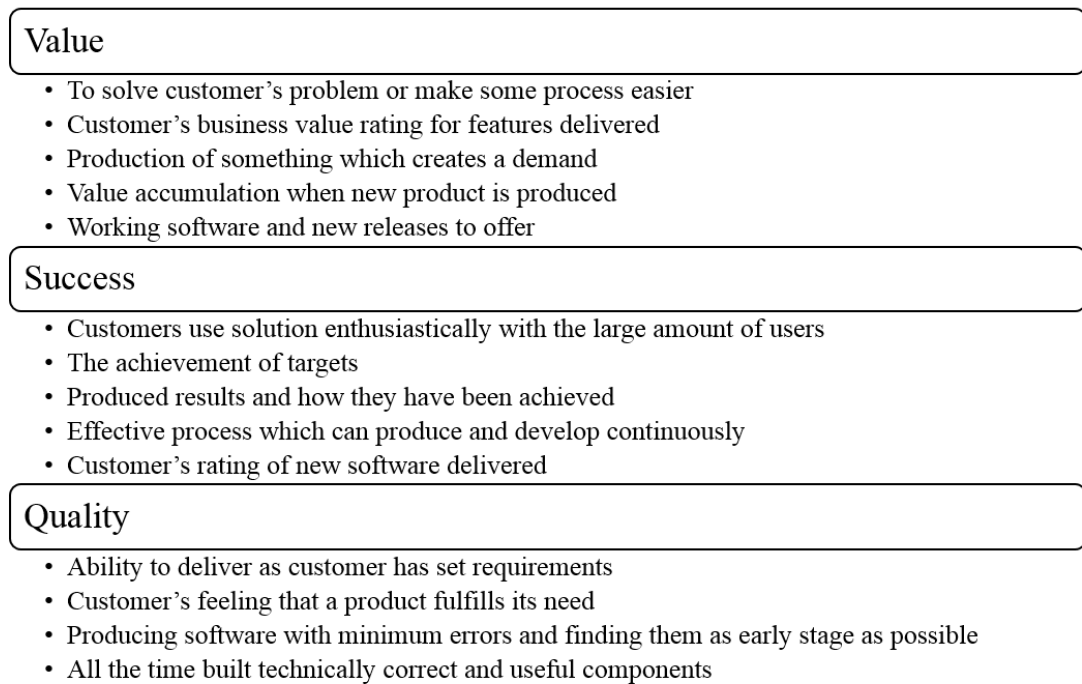


Figure 20. *The interviews' definitions for value, success, and quality*

Some of the definitions are related closely to agile development process, and some more generally to organization's ability to deliver products. Value is clearly related to the customer's satisfaction of products. The interviewees also pointed out that there can be certain things which satisfy users and the actual component of satisfaction need to be identified. Mentioned solution possibility was for example to track customer satisfaction with official surveys or ask feedback directly in projects. Success is mentioned by both customer's satisfaction and working process. Quality can be presented two ways which are technical definition and satisfying definition. It means technically product can have a good quality, but still it is not used by the customer. At the end, need for a product will

define its quality. In the workshops, success is related to target values. If certain components has been delivered as planned and with required scope, it is successful. But another point is to watch success in broader vision when success is defined by trend. If for example the amount of defects is small enough and trend is not growing, it means achieved success.

Agile development has significantly shorter cycle so indicators need to be analyzed that they are able to adapt to the used development method. In that context, it is important to have customer close to the development with the purpose of avoid miscommunication. In waterfall development, this particular fact can be seen as a threat. Agile development is more flexible for changes because the definition phase is so much shorter than in waterfall projects. Demos in agile development are working as the metrics of produced functionality, and customer can see what have been produced and share feedback. In this context, the agile and waterfall cannot have similar metrics.

5.2.3 Indicators

Indicators can be categorized to financial and nonfinancial indicators which are both contributing for the company. Financial measures are usually used more at management level where profit and margin are mostly audited. It is important also for a company that financial stability is good. Strong financial position of a company help to get funding and owners are reviewing those as well. Nonfinancial values are increasing the quality of deliveries which will have a strong impact to customer satisfaction. Both financial and nonfinancial metrics are essential in company's success. One interviewee also summarized that financial measures can be seen as results and nonfinancial measures as reasons. Financial aspects usually follow when the right things have been done.

Financial and nonfinancial metrics use different approaches. Nonfinancial metrics are measuring the actual work and are very interesting for the team level where the actual work is done. On the other hand people, who are financing the development or calculating financial results, are focused on financial measures. Still it depends about the role what measures are followed. A role is the factor which defines what measures different people follow. Financial measures are followed at upper level, but of course they also follow nonfinancial factors which forward valuable information about performance.

Among financial metrics, the most important indicator is the gross margin of projects. In large project portfolios, they are usually divided to smaller parts which can be measured separately. In the project accounting, the easiest way to manage costs is if work can be done and invoiced hourly basis. Otherwise risks transfer to be carried by a company. Project managers should be responsible of their projects also in financial matters. If resources turn out to be more expensive than expected, they can react and try to compensate the issues. Forecasts are very important in expenses, and their predicting is quite close of agile type predictability measure.

Another categorization of metrics is product and process indicators which are both important. The efficient process is not enough if the product is not early in the market. Agile development is focusing very much on streamline a process, for example by combining development and operation functions. Efficient process have to be built-in. Process defines the output which will be received. From the product perspective, customer perspective should be along development all the time. Development can be done by testing small batches and new things which can generate new opportunities for a company. Products and processes can both be valuable for the customer. Faster development cycle enables to produce value sooner. A company can try to create solutions to issues which customer has not even identified to be a problem.

Measurement strategy need to be evaluated and considered in order to understand what issues are wanted to be measured. Indicators may represent hard as well as soft measures. Financial perspective is important, but in project environment also the team statistics and satisfaction are very important. One interviewee mentioned that predictability measures should include both features and business value. In that case, organization will see that feature size and proceeding are both done correctly. Metrics are settled to strategy and measurement targets. There can be a wide set of indicators. Collection of the most important indicators according the interviews are presented in the Figure 21.

