CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

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DEPARTMENT OF INFORMATION ENGINEERING

FRAMEWORK FOR EVALUATION OF ENTERPRISE SOFTWARE IN SMALL AND MEDIUM ENTERPRISES

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Abstract

The research is concerned with problems arising in the process of management of enterprise software integration for better fitting to business needs, through the evaluation of its performance and user's satisfaction. The study proposes the enterprise software evaluation method, which was tested in three small and medium enterprises (SMEs). The method can be applied to SMEs to substitute complicated, expensive and high human recourse demanded methods. The survey specifically designed for the current study was conducted at the initial stage of the research. This work adds to the existing literature on software evaluation methods in SMEs during operational phase, as well as software evaluation in SMEs in Kazakhstan.

Keywords: enterprise software, SME, software evaluation.

Declaration

I declare that the doctoral dissertation titled "**Framework for Evaluation of Enterprise Software in Small and Medium Enterprises**" has been completed by me, without any other outside help and I have used only the sources mentioned at the end of the thesis. It is submitted in partial fulfilment of the requirements for the PhD degree at Czech University of Life Sciences Prague, Faculty of Economics and Management. It has not been submitted before for any degree or examination in any other University.

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Date: October 22, 2018

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Azamatov Bakhytzhan

Content

1. Introduction

These days, software products are mostly commercial products that consist of a software package together with its documentation. In addition, there are quality standards to confirm the quality of the product. However, it is not necessary for a software to meet these standards. Compliance with international or local standards definitely give people confidence that this product has a certain level of quality. Currently, in the field of information technology, data standards presented by international organizations ISO and IEC are recognized as international standards.

Integrated enterprise systems are current technological innovations that are of great benefit to businesses. Enterprise systems enhance the smooth operation of a business through increased data accuracy. This is attained by the extensive use of single source databases. Besides accuracy, these systems bring coherence in business operations and enable easy monitoring, planning, and resource management. Efficiency is quite crucial in conducting businesses, and this has led to the increased popularity of the implementation of enterprise systems into organizations[1]. Enterprise systems vary according to the requirements of a business, whereby there are the custom-made systems that are designed to fit specifically into the operations of a given firm. The readymade systems are designed to cater for the basic operations of a company, thus making them less effective when compared to custom systems. Thus, an evaluation of the software product quality is beneficial to identify its fit to organization's needs during the operational phase. For the lack of clarity, the term "evaluation' being used in this research to distinguish it from the other important and similar actions as "assessment" or "assurance" of the software quality. The term evaluation is the best describes the scope of this work, to evaluate, thus to judge the quality of the product. Whereas "assessment" and "assurance" are process oriented. Moreover, "assessment" implies following improvement, which is out of the main goal of this paper.

In this research, an optimized method for software quality evaluation is proposed. This method was implemented and tested in three organizations in Kazakhstan. The method is focused on the operational phase of the life cycle of the software product, after it is delivered to enterprises. The user-based approach of the method enables enterprises to determine the capabilities of the software product, based on their needs. A distinctive feature of this method, which deviates from the known evaluation method of the ISO standards, is the orientation on enterprise's experience and expectations.

The research was build on the preliminary overview of the current ICT development in Kazakhstan, literature review of the existing software evaluation models and standards, that was followed by the survey of the selected SMEs in Kazakhstan and design, implementation and testing of the optimized evaluation method in three pre-selected organizations. To analyse the survey results, different statistical techniques such as t-test and Analysis of Variance (ANOVA) test were utilized. To collect data, the SQL database was used.

2. Goals

The main goal of the current work is to propose a quality evaluation method to improve the integration of enterprise software packages in small and medium enterprises (SME) during the operational phase. Businesses must clearly see their needs and track experience with software they use in order to improve or substitute deficiencies accordingly. The motivation for this research is thus based in the fact that enterprise software evaluation is rarely used in SMEs after acquisition. Apart from that, most of the existing evaluation methods require a large range of inputs; for example, training staff or the hiring consultants or the purchasing of additional tools. Therefore, the aim of the research is to develop an optimized and cost-efficient method for software product evaluation in SMEs, with a particular focus on operational phase of the software life cycle.

To achieve the proposed goal of the study, the following questions will be investigated:

- What are the models and standards available for software quality evaluation?
- What is the current state of software evaluation in operational phase by SMEs in Kazakhstan?
- What is the situation with enterprise software support in SMEs in Kazakhstan?
- What are the possible outcomes of the optimised quality evaluation method, specifically designed for SMEs to evaluate the fit of software to organizations functional objectives during the operational phase?

3. Thesis structure

This thesis is divided into nine chapters:

The first chapter is a general introduction to the topic of information systems and an evaluation of their quality.

The second chapter describes goal, research questions and motivation for the research.

The third chapter describes the thesis structure.

The fourth chapter is the Literature Review

The fifth chapter is Small and Medium-sized Enterprises Overview. The section presents an overview of the current state of ICT in Kazakhstan and its attempts towards an innovative economy. Also, it briefly discusses about ERP market in Kazakhstan.

The sixth chapter is overview of software quality models and some brief analysis of the models.

The seventh chapter explains the research methods.

The eighth chapter explains experimental part of the research.

The final chapter is the conclusion, the final evaluation of results, and further recommendations.

4. Literature Review

To date, the literature available shows that very limited research has been done for software evaluation during the operational phase of SMEs. Most of the evaluation processes are focused on the product development process and acquisition process. Moreover, enterprise software evaluation is predominantly run for the large enterprises. From time to time, during the operation of the enterprise software, businesses face tough questions, such as "Should I replace or upgrade my enterprise software", or "What can I take from my previous experience with enterprise software?" Indeed, most of the literature in the field of software evaluation that focuses on software acquisition process miss those important questions. They offer a selection process based on models, which can be far from the experience of a particular business. The following literature reviews the specifics of Quality evaluation in IT.

System Evaluation

System evaluation refers to the process of assessing the benefits of different systems to an organization before settling for the system that is comparatively more advantageous than the rest. Oracle and Microsoft are two of the most significant technological companies that provide enterprise system services to clients [2]. The two firms mainly offer these services to small businesses, as large organizations prefer to have custom made systems that fit their operations in every aspect. Since there are many options for enterprise systems in the market, it essential that firms carry out an evaluation process, thus enabling them to choose the best system [1]. Notably, there always is a general trade-off between functionality and cost, particularly when it comes to the selection of an integrated enterprise system.

Evaluation in Operational Process

Many criteria need to be considered before settling for a given system. The decision on which software to adopt in a business should be primarily based on the requirements of the firm, and the ability of the application to effectively meet all these requirements. As such, the system chosen from the market has to be the best fit, while taking into consideration of the basic operations of the organization. Each organization has its integrated enterprise system evaluation criterion, which is used to check whether the system works as expected [3]. One of the essential elements regarding the operation

of the system that should be considered is the company's size. If it is a small company, the system should be scalable, as well as provide features that give the company a competitive advantage in the market. The fundamental function of an enterprise system is thus to facilitate the integration of business procedures, such as sales, accounts, and human resource [2]. This is performed through information sharing between departments and workforce hierarchies. A perfect enterprise system should transform operations for the better and provide for technology adoption and improved performance.

Functionality is one of the main operational evaluation factors that should be considered. Enterprise software is usually preconfigured to perform the functions that recur across industries. The function of the system is therefore the primary component that brings change within the operations of a business and enhances improved performance. Thus, it is crucial that an organization sets up a team to detail its functional requirements and considers them in the configuration of the enterprise's system [3]. This will ensure that the system is aligned with the scope of the firm, and also promotes the achievement of its primary goals. Additionally, a well- configured system should promote the effective use of available resources in a business, thus maximizing production. Technology platforms and the framework on which an integrated enterprise system framework is built on are also essential. This is because different platforms allow for different cross-functional capabilities. Interoperability is a crucial element that is currently considered by most of the system developers [2] . Every organization wants a system that can perform multiple functions and has a simplified user interface. The platform, on which a system is built, however, brings in other costs, such as lifecycle costs and capital expenditure.

System value and the time taken to implement the system should be considered in cases where the organization is more concerned with the benefits that the integrated enterprise system will bring to the firm. Preconfigured systems take less time to implement, but are not as beneficial as customised ones. This is the main reason why firms that requiring more personalized systems may have to cater for a longer implementation time.

Evaluation Methodologies

A strategy that can be used in enterprise system evaluation is called the SMART approach, a theory that weighs the importance of system selection criteria on a scale of

1-10. The approach seeks to establish the most critical elements that should be considered in the selection of an enterprise system [4]. This system finds the best possible function of all criteria, thus coming up with a compilation of the topmost criteria for consideration. Analytic hierarchy processes is yet another strategy that is extensively used to evaluate enterprise systems [5]. This approach mainly considers the underlying risks associated with a system, thus enabling an organization to settle for the least risky system available. In this case, hierarchy refers to factors considered in the selection criteria, such as attributes and evaluation items. The cost-benefit analysis is also used in the evaluation of an enterprise system. Ideally, these evaluation methodologies attempt to ensure that the system selected serves the best interests of an organization.

Impact of Evaluation on Software Life Cycle

The evaluation of integrated enterprise systems has been found to have a profound effect on other processes of the system life cycle. The system implemented in an organization is mainly guided by the evaluation process findings, which primarily seeks to identify the best system. The adoption and decision phase is the first to be affected by the evaluation process, as this is the phase where system design and architecture are decided on. Ideally, the selection of a system should confer with the suggestions and proposals provided after evaluation [4]. The acquisition phase is also affected as it deals with the actual procurement process of the system. Selection of an appropriate vendor for the provision of an enterprise system is based on the consideration of certain underlying factors, such as system design, platform, architecture and functionality [1]. Different vendors provide different systems, and thus the evaluation process plays a critical role in the guiding of the vendor selection process.

5. Overview of Small and Medium-sized Enterprises

This chapter starts with definitions of the Small and Medium-sized Enterprises, Enterprise software, outsourcing in IT industry as well as provides an overview of the current state of ICT development and ERP market in Kazakhstan. Thus, overview in this chapter helps to build the base understanding of the importance and specifics of enterprise software in SMEs, and its situation in Kazakhstan in particular.

5.1. SME definition

SMEs have an important role in a country's economy globally, due to their contribution to total economic output and the job opportunities they provide [6].

The term "SME" encompasses a broad variety of definitions. Different countries and organizations give different definitions to SMEs, and they are often based on the number of employees, sales or assets. The European Commission defines SMEs in the following way; "SMEs are a category of micro, small and medium-sized enterprises (SMEs) that is made up of enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million" [7].

The classification of the status of the small and medium-sized businesses in Kazakhstan is based on the Entrepreneurial Codex of the Republic of Kazakhstan [8]. As such, Kazakhstan defines medium-sized entities as enterprises with EUR 2.4 million assets and 250 employees. Small entities have EUR 0.4 million in assets and 50 employees and both criteria above should not exceed the limit [8].

5.2. Enterprise software

Enterprises use many different kinds of software, but very often the software used do not actually fit the definition of enterprise software. For example, if an employee buys software used by another company as enterprise software but uses it for his personal needs, then it is not be considered as enterprise software [1]. Enterprise software is defined as that used for the organisation needs rather than personal needs. The notion of enterprise software can also be explained as being a specialized integrated suite of software applications that can provide a common data model, and processes at

different levels and units of the organisation. This is unlike business software, which can have a wider definition and can include any software that increases productivity.

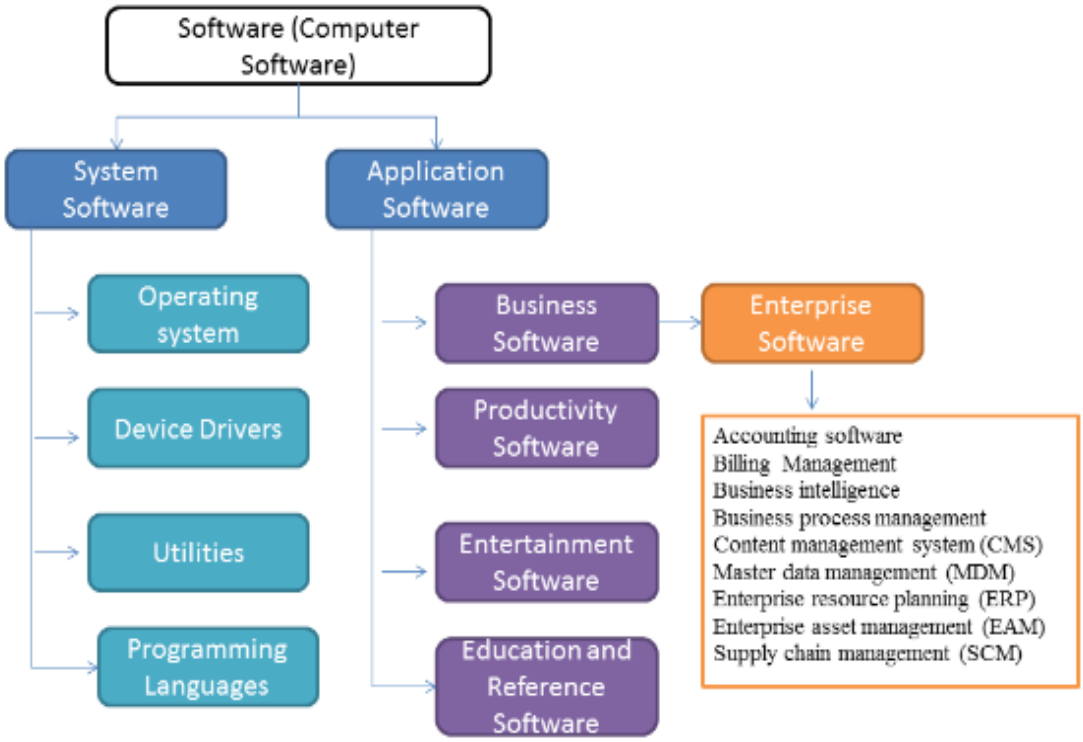

Figure 1: Enterprise software Source: own.