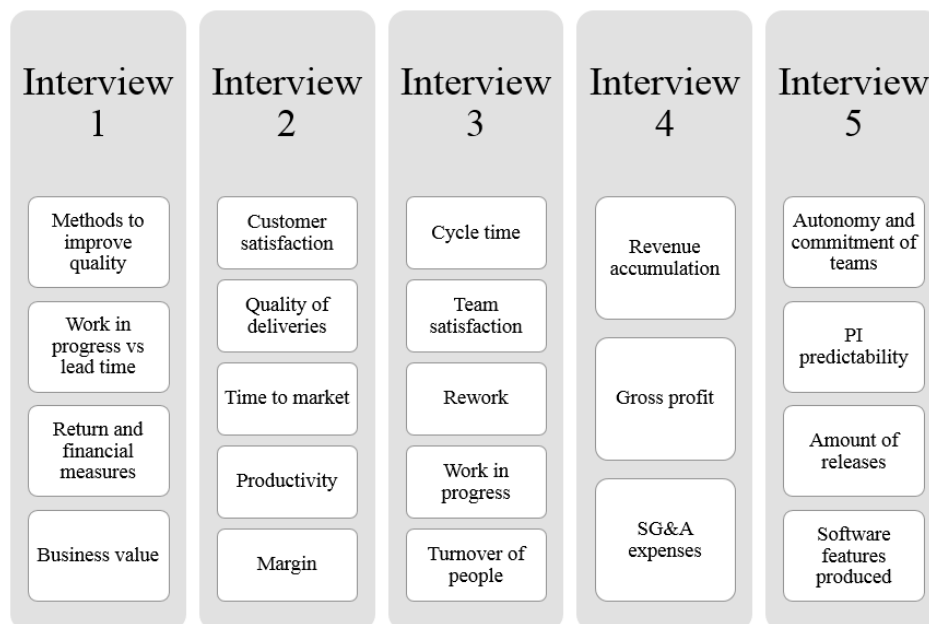


Figure 21. *The summary of the most important indicators in agile software development*

When metrics are under consideration and evaluation, different sensitivity analysis need to be done. Metrics must be investigated and see what are the factors behind the results. For example lead time can increase if any of its phases increase. That means longer cycle times in features can also be caused by some other people than development team. Lead

time, the amount of defects, and predictability were pointed out as most important metrics in the workshops. Especially the lead time of delivery and its defects are suitable to all development work. Lead time can be expanded to measure the stages of development. That is the way to find the most important aspects. Predictability is essential in agile working environment, where work is done in iterative schedule. One interviewee summarized that quality indicators are defining how much rework needed to be done when certain output is produced. So obviously weaker quality will make lead times longer when rework must be done. The amount of produced value can be measured by following how often software is deployed and released to customer. Some indicators can have a tradeoff between factors. For example lead time can worsen if work in progress increases. However, metrics are at first settled and then evaluated.

5.3 Performance Management

5.3.1 Metrics

From metrics' perspective, the interviewees usually pointed out two main points. The first point is to determine what is measured. And the second is to define who is using measured information. Two interviewees separated metrics to two different categories. KPIs are for management level monitoring, and team level metrics for teams' own improvement goals. At first mentioned can be defined as strategic targets, and latter ones as supportive metrics. It is essential to understand that in agile development all the metrics do not need to be used to management, but teams can measure certain factors to improve their own work. Those indicators which are useful for management side as well, can be aggregated for project portfolios. Practical metrics are important to measure and follow continuously and then possible differences will be investigated. The amount of measures is important to determine. If there are too many metrics, it will be exhausting for people and a system. Only some measurements are required to use officially, but some can be used just for internal improvement without any specific reporting effort. In the workshops and interviews, suitable amount of KPIs was usually mentioned from 4 to 6 different metrics. In addition, there can be other background metrics, but they are not in active tracking.

Results and quality can be improved with indicators if certain requirements are met. Firstly the definitions of metrics must be clear. Gathering accurate and correct data makes it possible to lead a company. The second aspect is the measurement system which must be supportive to organization's goals and be implemented correctly. Wrong data will lead to wrong decisions, so data gathering is essential in a system. The third point is to find reasonable and practical ways to analyze and use the data. That enables correct and improving output. An interviewee's three requirements for improving are described in the Figure 22.

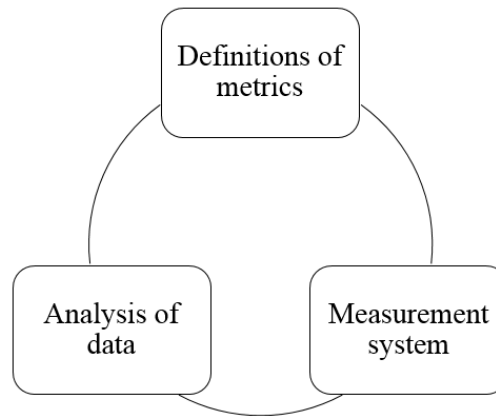


Figure 22. *The requirements of system's accuracy*

Performance measurement systems need to be defined by used methodology. In agile models, delivery cycle defines how the measurements is done and how the feedback is shared. If measurement is done in waterfall perspective, the schedule for measurements, analysis, and data usage must be defined. Concepts have very different ways to operate which must be analyzed in designing.

When performance measurement is settled up, there need to be considered how people are measured. The most detailed measures should be added for technical perspectives whereas more general level indicators for people. Technical measures are usually easier to aggregate for broader level, even if there is very large amount of indicators. On the other hand, if people are measured too detailed, their behavior may change measurements. Similar way, if management tries to manipulate indicators to certain direction, there can problems with internal quality and balance. Achievable metrics enables their active tracking. They should be actively maintained and updated at all levels. Team level work is the most important aspect which need to be supported from other levels. Metrics can be defined with bottom up -methodology at team level and then aggregated to upper levels.

5.3.2 Leading an organization

Agile development is based on autonomous teams and motivating people behind the common goal. Motivation can be defined by dividing it to intrinsic and extrinsic parts. If motivation is tried to increase only with monetary bonuses, at some point the motivation can cease its improvement. There are also other ways to motivate and indent people to company's objectives and sometimes absolute indicators are not showing the root cause behind certain things, but instead those causes should be analyzed. Autonomy and opportunity to impact are many times the most powerful ways to increase motivation. Also transparency is essential in agile development. All the important metrics need to be communicated and their priority shared openly. When all people in the organization know the

most critical measures, everyone can help to keep on track with measures. Strategy, metrics, and their connection will enhance the understanding of work and own position in organization. A centralized system enables to get results easily and avoid miscommunication and unnecessary effort.