In this research, enterprise software is considered as a part of business software. Examples of enterprise software are accounting software, business intelligence, enterprise resource planning and other as in the orange box on **Figure 1**.

5.3. Importance of the Information and Communication Technology in the Small and medium enterprises

The role of SMEs in a national economy has been accentuated globally, for their contribution to total productivity and to job opportunities [6]. The importance of SMEs often increases according to countries economic growth. At the same time, the rapid growth of information and communication technologies (ICT) determines the performance and competitiveness of the SMEs. It is believed that ICT has become a necessity in the SMEs' contemporary management in order to survive in the modern business environment. According to Porter's theory, there is the particular potential for ICTs to attain a competitive advantage [9]. According to him, the technology will affect

the cost or differentiation. Furthermore, it will also affect other drivers of cost and uniqueness.

The main goal of the implementation of ICT in SMEs was in the optimisation of the enterprise operational processes. Cardona, Kretschmer, and Strobel (2013) asserted that the high growth rate in the US economy during the 1990s, which saw productivity and employment rise, was due to the early and fast adoption of ICTs [10]. However, some experts argue that due to ICT being widely used by enterprises now, it has lost its effectiveness as a strategic instrument of a company's differentiation and companies no longer are advantaged as they were at the onset of ICT [11].

IT management is thus important in the following respect as it improves efficiency through ensuring service delivery is faster, as well as succinct. In addition to that, it helps companies align business operations in an effective manner.

Cloud computing on its part is important as it is cost effective in nature and stores an unlimited amount of information, in addition to backup and recovery.

In contrast, mobile computing is also important as it saves time for the users by reducing incurred expenses. In addition, it has locational flexibility, as users are able to use it anywhere, as long as there is a connection.

In a similar fashion, social networking leads to an increase in traffic in a given site, thereby increasing the awareness for the site and making it more prominent.

While external sources for software and maintenance presents other possible and potentially economical alternatives for organisations, choosing the best alternative is an easy decision process which must be understood and supported. As application acquisition and maintenance constitute a majority of the present-day IT budget of most organisations application sourcing and maintenance decisions have to be thoroughly studied. In some cases, software maintenance can reach up to 60% of the organisation's IT budget [12].

5.4. Software maintenance

According to the Institute of Electrical and Electronics Engineers (IEEE), software maintenance is the process of modifying a software system or component after delivery to correct faults, improve its performance or other elements, or accustom it to a changing environment [13]. Maintenance plays an important role in the life cycle of a software product [14]. There are four types of maintenance: corrective, adaptive,

perfective, and preventive [15]. Adaptive maintenance encompasses the changes needed as a result of some changes in the environment in which the system must operate in. For instance, the alteration of a system to make it work on another hardware platform, operating system, Database Management System (DBMS), Teleprocessing (TP) monitor, or network. Corrective maintenance is in the diagnosing and fixing of errors. Preventive is in increasing reliability to prevent problems in the future. Finally, perfective maintenance depends on users' requests; examples include insertions, deletions, extension, the modifying of functions, improving performance, or the improving of the ease of use [15]. Pigoski suggests enhancements as the putting together of the adaptive and perfective categories, as these types of changes are improvements [16].

5.5. IT Outsourcing

Outsourcing refers to the practice of transferring business activities of a firm to a third party vendor, either within the country or without, so that the firm can concentrate on its core business [17]. IS outsourcing can be defined as "the practice of turning over part or all of organizations IS functions to the external service provider(s)" [18].Several empirical studies have identified various reasons for outsourcing. These include a closer focus on the core business, rapid introduction of new products, cost reduction, improved access to technical skill, and the lack of required resources or expertise to develop internally [19].

Three types of outsourcing can exist. Partial – when only a few parts of the software system are contracted. Complete - when the whole software system under development is contracted. The last alternative for classification of the outsourcing can be planned or ad hoc [20]. The planned outsourcing is a part of the company's strategic business plan. The ad-hoc outsourcing can further help with solving unexpected software problems.

5.6. ICT development and enterprise software in Kazakhstan

ICT is growing to be an important aspect of economic development in many nations around the world. For this reason, many governments are putting in place measures to support the ICT sector to a large extent. This would, in turn, benefit the nation in the long-run. One of these countries is Kazakhstan, whose government is on

the front line of providing the required support needed in the ICT sector. The following sections provide an overview of the current ICT situation and its prospective in Kazakhstan.

5.6.1. Perspectives of ICT sector development in Kazakhstan

After economic crisis of 2008, there was a sharp increase in the volume of direct investment in the information and communication sector in Kazakhstan. However, in 2012-2013, according to "Taldau", there was a slight decrease in the share of investments in the information and communication sector as compared against the total volume of investments [21]. The reason for this was the accentuated attention of the state regarding investment stimulation for the development of the industrial sectors (processing and extractive industries). In 2014, the venture fund "ICT Development Fund" was formed at the expense of private capital, as well as the capital of international companies. The Fund will invest in different projects with the possible ranging of financial support from USD 100 thousand to USD 3 million. With the fall in energy prices that began in 2014, the state has sought to find avenues for new projects, including within the ICT field.

The **Table 1** presents indicators of the use of information and communication technologies in enterprises (in percent).

	2007 %	**2008 %**	**2009 %**	**2010 %**	**2011 %**	**2012 %**	**2013 %**	**2014 %**
Enterprises with computers	79,4	76,6	69,8	62,7	65,2	66,9	66,2	58,1
Enterprises with access to internet	61,7	55,5	54,2	52,9	55,4	58,4	60,7	52,4
Enterprises with web recourses	13,6	7,4	7,6	24,8	20,4	5,8	26,2	19,3
Enterprises with Intranet	9,2	5,4	16,5	17,3	21,0	21,3	25,8	15,0
Enterprises which has web-order service	17,3	14,1	13,0	13,0	4,7	4,5	6,7	7,1

Table 1: Usage of ICT in enterprises in Kazakhstan Source: KazSTAT 2015 [22].

As can be seen from the data of Committee of Statistics of the Republic of Kazakhstan (KazSTAT), the development of ICT in the enterprises of Kazakhstan leaves much to be desired. Many of the indicators decreased over time. This was despite the fact that the number of enterprises has not undergone a major change.

With regards to the development of the ICT industry, along with the challenges of time, there were organizational, economic, and regulatory issues:

- Regulatory and legal inadequacy of the legislative framework;
- Weak level of work on the adoption of standards;
- Unattractiveness for foreign direct investment;
- Low profitability of the IT industry;
- Lack of qualified personnel;
- Lack of a clear vertical management of the industry;
- Lack of the proper information infrastructure;
- The presence of administrative barriers;
- Weak specialization of IT companies, including within subject areas;
- Low level of statistics of the industry.

Low domestic demand for information technology from citizens and businesses was a factor restraining the development of domestic companies. The low penetration of broadband internet access among the population, along with the scarcity of Kazakhstan's web resources and the lack of original content in the Kazakh segment of the Internet reduced the investment activity of business, with regards to the development of e-business and e-commerce.

However, the gradual development of communication technologies made their own adjustments: cable and satellite broadcasting were expanding, thereby increasing confidence in electronic mass media as an important source of information regarding global events.

The transition of Kazakhstan into the information savvy society depended on the consolidation of the efforts of business and the state, and their wide application of ICT and provision of electronic services.

5.6.2. Enterprise resource planning in Kazakhstan

According to the author’s own experience back to Kazakhstan in the IT sector, large amount of attention is paid to software developers in Kazakhstan, although it should be recognized that in the segment of enterprise management systems, international solutions prevail. Foreign developers offer their customers industry

expertise, international partners' experience, and implementation methodology. However, when taking into account local peculiarities of legislation, accounting, taxation, and similar process, Kazakhstan companies that have chosen to use products of foreign vendors often require a serious adaptation of their solutions, thus leading to an increase in the timing of the implementation of projects and the increased cost of supporting a readily available solution.

On the global market Panorama's independent ERP research in 2012-2015 showed that the average cost of ERP implementations has been $4.5 million and the average duration has been 17.3 months. In this period, approximately 54-percent of projects have exceeded their planned budgets, 57-percent of projects have exceeded their planned durations and a full 46-percent of respondent organisations have received less than 50-percent of the measurable benefits that was anticipated from their ERP software initiatives.

YEAR	COST	% COST OVER RUNS	DURATION	% DURATION OVERRUNS	% RECEIVING 50% OR LESS BENEFITS
2015	$3.8M	57%	21.1 Months	57%	46%
2014	$4.5M	55%	14.3 Months	75%	41%
2013	$2.8M	54%	16.3 Months	72%	66%
2012	$7.1M	53%	17.8 Months	61%	60%

Table 2: Cost of ERP implementations; Source: Panorama consulting 2016 [23].

Regarding statistical data, the world, along with some regional markets are tracked well. However, with Kazakhstan, the matter is more complicated. International Data Corporation (IDC) provided data noting that to the volume of the local software market for ERP was valued at US$60 million in 2013. In general, one can observe the positive dynamics of the market development, especially after the crisis of 2009: over the last half a decade, the market volume of ERP-systems has grown almost 5 times.

Over the past few years, there has been a steady growth in this area and, according to experts, the market capacity has not yet reached its maximum potential. In addition, new technologies can drastically change the principles of the functioning of ERM-systems, and could become the next main driver of the market. Experts say that it is currently the era of the "third platform" of information technology, and in the near

future, the market will focus on mobile solutions, social networks, large data analysis, and cloud services. Recent trends have not bypassed the "heavy" products, including CRM and ERP-systems, which, according to analysts, will eventually go completely into the "clouds".

According to IDC, SAP is the leader in the market share of more than 70%. Who owns the remaining 30% cannot be exactly identified. By the year 2016, 13 of the 20 largest companies in Kazakhstan used SAP solutions, with the number increasing. Assuming that SAP occupied a share of 70%, all other vendors would then account for only 30%, which meant that hardly any of them can claim more than a 6-8% share of the market.

It should be noted that the ERP market is traditionally calculated in monetary terms. However, the cost of solutions for vendors is significantly different: the price of SAP is several times higher than the cost of the same "1C-Enterprise" that is distributed in Kazakhstan. Thus, in quantitative terms, the outlook is completely different. "1C-Enterprise" can cost for one user place around USD 70 when SAP can be over USD 2000.

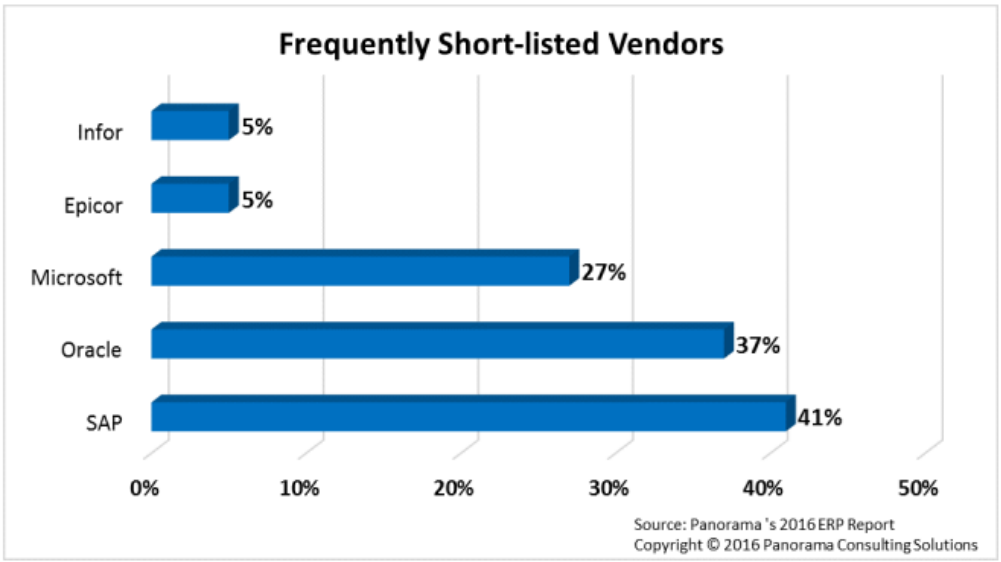

Figure 2: List of global Vendors [23]

In the **Figure 2**, we can see the shares of ERP vendors in the global market. There are three main players in the market and four from the full list of them are represented in Kazakhstan.