Organization culture defines how measurements will be felt within employees. If management focuses too much on bad measurement results, it will weaken the common feeling of restriction. There is a need for supportive leadership which encourages to innovate. Negative feedback and too compulsive environment to learning will lead to bad results. All the changes should be created with internal motivation. The common opinion of performance measurement can be improved by stability, flexibility, and learning opportunities. The stability of work is important in order to make people confident for their position. If organization need to do changes, it must be communicated transparently and help people to orientate to new tasks. Managers should be leading by example and support their employees. It is essential to keep people along when measurement results are evaluated. This helps to hold common environment positive about the measurements. Management should let people tell reasons and explanation when improving performance together. If something is required from the employees, it is important that everyone does those things also in the management. Bad impacts were described by an interviewee:

“The worst case is when the management does the opposite than what has been communicated in the company.”

Measurement information is important to collect and use correctly. For example the utilization rate of employees is usually investigated in order to find resources available to different projects, but in heavy use it can turn out to be too much monitoring to people's work. If measures like that are used wrongly in a company, bad results may follow. Employees can use too much time just to make sure their effort is correctly understood and in the worst case people will allocate their work incorrectly. It is also the meaningful perspective of quality that defects are not felt to be a bad thing. It is always good, if they are found during the testing and not going through production. Organization culture and management actions will guide the common sense of control.

Measurements may be hard to communicate when considering frequency. If results are shared often, they will suffer inflation. On the other hand, if results are shared rarely, there are usually opinions that too little information is shared. It is reasonable to consider how often information is shared and what information it includes. Data is not interesting for the most people. That is why shared data should be practical enough for people. For example testers might be interested in the tickets of their own testing activities, but not about some financial information which they do not really understand. Measurement should support working and be done without having a big impact to actual tasks. That is the key to lead them correctly. Indicators are captured as the part of working without having controlling aspects to tasks. In the workshops, it was also highlighted that there

need to be clear responsibilities for the different indicators. It makes it more organized and decreases the errors in the measurement process.

Companies have an operational level which people usually feel there are too many measures. This feeling of heavily measured organization can be helped by sharing the information how and why measurements are used. When going to upper levels in organization, the maturity and understanding of business impact will increase. All people see measurements a bit differently so they should be tried to define similarly for everyone. Common sense of measurement can be improved by two ways. The first one is to have a suitable and flexible system to measure performance. All measured metrics should have some purpose and objective, but besides attention should be paid to issue how to streamline data collecting activity. Another way to make a system lighter is to create the system which is easy to implement and supports working.

5.3.3 Management and administration

When measurements find some unusual results, management actions will define how much value the measurements can create. If for example projects are identified to be unsuccessful, their management can be under extra support in order to find reasons and fix the situation. If a company works correctly, they can encourage and support project staff to improve project's performance. If project is marked to be unsuccessful, all the attention will highlight it, and often a project turn to be good again. As an interviewee stated:

“Nobody wants to lead a bad project.”

Target setting can be based on various estimations. One option is to set target with historical data. In the workshops that was found problematic because history data is not always predicting to upcoming measurements. History data may sometimes be measured differently which makes it insufficient. Objectives can be set by defining desired levels of performance. However, this approach requires the broad understanding of current situation and future's needs. Otherwise, target setting is not reliable. Targets can be set just to follow performance, but if they are combined to incentive or sanctioned programs, there need to be very reliable targets. Contracts should have very specified formulations for values and comments how to interpret values and their root causes.

If bad results are faced, explanations and reasons should be forwarded to all groups who are evaluating results. The SAFE model offers tools to have discussions and summaries for the metrics. Tracking and following of metrics depends how it is collected. Reporting data can be evaluated with the same cycle than reporting. In many metrics it would be good to have analysis quite often and consider root causes and explanation for anomalies. Data usage defines quite much how measurement need to be done. Real time measurement for agile development should be seen as a way to continuous improvement, not as a control mechanism. Organization culture have a big role to make measurement accepted

in the companies. Incentive programs can be based in performance metrics. One possible perspective is to set values for metrics and after completed certain value, employees will get bonuses. When data shows some differences to the reference material, there should be considered the reasons for that. One interviewee noted that:

“It should be always investigated if something has gone very well or bad.”

Challenges can be caused if customers are hard to forecast. Many measurements are done in order to get better perspective of company's situation and position, but sometimes even measured information is not able to provide needed viewpoint. Another challenge can follow if some of employees are not familiar enough to issues they should know. In financial side project managers for example need to have sufficient understanding of business and accounting. It is important to have trainings so that all the necessary people know as much as they need to. In the agile development, it is important that teams are self-controlled. They can measure different things to improve own performance. Management should follow only the most essential metrics which are reasonable to be reviewed by higher levels. Metrics do not need to be reviewed daily or weekly, sufficient frequency could be monthly or quarterly.

In the interviews many aspects were mentioned about PMS and its management. When metrics are defined and measurement is done practically, management should pay attention for certain things. The most important aspects were monitoring, analysis, actions, and communication. In monitoring, it need to be decided how often to track the results and metrics. Secondly, there are analyses to be done when measurement results have been seen. They need to be compared to target values, thinking about root causes for certain actions, and defining people who are part of the analysis. After analysis, if some anomalies are found, there is actions to be done. One interviewee warned that too fast actions can have bad impacts. It need to be understood well if there are some causes for the metrics. If there is too much uncertainty or too fast reactions to results, it can weaken to common feel of it. Motivation have two different aspects like mentioned earlier. Programs with incentives or sanctions can create external motivation, but it is also important to develop intrinsic motivation. Agile development is based on good transparency and communication so data and actions need to be defined clearly. Culture defines how data is used and how stabile organization is created with the results. Communicated feedback is essential to consider with the reporting cycle. The summary of different aspects is presented in the Figure 23.

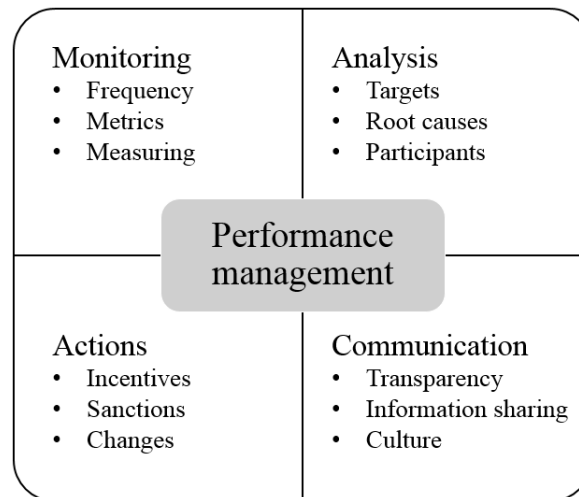


Figure 23. *The aspects of system's management*

Metrics are usually defined by some formulas which tell how to calculate values. Those formulas should be easy enough to be easily implemented. And then values need to be scalable to different organization levels. All the tools should help to build measurement system. Stakeholders reporting cycles can be synchronized and shared systematically. In certain situations, there can be also other drivers to prioritize work for example competition which can raise new reasons to implement something in order to prevent competitors to do so. In the financial measures side, some projects can be less profitable than normal level if it is argued to believe for future's income. All the drivers and indicators need to be considered in their business context, so the values of measures are not only things to have a look into.

The tracking of measures is the important part of communication. It enables to get a correct view of company's performance and analyze which actions improve operations. The frequency of examining metrics and results can differ quite a lot depending on the targets and objectives. Operational level measurements are appropriate to monitor on a daily or weekly basis, but more strategic level metrics usually need longer time period with various reasons. In many cases, there is no crucial need to get real time results. Management level uses metrics to predict future and to plan company's strategy so it is better to have many measure points where to base decisions.

6. DISCUSSION

This section has a discussion based on the theory and the empirical part. The objective is to get the comprehensive understanding of related concepts in the performance measurement of agile software business. The discussion is structured by the performance measurement framework of the section four and it compares the theoretical background and the empirical results with the knowledge gathered during the research. The research questions were defined in the beginning as:

- What kind of factors impact the performance measurement of agile software business?
- Which metrics and indicators should be used to measure agile software development?
- How should performance measurement systems be managed in agile software industry?

The research questions focus on the different phases of performance measurement framework and they are covered in the parts one, two, and three of this section. However, the research questions in general and their implications are covered in all parts. The fourth part considers the special questions which have raised during the research process. The fifth part synthesizes the literature and the empirical part by summarizing the metrics and aspects of agile performance measurement.

6.1 Business Objectives and Organizational Goals

The first research question asked to find out the issues impacting to performance measurement in a company. In the literature, there were underlined aspects of business strategy, industrial characteristics, competition and markets, social and political circumstances, technological environment, and stakeholders (Miller 1988; Daft et al. 1988). In the empirical part, those factors were also mentioned, but they were of course more related to the industry of agile software development. The key elements of agile software business are predictability, reactivity, and customer focus with end-to-end perspective.

In the literature, the purpose of measurement and control was defined mostly with a need to steer company's actions towards its objectives (e.g. Siska 2015; Fisher 1995). In the empirical material that was not only point of view. The interviewees with agile mindset usually emphasized the opportunity to improve activities. Performance measurement data enables to see where improvements are needed. In addition, stakeholder perspective was broader in the empirical data. Some literature emphasized performance measurement as a management tool, but newer and agile orientated authors pointed also the entire organizational aspects which describe the benefits of performance measurement at all levels.

Measurement data enables improvements to all levels, but they have to be used correctly. In the empirical data, it was highlighted that too fast actions with incomplete data or too excessive monitoring might have more bad than good results. Management need to have a view and predict company's actions, so predictability is underlined in all areas. If leading can be done with the knowledge of company's abilities, the results will be successful. This was emphasized both in empirical material and in literature (Lindholm et al. 2017).

Reactive and proactive manner means that agile development need to have fast cycle time when functionalities are produced. It means all parts of delivery have to be optimized and measurement purposes should include understanding of how a delivery process is working and which steps exist (Alahyari et al. 2017). Iterative process keeps the delivery time short which enables to change, plan, and redirect development activities. Delivery time was mentioned in many sources as the Figure 15 shows. In agile model, the interviewees usually highlighted the importance of short cycle time as enabler for the achieved customer satisfaction which can only be achieved with ability to be responsive. The view was different in the literature where those factors were presented without a strong connection. From the social environment, the interviewees pointed out the employee satisfaction which enables efficiently working system. In the literature, employee satisfaction was presented as an internal factor, but without an aspect of performance measurement. The empirical material showed employee satisfaction as an actual indicator. In other words, employee satisfaction has intrinsic value.

Technological environment was pointed out in several researches. Fisher (1995) mentioned knowledge transfer as the important part of performance. Ralph and Kelly (2014) did analysis on success in the different phases of software engineering. A lot of similar things were emphasized in the empirical material. One of the most important indicators is customer satisfaction which is essential to follow. The demand of products is defining the value and success. Technological environment changes quickly so it is important to have a clear vision and innovative way of working. The interviews also pointed out that it would be magnificent to create innovations for customer before they have a direct need for them. Technological development offers a lot of opportunities and innovative culture is needed so that employees are encouraged to develop new solutions.

Strategically, financial targets are very meaningful, but also nonfinancial metrics should be analyzed. Brignall (2007) and some other authors (e.g. Laine et al. 2016; Bryant et al. 2004) highlighted the impacts of nonfinancial factors because they tend to increase also financial metrics. Nevertheless, nonfinancial indicators were usually mentioned as the important part of performance measurement metrics, but their role was not defined clearly. The empirical part showed essentially that financial and nonfinancial indicators have certain roles in the organizations. Nonfinancial indicators have a need at the team level where they support working and are used in order to find improvement opportunities. Nonfinancial indicator can be aggregated to higher levels so they can be used broader basis. That is important because nonfinancial metrics are usually forecasting companies'

future and future's market potential. Whereas, financial indicators were stated to be strategic level indicators. For example shareholders and other financially orientated people have a need for financial performance reports because they do decisions to lead or fund a company which cannot be done without financial data. Likewise, companies have internally several people who care mostly about financial factors. Financial responsibility of projects or portfolios is usually attracting persons to follow financial performance metrics and also reporting have the same interests. From the financial perspective, agile model is very stable because development is funded with controlled costs. That makes it possible to concentrate on customer satisfaction and development process.