SAP

As aforementioned, the German company is the world market leader, and with 165 clients in 25 sectors, is the leader in the Kazakhstan's economy. SAP holds market shares in strategic sectors such as the public sector, oil and gas industry, banks, transport and energy, metallurgy, extractive industries.

2013 was a notable year for the SAP Kazakhstan office, as the translation into Kazakh SAP ERP took about 2 years, with approximately EUR 25 million spent on localization [24]. Furthermore, in 2013, there was an increase in demand for SAP solutions in the medium-sized business sector, in industries as industrial and civil construction, retail and distribution, logistics and in the production of consumer goods. Nevertheless, in the annual report published on the official website of SAP AG, it can be seen that in Kazakhstan, the company showed losses for the last two years. Representation managers explained this as due to the investing in product localization (although the main investments were made in 2012), in the development of the market, and in the training of partners. Losses were also associated with the specifics of accounting methods within the company itself.

It is known that SAP implements solutions in the largest companies of Kazakhstan, including at the enterprises of Samruk Kazyna JSC, and in the near future, the vendor expects new large projects, as the programs of business transformation developed within the holding. This is currently being developed in the Samruk group of companies. According to the speeches of government officials, they are seriously considering the possibility of implementing SAP in all "subsidiaries" of the state holding.

Oracle

The American corporation offers more than 50 product and industry categories, and according to external analysts', is estimated as the leader in the world. However, the key product of Oracle is still considered to be the Oracle Database, as well as the assets of the acquired company Sun Microsystems. The corporation in Kazakhstan has about 100 partners. In 2013, Oracle opened a representative office in Astana for closer cooperation with state bodies, such as the Committee of the Treasury of the Ministry of Finance of the Republic of Kazakhstan, both of which are among the largest clients of the Oracle E-Business Suite [25]. In addition, serious projects are being implemented in the extractive industry and in education.

Microsoft, Epicor, Galaxy, 1C

In Kazakhstan, Microsoft has a very diverse portfolio of projects, in sectors such as the financial sector, in retail, and in the extractive industry. Furthermore, one of the projects on the introduction of Dynamics AX has won the title of the Best IT Project of the Year.

The main income of Epicor, which amounts to 84%, is from North and South America. The Europe, Middle east, Africa (EMEA) region brings 11%, from which it can be assumed that Kazakhstan occupies a very modest position. And yet, the company is represented on the Kazakhstan market, and the key to it are customers from the production and distribution sectors.

"1C" has been working in the ERP field since 2004, and 4 distributors and about 400 franchise partners work in Kazakhstan.

As for the "Galaxy", this Russian company has worked in the market of Kazakhstan for 17 years, and its clients include a large companies from the oil, gas, and extractive industries.

Vendors vs. partners

SAP has 26 partners in Kazakhstan, with more than 500 consultants. In addition, the company plans to increase their number within the next 2 years.

Oracle in Kazakhstan has 25 partner companies with the status of Oracle Platinum, meaning that they have 5 or more specializations for Oracle products.

Unlike competitors, Epicor does not seek to create a large channel of resellers to compete amongst themselves. Epicor offers a real partnership, often with a certain specialization that is perhaps subject-oriented or vertically oriented, or aimed at covering certain geographic areas.

Microsoft provides software and a share in the license fee, depending on the sales volume. In Europe, for small and medium-sized businesses, there are no competitors to MD NAV. Thus, such a strategy justifies itself. In the CIS countries, the standard of accounting is "1C Accounting". In these circumstances, selling MD NAV is extremely difficult.

Implementation problems

Problems in the implementation of the systems within the enterprise in Kazakhstan are the same as those globally: there are specifics unique to different

business processes, the resistance of the company's employees, insufficient training of personnel, a wrong design approach, insufficient qualification of consultants, hidden costs, and so on. On occasion, there are reports of another project, the implementation of which exceeded all the deadlines or even the complete failure of working with the system. Indeed, more often than not, the SAP market leader is criticized for the cost, timing, and effectiveness.

Small and medium-sized enterprises often do not want to apply new forms of information technology, such as ERP, due to lack of financial resources, or knowledge of the use. "1C-Enterprise", which is associated with "1C-Accounting", in Kazakhstan is used in approximately 92% of cases (according to 1C representatives in 2014) in SMEs. They have thus almost completely conquered the "lower" floors of the business, where SMEs are located. In the survey conducted by the author in the experimental part, one can be convinced of this.

5.6.3. Perspectives of the enterprise resource planning systems market in Kazakhstan

It is clear that each of the ERP vendors is already entrenched in its particular niche. Nevertheless, the recent actions of large, foreign ERP systems indicate that they are ready to reacquire the already monopolized SME market. One of the main problems of this remains in that their products are markedly more expensive, even with the proposed boxed versions. Another factor is the development of the 1C market in Kazakhstan. It is often the case in Kazakhstan that SMEs recruit IT professionals and accountants based on their knowledge of 1C products. These signs are very important, and consequently, a coordinative change in this market segment in the near future is not expected.

5.6.4. ICT and government’s policy towards innovation

Kazakhstan is one of the fast-growing economies in the post-Soviet region, with the private and state enterprises growing and developing at a high pace. Therefore, the government of Kazakhstan has been stressing the importance of taking action toward the facilitating of business development, as well as increasing business competitiveness and moving from the “raw material economy” to a knowledge-based economy. Hence, on the January 9, 2012, the President of the Republic of Kazakhstan signed a law regarding the state support of industrial innovation. In accordance with the state policy, the Samruk-Kazyna Fund, which owns the national development institutions, national companies, and other entities, promoted the policy of implementing the so-called

Management reporting system in the main state organizations. Samruk-Kazyna, also known as National Welfare Fund, can be described as a joint stock company, as well as a sovereign wealth fund that is based in Kazakhstan. It is the owner of various companies in the nation that are the core of the nation's economy, with the being the sole shareholder of the given fund that came into being in 2008 after a merger of two funds ,known as Samruk and Kazyna.

According to the official information available on the website of the Fund, its main role is to:

1) Assist in the modernization and diversification of the national economy

2) Support economic stabilization

3) Facilitate the companies' efficiency growth.

In the framework of the facilitation of the companies' efficiency growth, the Fund supports ICT development in Kazakhstan. Implementation of the ERP and CRM systems is among the most important initiatives of the Fund. The report of the National Agency for Technological Development is included in **Figure 3**, which shows the share of innovatively active enterprises increased from 2.1% in 2003 to 7.6% in 2012. This was since the adoption of the Policy of Industrial and Innovative Development in Kazakhstan. In comparison, the average figures for these indicators in developed countries are 40-50% [26].

Figure 3: Share of active enterprises in Kazakhstan [27]

In **Figure 4** (2012), it can be seen that there is a significant gap between Kazakhstan and developed countries in the area of the innovative activeness of enterprises.

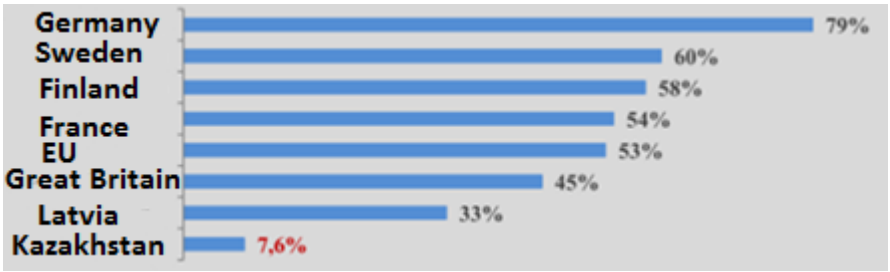

Figure 4: Activeness of enterprises in innovation [27]

5.6.5. The Concept of innovative development of Kazakhstan 2020

The Concept of innovative development of Kazakhstan 2020 is aimed at facilitating the entry of Kazakhstan into the 30 most competitive countries in the world, through the development of new technologies and services that will ensure the transition from “raw materials” to an “innovative” economy.

Achieving this objective will be through tasks, such as:

- facilitation of an ‘innovations’ generation in Kazakhstan;
- further development of the leading innovation clusters;
- a specific scenario for prospective technological directions;
- providing enhanced regional innovation systems;
- using the raw potential of the country to attract new technologies and the creation of high-tech industries[26].

According to this Concept, in 2003 the JSC "National Agency for Technological Development" was established as a specialized institute for the development of innovation. It is now is the core operator in support of the innovation in the country.

Instruments of the state support of innovation activity include project and venture financing, innovation grants, technology business incubation centres, commercialisation offices, industrial design centres, service centres of international technology transfer, and innovation competitions [28].

In 2005, Kazakhstan adopted the "State program for creation and development of the National Information Infrastructure of the Republic of Kazakhstan" for ICT development. **Table 3** shows the achievements from that period.

UN World ranking (193 countries)	2014	2013	2012	2010	2008	2005
E-Government development index	28	-	38	46	81	65
Human Capital Index		-	25	16	22	22
Online Services Index	23	-	14	95	24	24
The index of telecommunications infrastructure		-	77	96	91	91
E-participation index	23	-	2	18	31	31
Ranking of the World Economic Forum (WEF)	2014	2013	2012	2011	2010	2005
Network Readiness Index	38	43	55	67	68	-
The sub-index of readiness		62	52	56	74	-
The sub-index of use		54	65	56		

Table 3: Achievements of the E-government of Kazakhstan from 2005 to 2014 [29].

The purpose of the introduction of the E-government was a desire to save time that people may lose when they visit public institutions. The second reason is the saving of public resources: the amount of long-term recruitment of civil servants can be reduced to the level of "front office".

To summarise, Kazakhstan as an emerging economy has experienced a significant ICT development in recent decades, which is predominantly supported by the Government initiatives. Despite these achievements, and counting for its strong growth potential, the ERP software market is still developing and need considerable attention to better serve the country’s businesses.

6. Software quality models

The following subchapters review and analyse the quality evaluation models in order to identify the most suitable model for the current research purposes.

6.1. Quality definition

To develop high-quality software we must first clarify the precise specification of the term "quality" [30]. Even if specifications are right and complete, it will become invalid over time, due to technological or other changes. Thus, quality control of software is compulsory to keep high quality of it.

To have the quality, the "product" must meet some requirements. For example, ISO 9000 defines the quality in the manufacturing approach as a conformance to requirements. ISO 8402 in product orientation defines quality as the presence of specified features. Goal orientation of quality in use in ISO 14598-1 explains quality as meeting the user's needs. However, requirements can be also reliant on a product, system, component, process or service.

There are five definitions of quality by Garvin [31]:

- Transcendent Definition (philosophical): quality un-analysable property that we learn to recognize only through experience.
- Product-based Definition (economics): quality as a precise and measurable variable.
- User-based Definition: high-quality products are those that best meet the needs of consumers.
- Manufacturing-based Definition: conformance to requirements, excellence is equated with meeting specifications.
- Value-based Definition: quality product is one that provides performance at an acceptable price or conformance at an acceptable cost.

6.2. Process vs Product quality

In line of this research work, software is considered as a product and I measure its quality in the specific area of business. However, in the 1990s, there was a huge increase in another point of view of quality, called "process quality". Since then researchers have mostly concentrated on investigating process quality. This is because process quality is the core of manufacturing. The idea of process quality is that if the

level of quality of your processes is high then you will have high-quality products. ISO 9000 can be the example of a process view of quality. The ISO 9000 has a proposal of establishing a quality management system in an organization, which will bring high-quality products. The standard itself is not concerned with the quality of the products, but with the quality requirements within the company which produces the products. In some sense, having been certified by ISO 9000 is still beneficial to the company as it shows that the company has clear quality assurance policies. However, the company pays for it with additional bureaucracy procedures. There were two different major initiatives: the CMMI standard in America and SPICE in Europe. Later on, SPICE became ISO standard (ISO 15504). These standards offer prescriptive and normative approaches to improve their processes [30]. The idea is that we can have ideal processes for the company that this company needs to achieve.

A problem of these standards could be the rising of paperwork. Furthermore, the evaluation of process quality is in fact independent from the product evaluated. As such, the process assesses "How" it is done but not "What" is done. In this research, process quality evaluation is not suitable, as we evaluate the product, which is the final result of the process and cannot be fully changed. Often, businesses have opportunity to use the product for trial period. In that sense, having a product quality evaluation approach is an adequate way to check the fitness of the specific needs of company. Process quality is important, but mostly it needs to be performed in manufacturing, or in development organizations.

6.3. Quality models

In order to make software quality measurable, McCall's model was proposed in 1977. The organizations which initiated it were General Electric, US Air force Electronic System Division (ESD), and the Rome Air Development Centre (RADC). Since the McCall's model was proposed, new models, which were similar but with redefined characteristics started their own development. The next successful model was Boehm's model. It was presented one year later after McCall's model.

There are many approaches to evaluate software quality. The most known methods/models are:

- McCall's model
- Boehm's model
- Dromey's model
- FURPS
- ISO 25000 and ISO 9126

McCall's Model

Jim McCall presented his model in 1977. Indeed, his quality model could pretend to be predecessor of many current day models. It was also named as the General Electric's Model. In his model, he attempts to find a bridge between the developer's priorities and users' views by focusing on quality factors which could be important to both sides[30].