6.2 Performance Indicators and Drivers

Performance indicators are forming the metrics for measurements. The second research question asked which indicators should be included to the performance measurement metrics. The literature usually underlined different perspectives which need to take into account when scrutinizing measurement based on metrics. Those points of view were summarized for example in the Balanced Scorecard (Kaplan and Norton 1992) and in the Square Route model (Atkinson 1999). In addition, there were discovered various important drivers which need to be measured. Those include usually components from the Figure 15. In the interviews, the focus of measurements was different depending which was person's position. There were mainly three different standpoints recognized from the all material of the work. Those are agile development, customer satisfaction, and management.

The first perspective is agile development which focuses on process. It highlights a need for the efficient operations of producing software. The SAFe model and agile perspective bring lean methodologies to the process with the aim of minimizing waste and maximizing the flow. The main idea is aiming to operational excellence which leads later to financial success. In this context, cycle time and predictability are the most essential factors. They define the operational speed of process, and company keeps its targets to predict its efficiency. The second perspective of indicators is customer satisfaction. That is the crucial part of agile development as well, but its goal is a product instead of a process. All of the interviews defined value somehow throughout customers and their opinions. As indicator, customer satisfaction can have predictions of the future. On the other hand, customer satisfaction is hard to track efficiently all the time. The Figure 6 by (Ralph and Kelly 2014) shows the framework which underlines market performance to be evaluated after a project is complete and a product performs in the markets. The interviews highlighted that customer satisfaction is important to predict as accurately as possible. Customer satisfaction can be defined with value and quality indicators. They can describe the results and rating of a product. Value need to be evaluated with customers or other stakeholders in order to set correct objectives and steer organization correctly. In the software industry, technical quality is usually measured with defects. That highlights two sides of

quality which are technical and satisfaction. Satisfaction has the customer point of view, but technical quality can be measured in software industry for example by tracking the amount of defects. The perspective is essential for customers who are trying to ensure there is no code delivered with errors because their fixing may be very expensive. From the process point of view, the quality would be defined as automation level of testing. It means the quality can be developed with a longer scope by automating testing processes. That point was mentioned in the interviews, but in the literature process quality was not having a meaningful role. As can be seen, product and process metrics are not totally independent, but rather have their distinct characteristics.

The third viewpoint to metrics is management perspective. It underlines the financial indicators which are essential for management and financial stakeholders. Margin and revenue accumulation seem to be the most traditional indicators in that context. As interviews summarized, usually those indicators are in middle of focus, even if there are first followed some other factors. However, it can be seen that different measures are not independent. Process efficiency relates to costs which decrease will improve profitability, and customer satisfaction makes them buy more which will increase the revenue. That is the reason why different aspects need to be considered and evaluated in the metrics. In the literature, nonfinancial metrics were underlined as an important area of performance measurement, but financial indicators are more common metrics. Management and owners are usually attracted more about financial metrics even when they know the short term aspects of them. One interviewee explained the important logic of agile methods from the perspective of finance. When the production cycle is short and all done work is immediately invoiced, the required resources are smaller. That makes agile development financially very efficient. From the perspective of profitability, agile model offers advantages because different programs are funded with the controlled amount. Then there will be no surprises in the cost side which helps to track profitability. The empirical material highlighted that performance measurement metrics should have different types of metrics and their use can be explained to different stakeholders.

Indicators are used to create the metrics for performance measurement system. Earlier described connection between process and product as well as between financial and non-financial indicators have to be identified. Agile software industry is trying to be flexible and fast in actions which sets some objectives for the metrics. Too coercive and strict measurement process may have an impact to actual work. Flexibility requires autonomy and decision power also for smaller units. Companies should try to form metrics which enables efficient measurements and monitoring, but at the same time supports the work of employees.

6.3 Performance Management

Performance measurement is a process which need to be managed and controlled correctly. That was emphasized broadly in the literature (e.g. Otley 1999; Jordan and

Messner 2012). It enables better performance and ability to increase it. The third research question asked how performance measurement should be managed. Performance management have to be done by respecting the industry and organizational needs. According to empirical material, management of the system has four main parts which are monitoring of performance with certain frequency, analysis and target comparison of KPIs, planning the actions when necessary, and communicate results with clear transparency.

The most part of the interviewees had a notation that performance indicators should have the different levels of priority. One interviewee summarized only two levels which are team and management level. Team level represents the operational level of performance metrics which are intended to team's own improvement actions. Management level has metrics to lead and develop organization which must be done with the knowledge of operations and processes. When KPIs and supportive metrics have been settled up, there need to be defined other managerial aspects relating to PMS (e.g. Davila 2000; Adler and Borys 1996). In the interviews, the importance of tracking, analysis, and actions were highlighted. Tracking frequency at different levels is evaluating indicators. KPIs of management level need to be tracked depending of their urgency and strategic objective. The interviewees stated that strategic level works proactively and they need to have view to organizational goals. That requires good predictability and ability to trust provided information. Data is aggregated to the different levels of organization which enables to get similar results for different size of projects or portfolios. At the operational level, the activities are more reactive in order to enable agile working methods and flexibility. Target setting must be done by respecting differences between units and their environments (e.g. Lindholm et al. 2017; Wouters and Wilderom 2008). According to workshops, historical data can be a baseline for targets, but those may be hard to set. Sometimes history data is not accurate enough in order to work as a baseline and in those cases targets should be settled by understanding of business and desired level of performance.

In agile development, it is crucial to have self-acting teams with high motivation. That was underlined in the literature (e.g. Blackburn et al. 1996; Kupiainen et al. 2015; Leffingwell 2018, pp. 1-13). The Figure 7 shows different possibilities of formalization, but in the industrial context of agile software business, too strong control will not have good impacts. In the interviews, it was underlined that agile development is not possible to do efficiently if there exist too strict measures. Wouters and Wilderom (2008) pointed out that all the measurements should have a supportive role to working. One interviewee emphasized the role of a measurement system in that case by it must be designed the way which enables reporting without unnecessary efforts. Furthermore, empirical findings highlighted the need to keep innovative culture which is especially important in the software industry with highly technical aspects. In the social environment, the importance of employee satisfaction was highlighted. Highly technical areas of work tend to be hard to implement if employees are not satisfied.