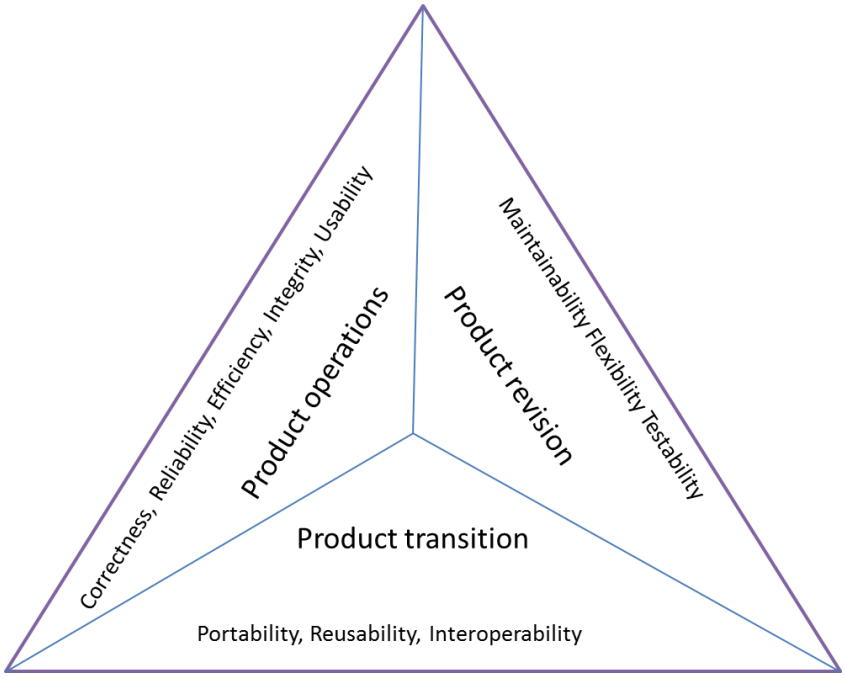

Figure 5: McCall quality model

The McCall quality model has, as shown in the Figure 5, three major perspectives for defining and identifying the quality of a software product: product revision, product transition and product operations. McCall's model has a hierarchical structure of major perspectives: Factors, Criteria and Metrics.

These major perspectives have 11 factors to specify. The factors describe the external view of the software, as viewed by the users. There are also 23 criteria from the internal view based on the developer's side. Criteria can have interrelated relationship with factors. For example, Completeness and Traceability belong to Correctness, when Consistency can belong to Reliability and Correctness. Metrics are defined and used to provide a scale and method for measurement.

McCall's quality model is based on the judgment on the person's answering Yes or No questions.

The actual quality metric is achieved by answering yes and no questions, which then are put in relation to each other. That is, if answering equal amount of "yes" and "no" on the questions measuring a quality criteria, you will achieve 50% on that quality criteria. The metrics can then be synthesized per quality criteria, per quality factor, or if relevant per product or service.

Boehm's Model

Boehm with colleagues presented their model in 1978 one year after McCall. Boehm's model is similar to the McCall Quality Model in that it also presents a hierarchical quality model. It is also structured similar. It has characteristics of three levels: highest level, intermediate level and primitive [32].

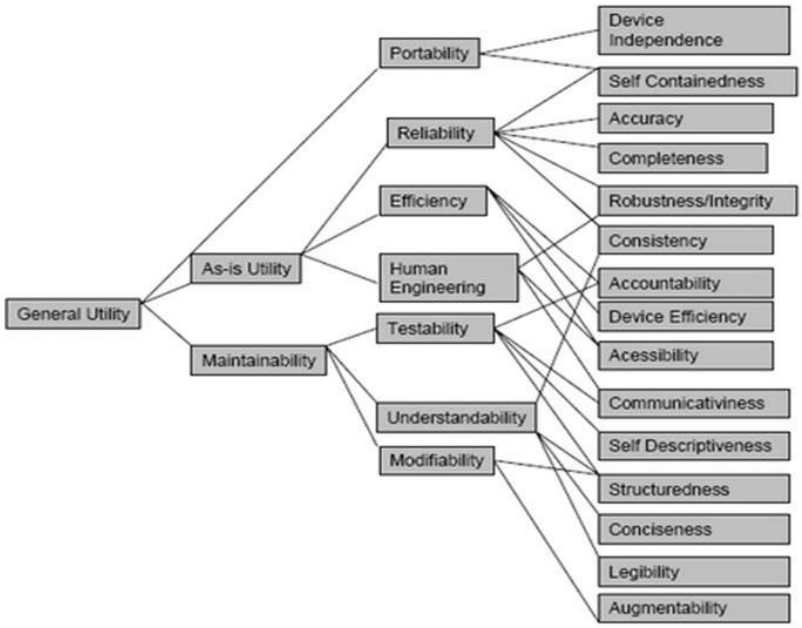

Figure 6: Boehm's Model[33].

The difference is that McCall's model primarily focuses on the precise measurement of the high-level characteristics of "as-is utility", whereas Boehm's quality mode model is based on a wider range of characteristics, with an extended and detailed focus on primarily maintainability. Boehm focuses a lot of the models effort on software maintenance cost effectiveness – which, he states, is the primary payoff of an increased capability with software quality considerations.

Dromey Quality Model

Dromey states the idea that quality evaluation differs for each product and modelling the process is needed to be wide enough to apply for different systems. His model is recognized as a product based quality model [34].

Dromey's main elements:

- Product properties that influence quality;
- High level quality attributes;
- Means of linking the product properties with the quality attributes.

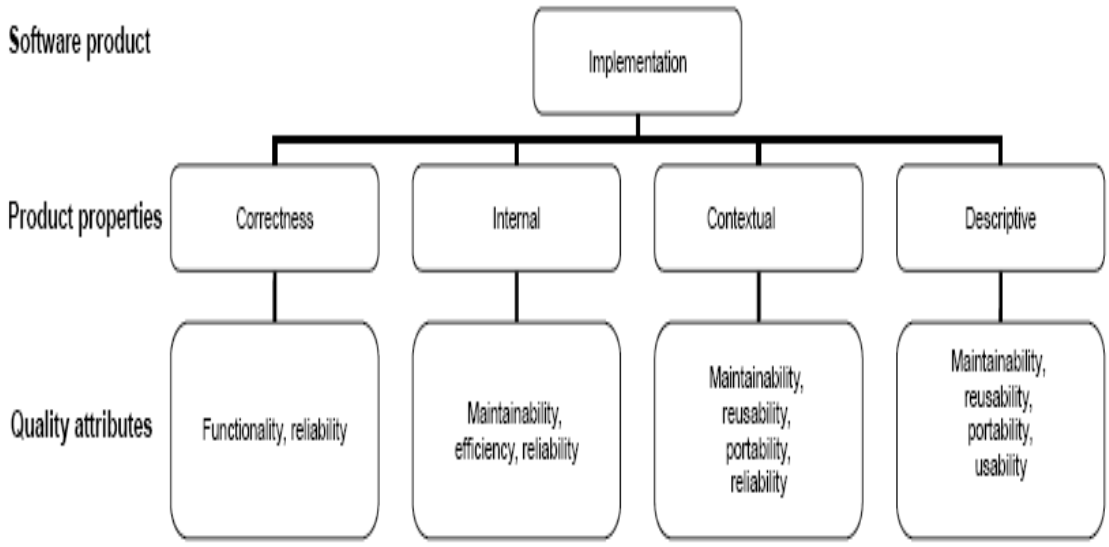

Figure 7: Dromney's model [34]

It is structured around a 5 step process:

- Chose a set of high-level quality attributes necessary for the evaluation;
- List components/modules in your system;

- Identify quality-carrying properties for the components/modules (qualities of the component that have the most impact on the product properties from the list above);
- Determine how each property effects the quality attributes;
- Evaluate the model and identify weaknesses.

FURPS Quality Model

FURPS model is presented by Robert Grady in 1992. Afterwards, it was extended by Rational Software (IBM Rational Software) into FURPS+.

FURPS has five characteristics [34]:

- Functionality – feature sets, capabilities and security;
- Usability – human factors, aesthetics, consistency in the user interface, online and context sensitive help, wizards and agents, user documentation, and training materials;
- Reliability – frequency and severity of failure, recoverability, predictability, accuracy, and mean time between failure;
- Performance – conditions on functional requirements such as speed, efficiency, availability, accuracy, throughput, response time, recovery time, and resource usage;
- Supportability – testability, extensibility, adaptability, maintainability, compatibility, configurability, serviceability, installability, localizability (internationalization).

The FURPS-categories are of two different types:

- Functional (F)
- Non-functional (URPS)

The categories can be used as both product requirements, as well as in the assessment of product quality.

ISO 25000 (SQuaRE)

The ISO 25000, which also referred as SQuaRE, quality model is the most useful one, as it has been build based on international consensus and agreement from all the country members of the ISO organization.

This standard was based on the McCall and Boehm models. Besides being structured in basically the same manner as these models, ISO 9126 as the predecessor of ISO 25000, also includes the functionality as a parameter, as well as the identification both internal and external quality characteristics of software products. SQuaRE and ISO 9126 will be described in more detail in the next chapter.

	Mac Call 1977	BOEHM (1978)	ISO 9126 (1991)	FURPS+ (1992)	Dromey (1992)	SQuaRE (2011)
Maintainability	x		x		x	x
Flexibility	x					
Testability	x	x				
Correctness	x					
Efficiency	x	x	x		x	x
Reliability	x	x	x	x	x	x
Integrity	x					
Usability	x		x	x	x	x
Portability	x	x	x		x	x
Reusability	x				x	
Interoperability	x					
Human Engineering		x				
Understandability		x				
Modifiability		x				
Functionality			x	x	x	x
Performance				x		x
Supportability				x		
Design Requirements				x		
Implementation Requirements				x		
Interface Requirements				x		
Physical Requirements				x		
Verifiability						
Expandability						
Survivability						
Safety						
Manageability						
Dependability						
Security						
28	11	7	6	9	7	8

Table 4: Comparison of quality models[34].

The **Table 4** shows the comparison of characteristics of described models. The comparison in the **Table 4** is from Boukouchi Y. Security and compatibility were both added as major characteristics in ISO 25000 in 2011.

6.4. Analysis of quality models

In this section, the main differences and some shortcomings of the selected quality models based on their types are described. The main types defined as:

- Hierarchical Quality Model
- Meta-Model-Based Quality Model
- Prediction Quality Model
- Assessment Model

It is to be noted that there can also be Multi-purpose models, which are not analysed in this section.

Hierarchical Quality Model

The first proposed hierarchical model was McCall's model. Then Boehm proposed his own model. The models are quite similar; they decompose the quality into quality factors. The main advantage of these models is that the evaluator can decompose the quality to the levels where it can be measured. Later on, these models were taken as a basis for the international standard of ISO/IEC 9126. The successor of the ISO/IEC 9126 is the new standard ISO/IEC 25010, which still keeps this decomposition rules. The close overview of these standards will be in the following chapter.

FURPS is also hierarchal model. It has main five quality factors where four of them are aimed at users. Only the 'supportability' aims on developers and maintainers. This is quite convenient, comparing with the ISO/IEC 25010 where some characteristics have mixed stakeholders.

The problem with these models can be the ambiguity of their characteristics. The newest standard brought a new measurement reference model, but there is still an insufficiency of detailed measures. Being flexible also brings an uncertainty to it as a standard in some projects that require strict rules.

Meta-Model-Based Quality Model

COQUAMO was developed by ESPRIT to make clear connection between measurement and quality factors. They also see the quality factors as a core of their model. The model argues that factors should have been differently evaluated, depending on its development stages. Furthermore, they appealed to have different metrics in those stages.

The concepts of Dromney's model are described the previous section. The model is an elaboration between product properties and external quality attributes.

Kitchenham build his SQUID relying on COQUAMO. The SQUID suggests monitoring internal measures, which has impact to external quality.

For these models, the lack of base quality models can be defined as a disadvantage.

Prediction Quality Model

The example of these models is the "reliability growth models", where the main idea is to monitor the failure behaviour of the software. This gives the ability to predict future changes in the behaviour of the software. These models also can be defined as statistical models if they use statistical methods of prediction.

The shortcomings of these models are in the difficulties of interpreting the results. The models mostly use regression or data mining methods to obtain the data for analysis.

Assessment Model

The EMISQ model is quite similar to ISO/IEC 9126. It also defines quality characteristics and has one level of sub characteristics. These sub characteristics can be mapped to the metrics. However, it can not only use a well-known metrics, but also ones that detect coding anomalies. The advantage of the EMISQ model is that its reference model has defined 1500 mapped metrics. However, the problem of these assessment models is the lack of clarity regarding decomposition of quality factors. We can have a lot of defined measures, but at the same time, there is a problem with the lack of structure of the quality model. The usage of some measures in certain senses can be problematic, due to motivation of its usage in the specific case.

6.5. Standardization of software quality and its measurement

Standardization is very important as standards help to unite the points of concern and create uniform rules [35]. In the area of Information and Communication Technology work on a global level, there are two international organizations used for standardization. They are the International Electromechanical Commission (IEC) and

the International Standards Organization (ISO). These days, they have a joint technical committee, which is ISO/IEC JTC1 Information Technology.

There is also a CMMI standard, which was initially American, but is currently a widespread standard. It has five levels of maturity [36].

Maturity levels characterize an improvement, which organization achieves relatively to a set of process areas. In contrast, capability levels characterize organizational improvement relative to an individual process area.

Maturity levels:

Maturity Level 1: Initial

Maturity Level 2: Managed

Maturity Level 3: Defined

Maturity Level 4: Quantitatively Managed

Maturity Level 5: Optimizing

Among the major old standards for quality, IS / ICT can be classified as mainly standards and technical reports: ISO / IEC 9126, ISO / IEC 14598, ISO / IEC 15939 and ISO / IEC 12119 "Information technology - Software packages - Quality requirements and testing ". The successor of these quality standards nowadays is the SQuaRE. SQuaRE series of standards is dedicated to software product quality only.

6.5.1. Quality model hierarchy

The ISO quality model categorizes the software quality into characteristics, and then further subcategorizes it into sub-characteristics and eventually, the last step is the quality attributes (**Figure 8**).

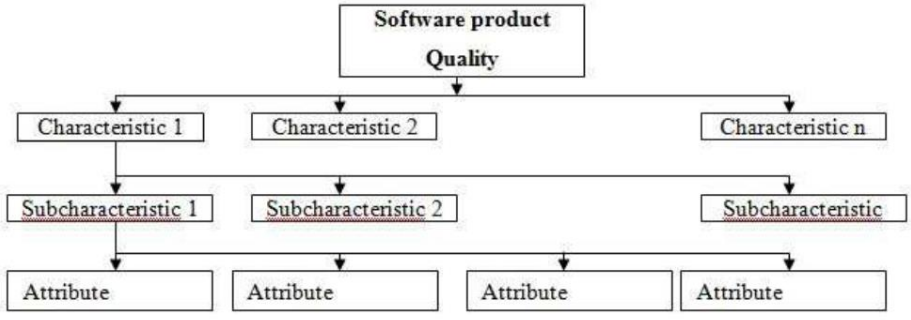

Figure 8: Tree quality model hierarchy (ISO/IEC 9126-1) [37].

In reality, the hierarchy above is not perfect, as some attributes may contribute to more than one sub-characteristics. **Figure 9** shows the real model.

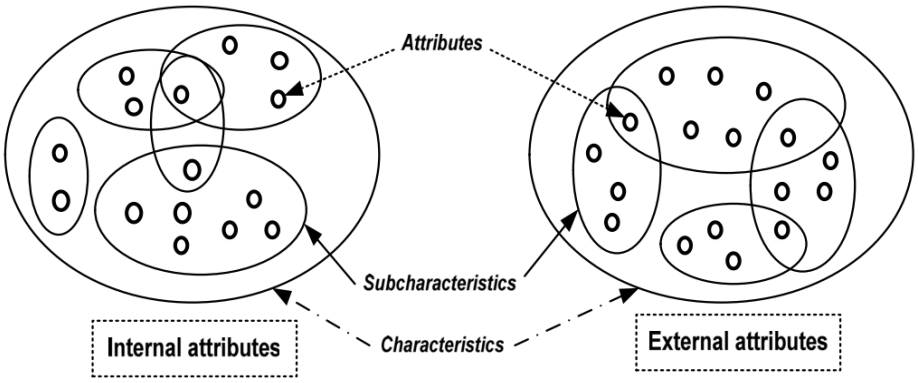

Figure 9: Quality model hierarchy [37]

The connection between internal and external attributes of the measures is never perfect, and the effect of the internal attribute in the associated external dimension is determined by experience, and dependent on the specific context in which the software is used. The internal measure is defined as a measure derived from the product itself. The external measure is a measure of a product derived from the measures of the behaviour of the system that it is a part of. Lately, ISO added 'quality' in use model, which can be measured by the level for which the users can possibly achieve their goals.

6.5.2. Standard ISO / IEC 9126

Having software to achieve a high level of quality is an essential tool for the maintenance of all processes in the field of economics, management, and environmental management. An evaluation software that can control product quality on the market is still a largely subjective process. Therefore, the rules for an objective and uniform assessment of software quality are definitely acceptable and have been the focus in the field of international standardization [38].

The first standard for the standardization of software quality was published in 1991, when it was known as the international standard ISO / IEC 9126 "Software Product Evaluation - Quality characteristics and guidelines for their use". After publishing the standard, Pfleeger reported on some important issues in the ISO / IEC 9126, such as the lack of guidelines on how to give an overall assessment of quality, that there was no guidance on how to measure quality characteristics, and how it focused on the point of view of the software developer [39].

ISO 9126 had six characteristics: maintainability, reliability, functionality, usability, portability, efficiency.

From 2001 to 2004, ISO has published an extended version, containing both the ISO quality model and an inventory of the proposed measures for these models. Version

ISO 9126 is a series of standards consisting of four documents, one standard and three Technical Reports [40]:

- Quality models - ISO 9126-1;
- External metrics (TR) - ISO 9126-2;
- Internal metrics (TR) - ISO 9126-3;
- Quality in use metrics (TR) - ISO 9126-4.

The major differences between the 1991 version and the 2001 version are:

• The introduction of normative sub-characteristics, most of which are based on the informative sub-characteristics in ISO/IEC 9126 (1991);

• The specification of a quality model;

• The introduction of quality in use;

• The removal of the evaluation process (which is specified in the ISO/IEC 14598 standards) [41].

6.5.3. ISO 25000 (SQuaRe)

The Software Quality Requirements (SQuaRE) is derived from ISO / IEC 9126, Software engineering - Product quality. In the old ISO / IEC, 9126 standards consisted of six quality characteristics, and the description of a process model of software product evaluation. ISO / IEC 9126: 1991 has been replaced by standards: ISO / IEC 9126:2001, the development of software - quality products and ISO / IEC 14598, Software engineering - Product evaluation.

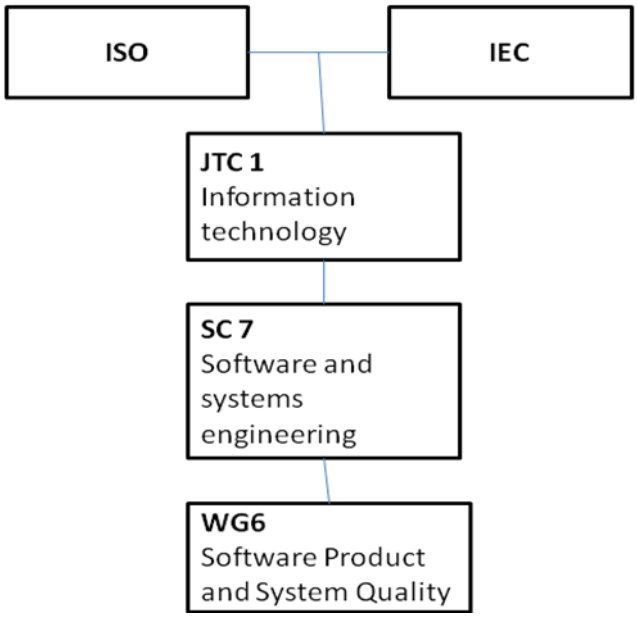

Figure 10: Map of the committees and groups [42]

The **Figure 10** shows us the structure of technical committees. ISO/IEC JTC 1/SC 7-Software and systems engineering committee works on SQuaRE. It consists of 17 Working Groups (WG) [43] with each of them working on their own topic. ISO/IEC JTC 1/SC 7/WG 6 works on Software Product and System Quality.

The part of the SQuaRE series of International Standards is ISO/IEC 25010, which consists of the divisions:

- Quality Management Division (ISO/IEC 2500n);
- Quality Model Division (ISO/IEC 2501n);
- Quality Measurement Division (ISO/IEC 2502n);
- Quality Requirements Division (ISO/IEC 2503n);
- Quality Evaluation Division (ISO/IEC 2504n);
- SQuaRE Extension Division (ISO/IEC 25050 – ISO/IEC 25099).

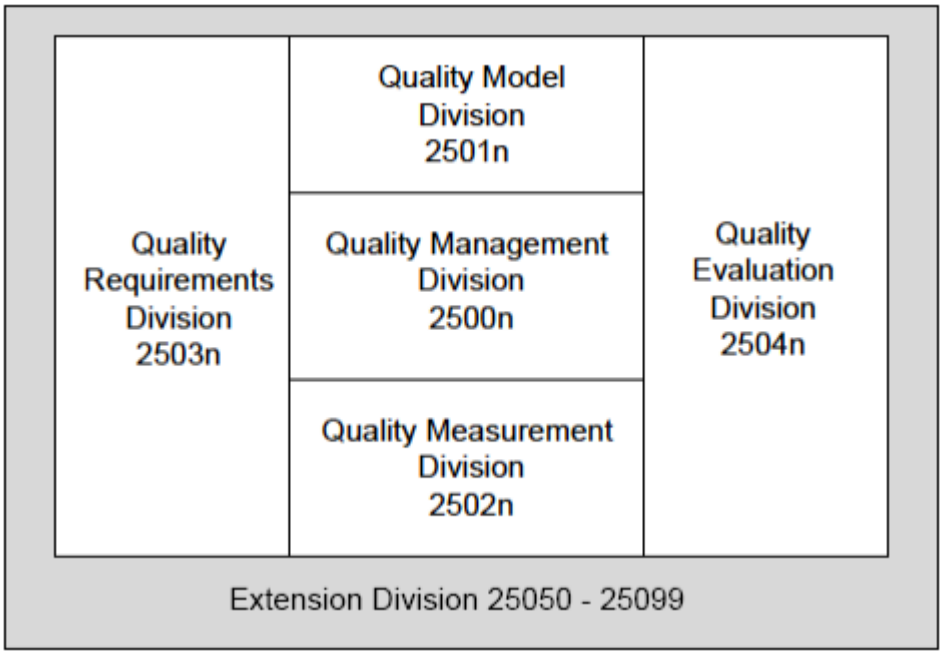

Figure 11: SQuaRE series of International Standards divisions [37]

Compared with the previous version of divisions, the last one has one more - SQuaRE Extension Division (**Figure 11**) (ISO/IEC 25050 – ISO/IEC 25099). This new standard includes requirements for the software quality of a commercial off-the-shelf software product, along with the general industry usability-reporting format.

The **Figure 12** shows the interaction between the different quality models and system models in ISO 25000.

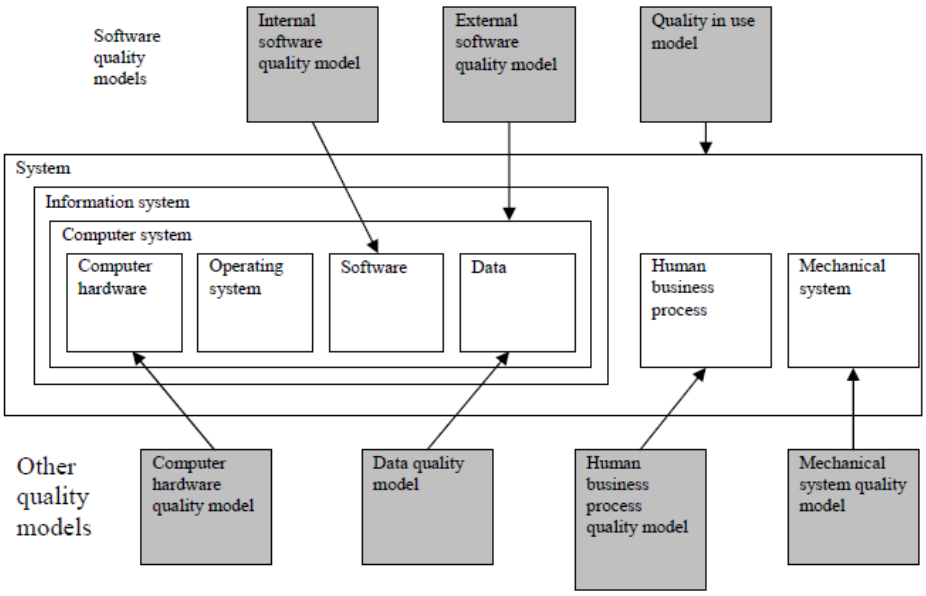

Figure 12: System model and quality models [35]

Intended users of this International Standard are:

- Acquirer
- Evaluator
- Developer
- Maintainer
- Supplier
- User
- Quality manager

Developers, evaluators, quality managers, and acquirers can select measures from this standard for defining requirements, evaluating system/software products, measuring quality aspects and other purposes. They can also modify the measures or use measures that are not included here.