When measurements are followed, action plan defines what to do if results are different than expected. Some companies have incentive or sanction programs based on the performance indicators. It was underlined in the literature, if management have a certain indicators to follow, they of course steer a company to that direction. That makes it crucial to analyze all the metrics that they will really move performance to desired direction. When unexpected results are faced, reasons must be considered. In the interviews, it was mentioned that actions should not happen too fast without understanding the background. Information sharing is essential, but stakeholders and information publicity have to be under consideration. Data usage may be complicated situation and the management must consider the procedures how to act with data. Action are important to communicate for the necessary stakeholders internally and externally. That enables efficient and transparent system.

6.4 Reflections on Challenges in Agile Models

From the theoretical and empirical sections, there have risen the special questions which are not fully covered within the research questions. Those questions are:

- What are the performance measurement characteristics of agile models?
- Which are the most important indicators to measure agile software development performance?
- How do different indicators affect each other?

Agile delivery models have their specific characteristics which are affecting companies' performance. Both the literature and the empirical data underline the aspects of scaling agile working. In the literature, Laine et al. (2016) highlighted the lack in the understanding of program level in agile models. One interviewee underlined that agile models have the different levels of operations and all measured data could be aggregated from lower levels to management level. When data is produced at several levels, there need to be clear procedures for the data review and sharing.

In addition to the aggregation of data, agile environment enables measurement activities better than traditional models with the compact structure of levels, teams, and schedule. Different metrics can be measured in teams which have a strong autonomy. Company levels are defined clearly, so teams can be compared and analyzed easily. As highlighted in both the literature and the empirical material, high frequency and short evaluation period have an ability to follow metrics better. On the other hand, there exist some requirements for the measurements in order to do them efficiently. Metrics need to be planned such a way that support working and may be measured within the normal routines (e.g. Hartmann and Dymond 2006; Adler and Borys 1996). Agile context aims to minimize wasted time and effort, so that need to be considered also in performance measurement.

The second special question asks the most critical indicators of agile software development. The Figure 21 summarizes the interviewees' and the Figure 15 the literature's view of the most important indicators. In the interviews, indicator selection differs quite a lot depending on the position of an interviewee. When empirical findings are reflected to the academic literature, some indicators can be concluded. As earlier described, there can be seen three viewpoints to measurement which are agile process, customer's satisfaction, and management perspectives. Value and success are defined usually with some other factors like quality, efficiency, or satisfaction. Predictability and lead time can be defined as indicators from the process side. Quality is divided to technical quality and satisfaction. Technical quality can be measured with the amount of defects. Satisfaction of a customer is harder to define, but examples are value rating and the amount of users. From the perspective of agile development, there also exist significant advantages in finance. The interviews and the SAFe model of Leffingwell (2018) emphasized that in agile methodology resource utilization is significantly better. The reason is the fact that short cycle time and more frequent and stable income enables more efficient use of capital. This has also correlation with the amount of work in progress. When the unfinished code and definitions in software industry are kept minimum, the resources are not taken by the income generated in the future. As one interviewee explained, unused definitions or code are acting as storages in the manufacturing business. Their optimizing is a way to improve finance. This finding is absolutely interesting from the perspective of business management.

The last special question continues analysis of the most important indicators. It asked how indicators affect each other. When indicators form metrics, they obviously have some impact to each other. Both the theoretical and the empirical material highlighted some indicators which have common impacts. In the interviews, the connection between work in progress and lead time was highlighted. Lead time can be decreased of course by limiting concurrent work. Another connection was between rework and lead time. In agile context, lead time increases if things need to do many times. That makes quality also the factor of lead time because functionality is the goal of software. In the literature, it was specified that decreasing testing will improve lead time, but decrease quality. That is not recommended and the theory also underlined that delays are better than bad quality (Harter et al. 2000). Testing does not have direct connection to lead time, but automation testing will shorten lead time by optimizing the throughput in the future. After all, there certainly exist some connections and linkages between indicators. When metrics and performance measurement is planned, it is important to determine and evaluate indicator impacts to each other and to a process under measurement.

From the research questions' perspective, the special question offered expansions and detailed information. The first special question highlighted the characteristics of agile software business and its measurability. The fast development loop and agile organization enables very efficient measurements if metrics are built correctly and support working.

The first research question did not highlight that perspective enough when the focus was more on the strategic and organizational impacts. The second special question extends the perspectives of process, product, and management by considering the criticality of value. Value perspective underlines the second research question and requirements for the metrics. All the different viewpoints are defined by value which leads to success of certain perspective. No indicators should be measured without reasons. The last special question considers the effects between different indicators. That is meaningful for the management perspective of the third research question. Indicator selection and metrics need to be evaluated in order to make them support organization and its objectives.

6.5 Synthesis of Literature and Empirical Research

As the summary for the performance measurement in agile software business, there can be underlined several characteristics which are described with the research and special questions of this work. The perspectives of agile performance measurement are in the middle of this research. They describe business objectives, measurable metrics, and managerial perspectives of agile development. The Balanced Scorecard, traditional project triangle, and other performance metrics have created the ground for this approach. The perspectives of agile performance measurement are described in Figure 24. It includes the perspectives, the most important indicators, and the advantages of the indicators.

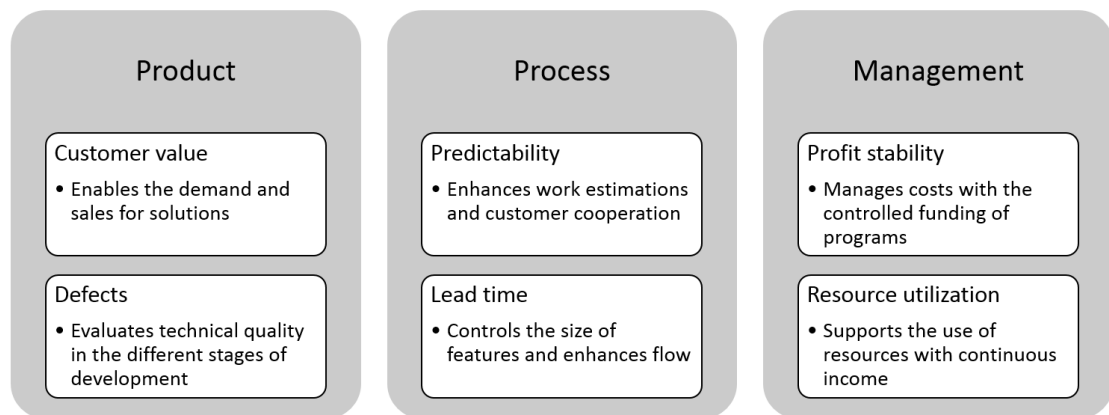


Figure 24. *The perspectives of agile performance measurement and the respective metrics*

Indicators can be divided by process and product or financial and nonfinancial, and this model combines those approaches. The product view has quality factors by customer value and satisfaction as well as technical approach by amount of defects. Customer value forecasts the success in the future. Defects, which are measured in the different stages of development, are informing about inefficiencies during in the production process. The process view maximizes the flow of work and keeps it predictable. Predictability is measured in order to make sure a company is able to predict its working and velocity. Whereas, lead time indicator defines that the features of development are sized

correctly. If lead time goes up, it means agile methodology is not able to work as efficiently as it should be. The profitability of projects and revenue accumulation are traditional metrics of the management side, but agile models offer other important aspects. From the management perspective, financial characters of agile methodology are supporting the business. Controlled funding for the programs and the small amount of rework enables financial benefits for the companies. Continuous entries of income together with the low amount of resources required to operations are creating financial advantages better utilization rate. There is less financial surprises in the agile models and financial resources can be used more efficiently.

The perspectives of agile performance measurement are the final synthesis of this work. Their nature as viewpoints in the measurement of agile software business draws guidelines for the creation and use of the efficient metrics. The perspectives consider all the levels of the performance measurement framework. Together used frameworks enable to build, monitor, and manage performance measurement in the agile software business.

7. CONCLUSIONS

In this section, there are evaluated the objectives which were set in the beginning of the work, and analyzed the achieved results. The first part summarizes the findings and discussion of the work compared to the objectives. The second and the third parts analyzes the contribution and implications of this work and what are the most important findings for the academic literature and the management of companies. The fourth part criticizes the data and defines the constraints on the generalization of the findings. The fifth part suggests some areas for the future's research.

7.1 Achievement of the Objectives

Performance measurement is the broad area of research, but it has been mostly covered from the perspectives of other industries. Agile software business has grown very much during the last years and therefore some discussion is needed on the area of agile performance measurement. This work built the structured model of performance measurement and its management. In the literature part, the objective was approached from the general perspective of organizational control and then concentrating on software industry and further to the agile development and its performance. Also value and success are broadly discussed in the literature, but their roles in agile development have some contradictions.

The research objective of this work was defined in the introduction part as: to build the systematic and structured understanding of performance measurement and its impact on agile software business. The objective was approached by the performance measurement framework which is presented in the Figure 12. It summarized the structured perspective of performance measurement in organizations and highlighted the research questions of background factors, used metrics, and management of the system. After the literature background, the objective was approached by interviews and workshops. Interviews were arranged based on the phases of the created performance measurement framework, and the data was analyzed together with the observed workshops.

The first significant finding of the work is the analysis of the different fields in the performance measurement framework. The framework analysis included business objectives and organizational goals, indicators and their drivers, and performance management. In the literature, the analysis of those areas was usually fragmented, but this framework collected different areas under the same picture. The areas of the framework are connected to each other, but theoretically they can be seen as the line of actions from planning to implementation. The framework starts by identifying business environment, operational activities, and strategic goals. After those, the key elements of value and success can be

identified and then formed into indicators to track them. After metrics is done, it need to be evaluated, monitored, and managed with clear procedures.

The second meaningful finding are the perspectives of agile performance measurement which are presented in the Figure 24. The perspectives have the comprehension of product, process, and management indicators in agile software business. The background for product and process perspectives comes from the literature. Ralph and Kelly (2014) and Shenhar et al. (2001) analyzed the different phases of measurement which are the efficiency of development process and the market performance of product. This work connected those standpoints to the agile software business. Process view in agile development is mostly related to improve the flow of a system and minimize the waste. That enables to maximize the output from the process. From another point of view, product perspective focuses on successful value delivery for customers. That can be achieved by having comprehensive quality assurance. Therefore, process and product perspective are certainly important aspects in the performance measurement process, and their connection must be clearly understood. The last perspective is management which highlights financial and nonfinancial indicator analysis in the agile software development. Management level indicators are financially orientated, but they have linkages to other indicators. Profitability is controlled by agile delivery model with allocated funding to programs, and resource use can be maximized with the continuous income. Financial stability is the requirement for the companies, but also other metrics are essential in order to operate well in the future.

The last notable finding is the allocation of metrics to different levels in the organization. Companies' structure can usually be divided to levels which have different metrics to be followed. Financial indicators are used mostly at the upper levels, but still their use depends more about the role than about the organizational level. It is essential to have several different types of metrics at the delivery level, but many of them can be used only to internal improvement. Management should follow only the most business critical metrics as key performance indicators and plan actions when necessary. The validation of data and targets have to be done with the holistic view of business.

7.2 Contribution to Existing Research

This research has several contributions to existing knowledge and it synthesized different perspectives and expanded the knowledge of linkages between performance measurement models. The research was based on the broad literature which included the Balanced Scorecard by Kaplan and Norton (1992), the Scaled Agile Framework by Leffingwell (2018), the article on project success by Shenhar et al. (2001), and the formalization of organizational bureaucracy by Adler and Borys (1996). Agile software business is not a new phenomenon in the software industry, but its role is bigger and practices are changing very fast. This work brings together the existing research of performance measurement in project and software business comparing to the agile development.

The framework of performance measurement highlights different stages in the process when a performance measurement system is designed, implemented, used, and reformed. Performance measurement is not the process which can be implemented and then forgotten but instead this work creates and approach what issues need to be taken into account also when measurements are in progress. Performance management is expressed as a management process which requires knowledge in order to be done satisfyingly. Organizational structure and business objectives have to be understood and utilized in the measurement. That means all different levels understand their role in the measurement and also have transparency to necessary information.