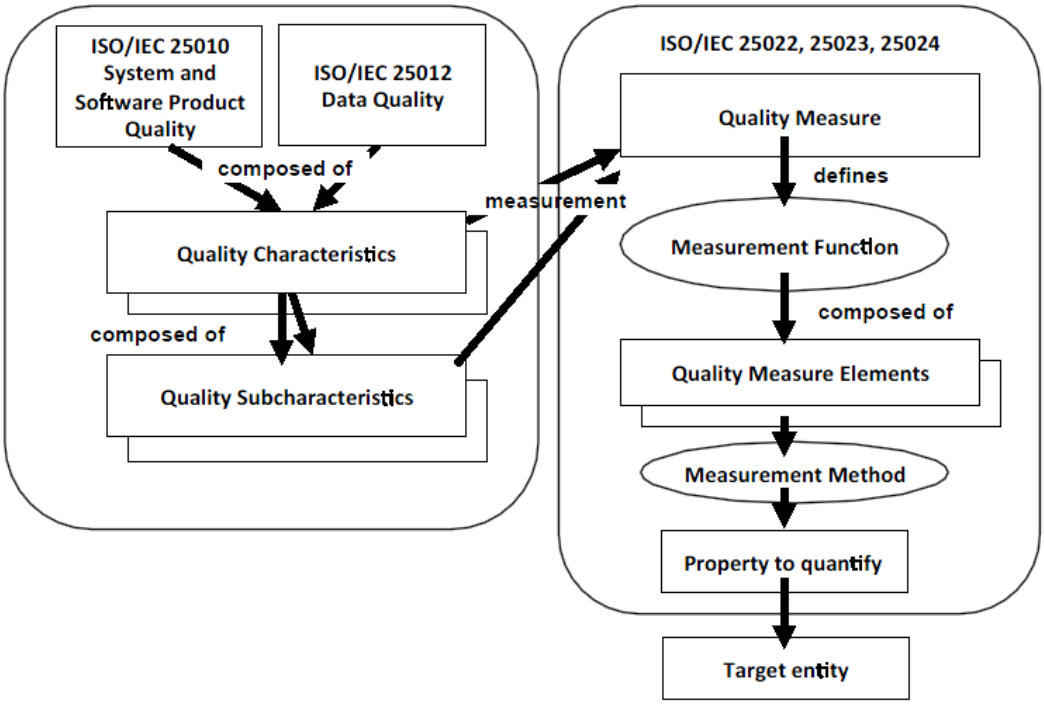

Figure 13: Measurement of quality characteristics [44]

In the **Figure 13**, it is shown how the quality characteristics are measured. The quality characteristics and sub-characteristics can be quantified by applying measurement functions. A measurement function is an algorithm used to combine certain quality measure elements. The result of applying a measurement function is called a quality measure. In this way, quality measures become quantifications of the quality characteristics and sub-characteristics. More than one quality measure may be used for the measurement of a quality characteristic or sub-characteristics.

25021	Attribute	An essential feature or characteristic of the object, which can be distinguished quantitatively or qualitatively by human or automated means (ISO 15939:2007)
	Quality measure elements	The measure defined in terms of attributes and measurement methods for quantifying it, including, if necessary, the conversion with the help of mathematical functions used to build quality assurance measures

25022 25023 25024	Quality Measure	The measure, which is defined as a function of the measurement values of two or more elements of a measure of quality

Table 5: Explanation of some the measurement values [45]

In **Table 5**, the explanation of the Attribute, Quality measure elements, and Quality Measure by SQuaRe is elucidated.

A	ID	Identification code
B	Name	Quality measure name
C	Description	What it describes
D	Measurement function and QMEs:	

Table 6: The format used to document quality measures [44]

The format in the **Table 6** is used for the **Table 7**. The **Table 7** describes some measurement examples.

Name	ID	Description	Measurement function and QMEs	Method
Task completion	EF-G-1	What proportion of the tasks are completed correctly?	X = A/B A = number of tasks completed B = total number of tasks attempted	Measure user performance
NOTE This measure can be measured for one user or a group of users. If tasks can be partially completed the Task effectiveness measure should be used.				
Task effectiveness		What proportion of the goals of the task is achieved correctly?	$\{X = 1-\Sigma A_i \mid X>0\}$ A_i= proportional value of each missing or incorrect component in the task output (maximum value = 1)	Measure user performance
Flexible context of use	CFL-G-1	Extent to which the product can be used in additional contexts of use.	X = A / B A = Number of additional contexts in which the product would be usable B = Total number of additional contexts in which the product might be used	Analysis of user performance or context description
Pleasure scale	SPL-G-1	Does the user obtain pleasure from using the system?	X = A/B A = questionnaire producing psychometric scales B = population average	Questionnaire

Table 7: Some measurement examples [44]

In the practical part of the work, the same concept has been used with some modification as in the examples in the **Table 7**. For example, the similar to “pleasure

scale" approach was used to evaluate the usability characteristics, at the same time the number of variables was greater than in the example provided.

Model for External and Internal software product quality

The software product quality model categorizes software product quality into eight characteristics (**Figure 14**) where each of them is composed of a set of sub-characteristics:

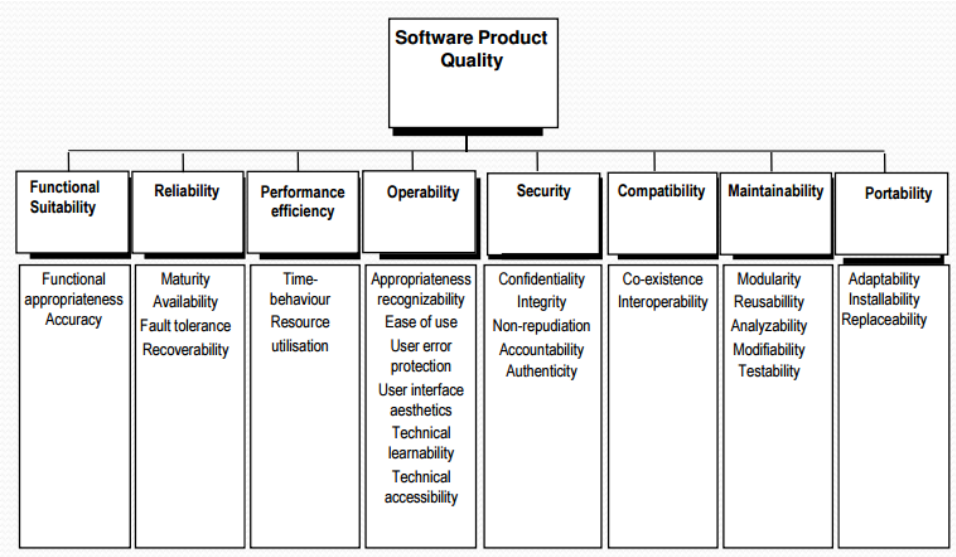

Figure 14: Software product quality [37]

External quality is the usefulness of the system as perceived from the outside. It provides customer value and meets the product owner's specifications. This quality can be measured through customer feedback and feature tests. Furthermore, it has direct effect on clients, while the internal quality affects them indirectly.

Internal quality is regarding how the system has been constructed. It is more about the consideration of things like clean code, component reuse, complexity, and duplication. This quality can be measured through predefined standards, linting tools, and unit tests, amongst others.

Compared with ISO/IEC 9126, there are two additional characteristics: security and compatibility.

Functional suitability expresses that the software shall provide the functionality to the user, fitting their requirements and expectations. This also includes its functional correctness, i.e. that the software does what is required. In many contexts, correctness is equated with quality. However, that is only one specific aspect.

Reliability describes how frequently the software does not provide the expected or required service.

Performance Efficiency describes how efficiently the hardware resources are used by the software, and how long does it take for the users get a response from the software.

Usability describes how well and with what satisfaction a user can operate the software.

Security has become important in ISO/IEC 25010. In previous ISO/IEC 9126, it was not part of top-level characteristics. It describes how software is prepared against attacks.

Maintainability or maintenance is essentially further development. In some contexts, this can also be understood as code quality or internal quality.

Portability is important in the process of bringing our software to new or further platforms.

Compatibility how user can easily can one combine the software with other software and hardware systems.

Quality in use model

Quality in use is the level in which the product or system may be used by specified users, to meet their needs for specific purposes with efficiency, effectiveness, and the freedom from risk, all in order to meet specific conditions of use (Figure 15). Quality in use is how the user sees the quality of a system, which contains the software. It is measured in the condition of the result of using the software in the specific environment, and it is less about properties of the software itself [44]. It can be measured by the level to which the users can possibly achieve their goals.

The quality in use is categorized into five characteristics (**Figure 15**):

Effectiveness assesses how the user can attain his objectives with accuracy and completeness.

Efficiency assesses the resources expended in relation to the accuracy and completeness by which users achieve goals.

Satisfaction assesses user's satisfaction with a product or system in the context of use.

Freedom from risk assesses the degree to which a product or system counters the risk.

Context coverage assesses the degree in which a product or system can be used with effectiveness, efficiency, freedom from risk, and satisfaction in both specified contexts of use and in contexts beyond those that are initially identified explicitly.

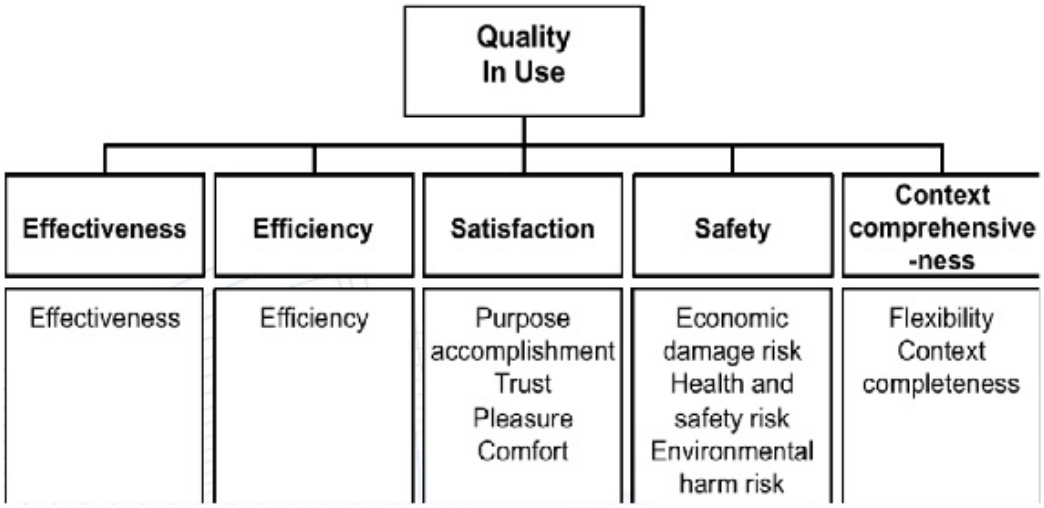

Figure 15: Quality in use model [37]

Data quality model

The data quality model in the Software product Quality Requirements and Evaluation (SQuaRE) is SO/IEC 25012:2008 Software engineering. This model can be used to establish data quality requirements, define data quality measures, as well as to plan and perform data quality evaluations.

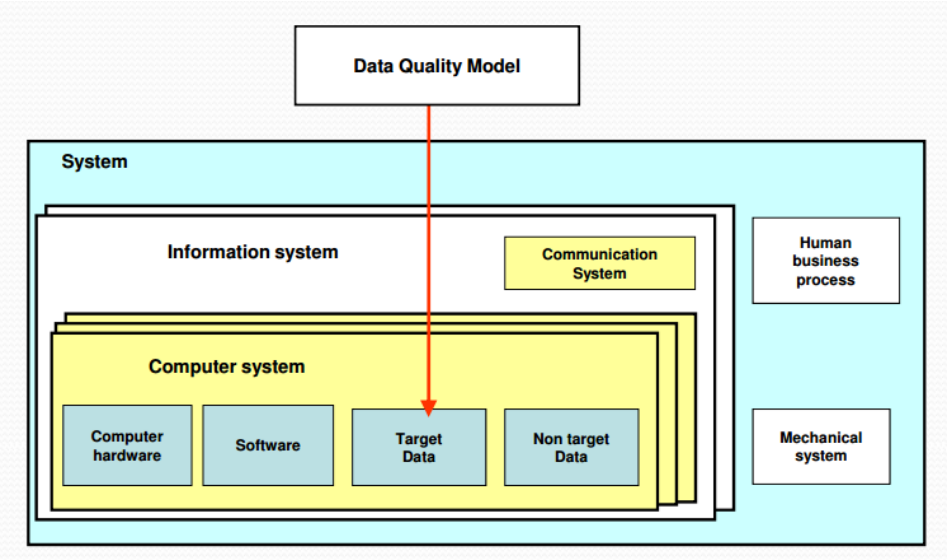

Figure 16: Data quality model in SQuaRE [46]

The International Standard focuses on the quality of the data, as retained in a structured format within a computer system and defines for the target data (**Figure 16**) its quality characteristics. The non-target is data, which is not supposed to be considered.

7. Data & Methodology

The primary goal of the study is to develop a method that will improve enterprise software usage in SMEs, in addition to clarifying the integration of their enterprise software into organization by evaluation its coverage and user satisfaction. The research was performed in two stages: running a survey and implementation and testing of the proposed quality evaluation method in the SMEs. The following sections explain both stages in details.

7.1. Survey

The first stage of the research was to perform a survey in order to understand SME's attitude towards enterprise software evaluation in Kazakhstan as well as analyse the users' satisfaction with the enterprise software support. In order to do this a survey was conducted. The survey, consisting of 29 questions, was applied in the Kazakh SMEs in March 2016.

Online sources of public information were used for enterprises selection, which were randomly selected and grouped according to the industry's share in the total economy, using the data from the Committee on Statistics of Kazakhstan (KazSTAT) [27] (**Figure 17**, **Table 8**).