The process, product, and management perspectives in agile performance measurement are expanding the understanding of control systems in the agile software industry. Those standpoints bring financial and nonfinancial indicators together and enable to compare them to the process and product perspectives. The role of nonfinancial indicators has been broadly discussed in the literature (e.g. Banker et al. 2000; Said et al. 2003), but still their role is not totally defined in the agile context. In the software development, they are essential by running the efficient process together with the comprehensive assurance of quality. Nonfinancial factors have to be linked to financial indicators, and performance management offers the perspective to that connection. Some roles have financially orientated targets and financial stability is a requirement for business. That why nonfinancial indicators must be used correctly at the delivery level where they enable efficient process which contributes to financial indicators like profitability and resource utilization.

7.3 Managerial Implications

This work includes several managerial implications to be implemented in suitable companies. Performance management is the important parts of measurement process in agile software business. It is essential to understand management role in the areas of performance measurement. Performance measurement starts by identifying business goals and organizational objectives to be achieved. Metrics and indicators need to be defined by understanding the value creation process and company's strategy behind measurement. A performance measurement system must be led with the suitable industrial context and formalization which makes organization effective.

The most important implications for the companies of software industry:

- Metrics have to be formed with the objectives and knowledge of strategy which makes measurement to support desired business goals. Connection between value and success factors is important to identify because the metrics should aim to generate benefits for the stakeholders.
- Agile methodology aims to operational excellence and the maximization of produced value. Those objectives can be measured by dividing nonfinancial metrics to process and product perspectives. Process perspective aims to predictability and

short cycles of development, whereas product perspective enhances customer satisfaction and technical quality.

- KPIs and supportive metrics are separated from each other. Management level follows business critical indicators, but team level may have additional metrics for their own improvement activities. The amount of indicators must be reasonable and enable that they support working and can be measured without too much time-consuming.
- Targets need to be set by the appropriate data or knowledge of achievable and reasonable goals. Actions and practices must be communicated the way that all associated people have suitable knowledge of how to achieve the goals.
- Active customer cooperation is essential in order to ensure products are in demand after completion. Moreover, employee satisfaction is important with the aim of creating innovative culture which encourages to find solutions to customers' problems.

Figure 24 summarizes the most important metrics from the perspectives of agile performance measurement. Management understanding of the related business impacts is essential in order to achieve positive impacts. Business environment set some requirements for the companies, but besides there have to be understood internal processes of delivery and organizational structure.

7.4 Limitations on Generalization of Results

This research was done for the subscriber company's need of the analysis in performance measurement process. Some constraints exist in expanding the results of the research to different contexts and companies. The literature review had material from different sources which have been analyzed to be reliable. Despite of that, the research had different approach than the earlier research so a lot of analysis and study was needed from the perspective of agile software business in order to generalize the results. The Scaled Agile Framework has a big role in this work, but its limitations can set restrictions to the analysis. As a framework, the SAFe can only be seen as the collection of agile and lean practices and model itself allows to modify it to suitable form of business. Therefore, model itself does not set constraints, but it is possible that the model was used by limiting its perspectives to the context.

As a methodology, interviews and workshops have some limiting aspects to the results. Semi-structured interviews have constraints relating to reliability, validity, biases, and generalization (Saunders et al. 2009, pp. 326-336). Reliability and validity obviously have impacts from the real environment where this research has been carried out. However, analysis from the interviews and workshops has been done by being meaningful of the environment. Interview situation biases were tried to minimize by having convenient environment and spirit in discussions. Those actions does not remove the constraints, but

they are relieving the problem. The interviewees were professionals of the topics and industry under analysis and their experience makes it more reliable to extrapolate results because their knowledge was not limited only to the case organization. That does not ensure that the results can be generalized, but they enable to consider results in the similar companies. The material had 6 interviews and 8 workshops which was considered to give an appropriate view of the topics. Nevertheless, more research in other environments is needed in order to generalize the results.

7.5 Recommendations for Future Research

In the future, there are several topics to continue this research. Agile software business will obviously boost itself in the future which makes the area especially important to cover by research. The phenomena like big data and digitalization will offer more and more data to be analyzed which makes performance measurement an essential factor of control. Results and constraints of this work indicate some new topics for the further research.

One approach is to research performance measurement in other areas of agile development. This research covered only one organization, but other organizations have obviously their own specific goals, so more perspective to agile software development is needed. On the other hand, agile methods and frameworks are changing and developed all the time, and different perspectives can be researched even to quite similar approaches. The perspectives of product, process, and management indicators could be analyzed further and expanded by metrics formulation. Organizational benefits and the implementations of metrics would be also a good topic for research.

The performance measurement framework was built in this research. Further research could analyze or test assumptions and expressions of this work. Another point of view to the framework would be to research its parts which are the objectives of measurement, indicators and metrics, and performance management. The objectives could be analyzed from the same perspectives than in this research. Indicators might have a need for the quantitatively analysis how they affect each other. Connections were only slightly covered in this research. The role of management is significant in companies and it would be interesting area to research in agile software development. Therefore, agile performance management and reporting would be an interesting area to cover more in the upcoming research.

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APPENDIX A: THE STRUCTURE OF THE INTERVIEWS

Warm-up part

The objective:

Introduce the research process, and create convenient and fruitful situation for the interview

The areas of discussion:

- Introducing the researcher
- Explaining the structure and the objectives of the thesis
- Telling practical issues like recording, the structure of the interview, and the usage of data

The first part: Business objectives and organizational goals

The objective:

Define the overall picture of performance measurement in the company. Find out stakeholders and their objectives as well as different kind of benefits and disadvantages for both operative and strategic perspectives.

The areas of discussion:

- Why to measure performance in organization?
- Stakeholders, benefits, disadvantages
- Operational and strategic objectives

The second part: Performance indicators and drivers

The objective:

Analyze different indicator and their use in agile software development. Define value and success and discuss about different metrics which can be used.

The areas of discussion:

- What indicators should be measured?
- Value, success, quality
- Drivers to measure organization's performance
- The characteristics of software industry and agile development
- The categorizations of indicators

The third part: Performance management

The objective:

Concentrate on performance measurement system and its management. Analyze organizational impacts and have a view to management level tracking and efforts to measurements

The areas of discussion:

- Enabling and coercive natures of systems
- Improving the culture of measurement
- Using metrics and executing actions
- Tracking the performance