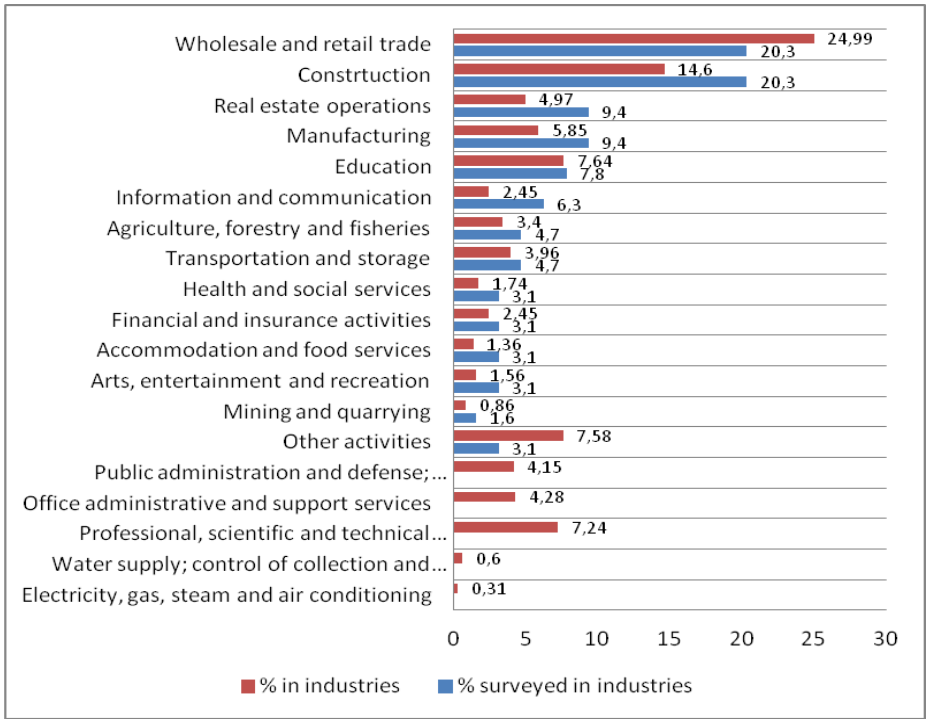

Figure 17: Number of surveyed respondents related to industries, Source: own.

Eleven regions out of fourteen were represented in the survey (see **Table 8**).

Region	#of surveyed enterprises
Astana city	8
Almaty city	20
Akmola region	1
Almaty region	7
Aktobe region	2
West Kazakhstan region	2
Zhambyl region	2
Karaganda region	11
Kostanay region	4
South Kazakhstan region	4
East Kazakhstan region	3

Table 8: Regions represented in survey, Source: own

The respondents, who worked with software, were found on the website of the Committee of Statistics of Kazakhstan and the survey was conducted by telephone. Out of 64 organizations that participated in the survey, only 55 organizations, from various industries that utilised a total of 77 software, were analysed.

Structuring the interview allowed me to optimize the questions to gain more results and incur less time spent. Another advantage was that the respondents were able to provide answers that were reliable to a great extent without concern of external factors. My initial attempts to run the survey through other means, such as social websites and emails, showed that the respondents did not understand the questions clearly.

The main questionnaire consisted of 29 questions, which were divided into three groups:

- Main
- Additional
- General

The structure of the Main questions for the interview is in **Figure 19**. Additional questions were asked in a formal form prior to the Main questions. Information for General questions was mainly collected from the internet and state resources, and were later confirmed by respondents. Different people in each organization who operated with the enterprise software collectively evaluated their experience with it. At least two respondents answered from each organization. At scale answer type the respondents had two steps to define the scale (**Figure 18**).

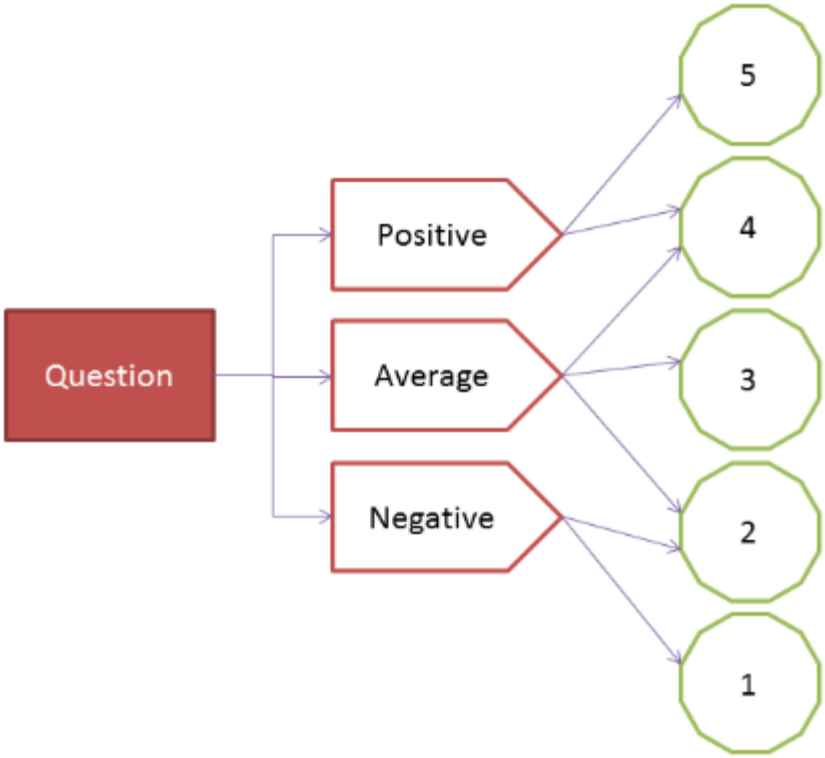

Figure 18: Scale defining, Source: own.

The tables below describes questions and the answer types to them.

Main questions	Answer type
Enterprise software existence	**Yes/No**
Software name	**Arbitrary**
Efficiency rate	**1-5 scale**
Understanding rate	**1-5 scale**
Satisfaction rate	**1-5 scale**
Software evaluation	**Yes/No**
Evaluation specialists	**List**
Evaluation frequency	**List**
Evaluation method	**List**
Reason of evaluation/no evaluation	**Arbitrary**

Table 9: Main questions, Source: own.

Additional questions	Answer type
Respondent range	**Manager/Employee**
Respondent type	**IT specialist/End-user**
Maintenance type	**Internal/External/No**
Ownership	**Private/Government/Foreign**
Future demand on specialists	**Arbitrary**
Software selection	**TopM/ITdep/WorkDep/Collective/ExtCon**

Table 10: Additional questions, Source: own.

General questions	Answer type
Organizations name	**Arbitrary**
Region	**List**
Industry	**List**
Phone contacts	**Arbitrary**
E-mail	**Arbitrary**
Website	**Arbitrary**
Short description	**Arbitrary**
Number of employees	**5-50/51-250**
Software description	**Arbitrary**
Software developers	**Arbitrary**
Software website	**Arbitrary**

Table 11: General questions, Source: own.

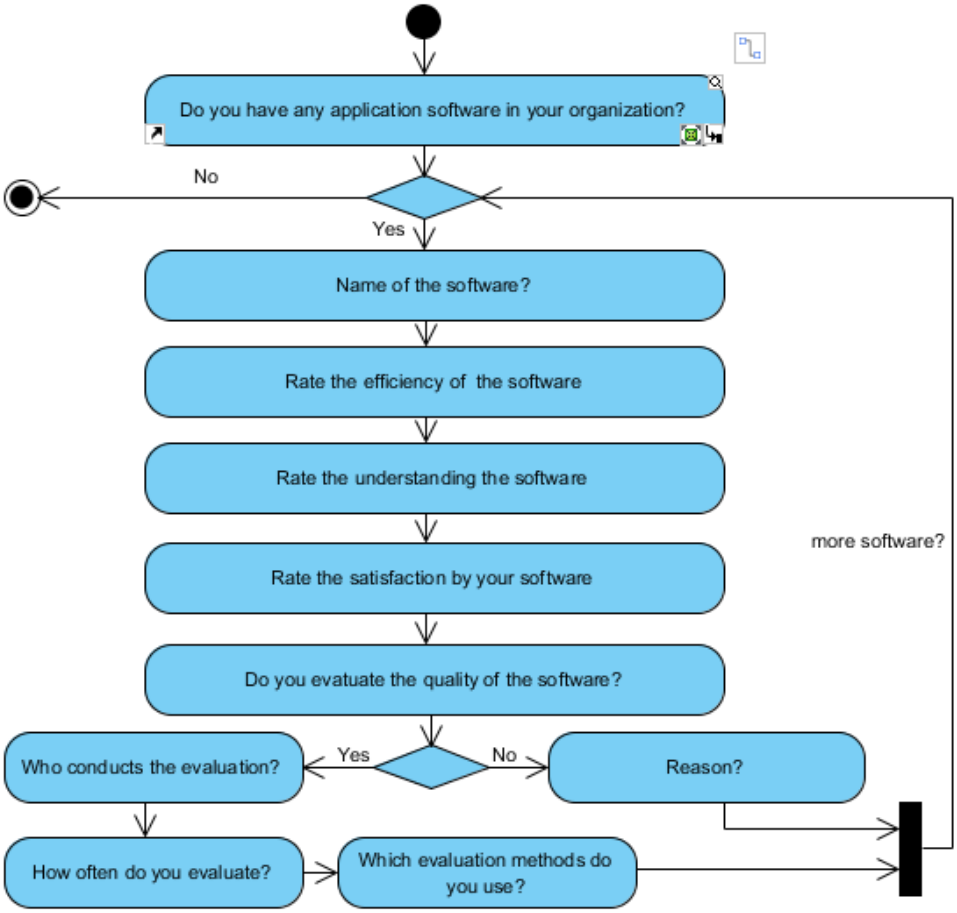

Figure 19: Structure of the main questions of the interview, Source: own.

Figure 19 describes the rationale behind the asking of the main questions. There were two decision points where the respondent can turn to distinct direction. If the respondent did not have any software in his organization, the arrow goes to the exit.

Figure 20 describes the structure of the tables in the database of survey and relationship between them. The table's category of Software contains the answers about the software. The table's category of Respondents contains all information about the respondents.

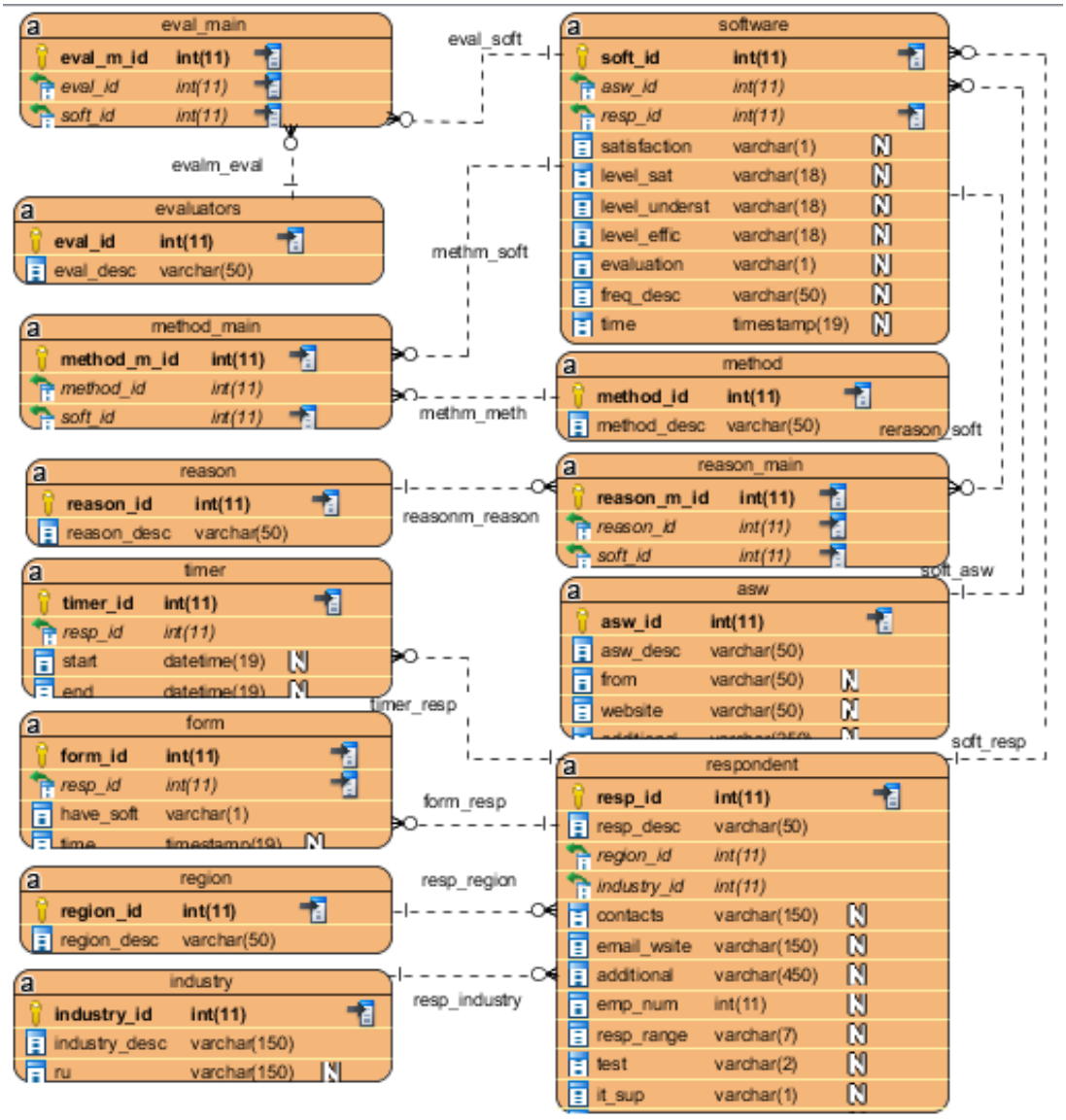

Figure 20: Table structure of the survey, Source: own.

The respondents were divided into two Groups: Group A - the managers and Group B – the ordinary employees. Each Group has been asked to rate their satisfaction with the enterprise software by answering three prepared questions, which were an additional part of the main questionnaire. Additionally, organizations were divided into three Types according to their service support types.

Three indicators were used for the evaluation by the respondents: satisfaction with software, understanding the software, efficiency of the software. In addition, three types of support were considered. The first was where enterprises have IT department or a person in charge and the users took the support continuously. The second type, which is called IT-outsourcing, is where the organization has external IT support due

to having a state contract with external IT support Company. The third type is the enterprise, which could also have external support, but does not have a defined IT support organization or person in charge. They pay their bills only when issues occur. To study research findings, the statistical analysis such as t-test and ANOVA test were applied.

7.2. The method to evaluate enterprise software

The second stage of this research was to develop, implement and test an optimized method for software product quality evaluation. This method is intended to offer an optimized evaluation approach to the interested stakeholders, which will be applied specifically at the operational phase. This phase presents the actual interaction of the organization with the software. Therefore, the evaluation during the operational phase can support in the decision-making processes in the subsequent phases of the software lifecycle. Furthermore, it appears to be crucial in the achieving of software optimization. Large enterprises regularly perform the evaluation of the various enterprises' software during the operational phase, as a part of the company's whole IT system evaluation, which beneficial to their businesses. This is unlike SMEs, where the enterprise software can be the only one or the main IT system. Thus, it seems to be beneficial for SMEs to evaluate the software at the operational phase. However, they usually do not evaluate their software due to lack of specialists within the organization and additional expenses that may incur. Therefore, the proposed method in this research tend to eliminate the costs associated with software evaluation.

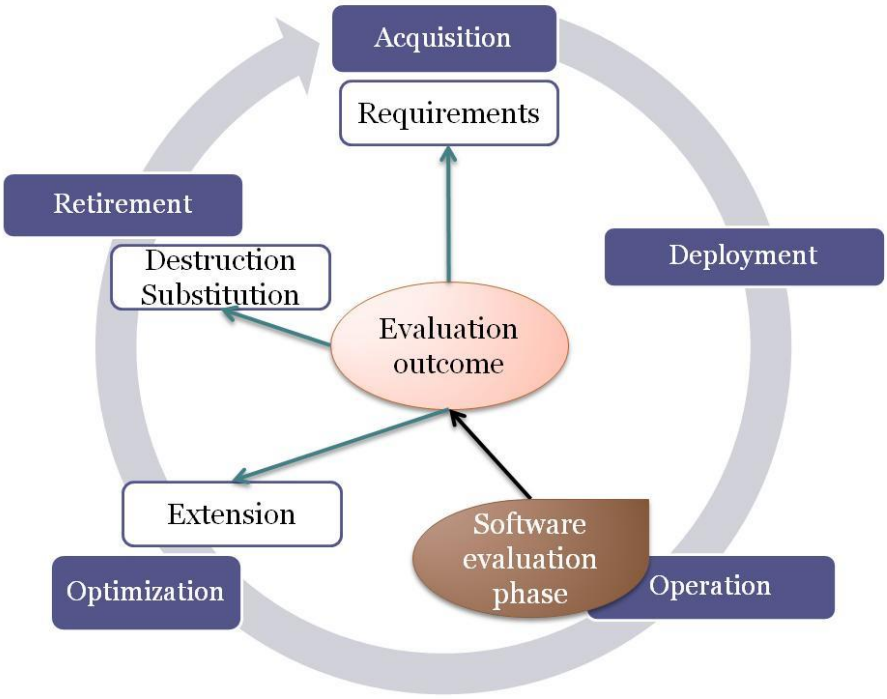

Figure 21: Identification of the evaluation phase, Source: own.

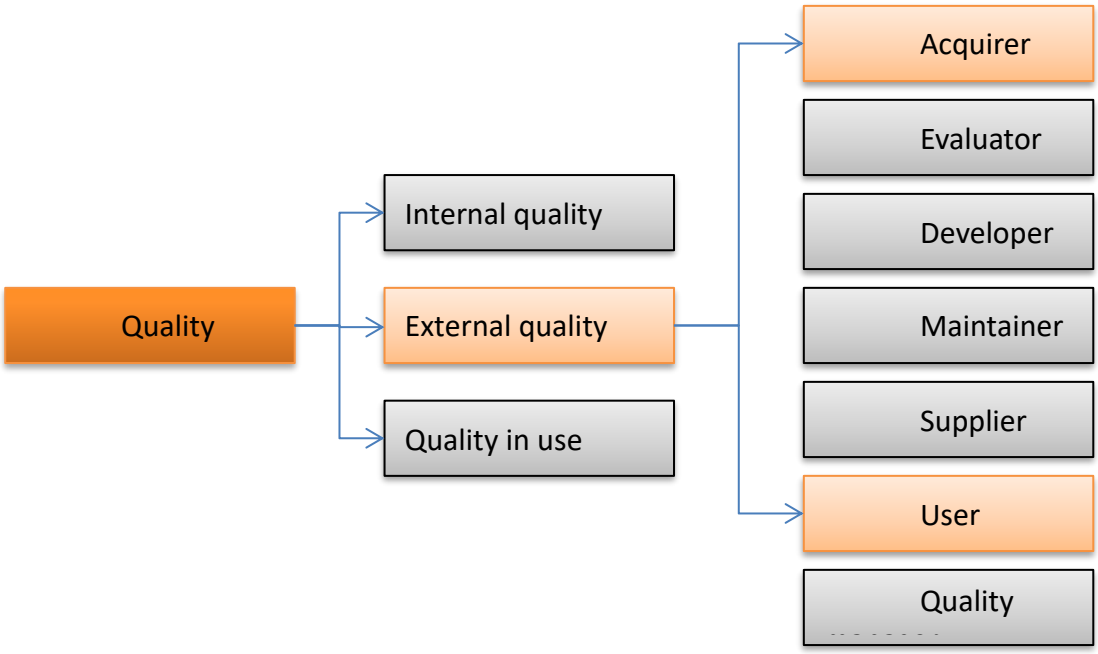

Figure 22: The intended users of the proposed method (highlighted in light orange), Source: own

In the **Figure 22**, we can see the users of software who are supposed to use the proposed method. The primary users of this method are managers, analysts or strategic planners in SMEs. For the acquirers, the method can be suitable for use in a trial period of software usage. Also, it is possible to examine existing software to avoid its limitations in future acquisition. Only the external quality of software was taken into account as the main evaluation parameter for the users. The internal parameter is more suited to the needs of software developers, not the final user of the product. The parameters of quality in use have less relation with product quality itself, as it is mostly concerned with the influence of the software on the environment.

Defining the parameters to evaluate the software consisted of three phase (see **Figure 23**). In the ISO 25000, parameters are known as characteristics, or sub-characteristics.

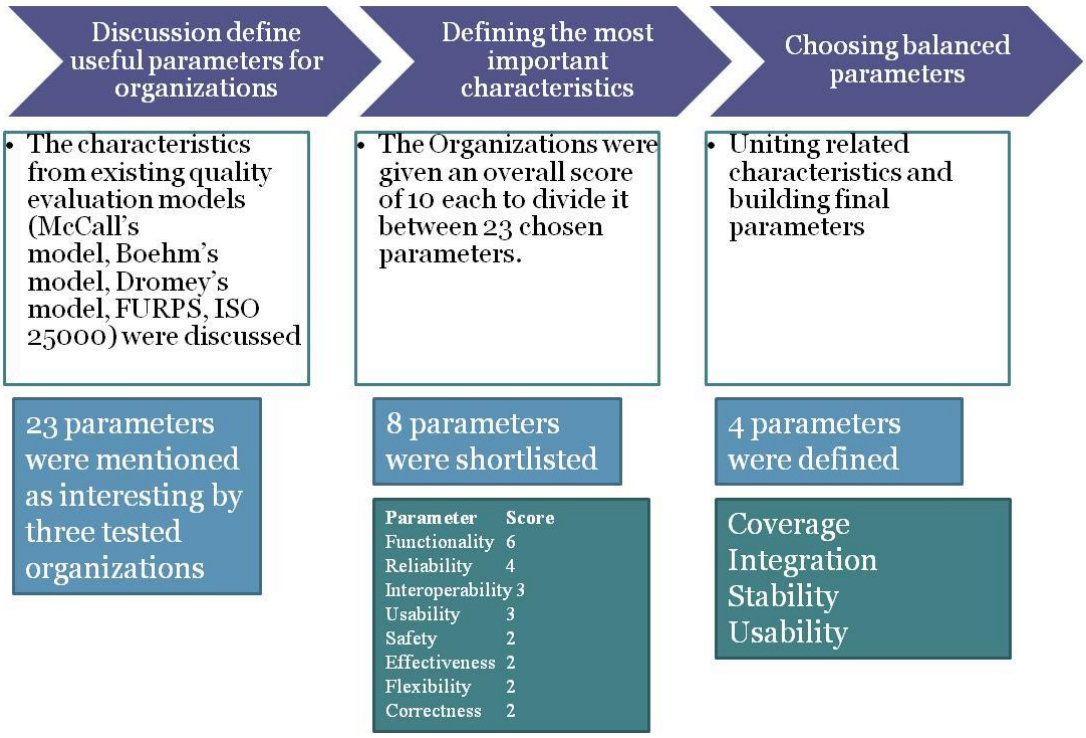

Figure 23: Stages of choosing parameters, Source: own

The organizations were given an overall score of 10 each to divide it between parameters. As such, there was eight shortlisted parameters remaining (**Figure 23**). The others had 0 or one score.

After further discussion of eight shortlisted parameters, which received the highest rates from the three organizations assigned for the test, it was decided to unite

some of the closer parameters in order to optimize evaluation process by reducing the time spent by users. Reliability and safety were united into Stability. The attributes of other three parameters were split between Functionality and Interoperability, which become Coverage and Integration parameters. The eventual four testing parameters were:

- Coverage
- Integration
- Stability
- Usability

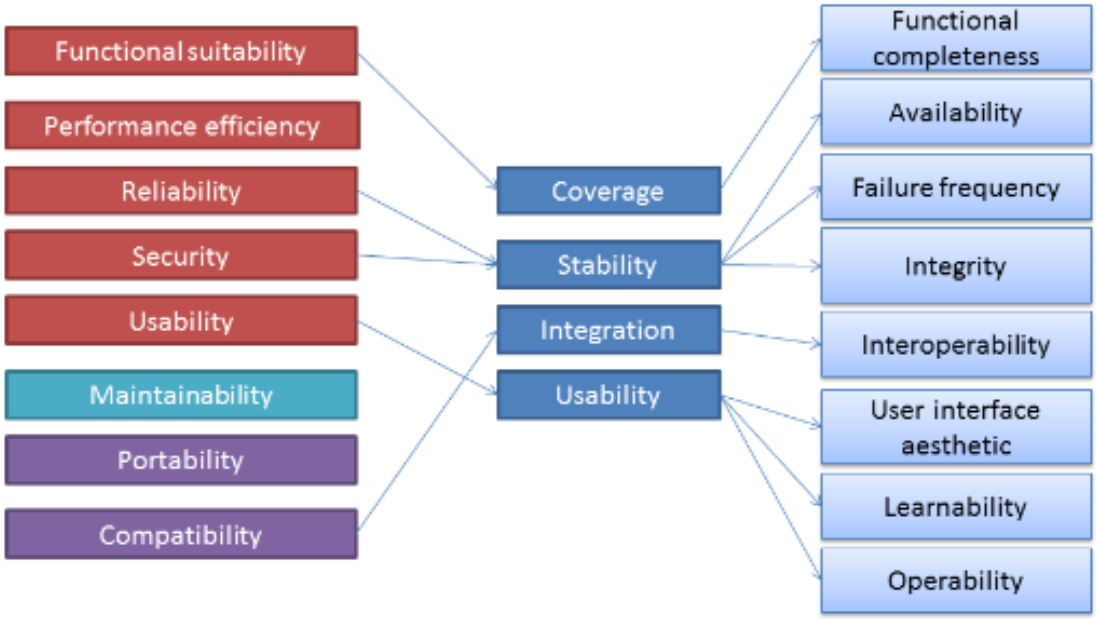

Figure 24: Adaptation of ISO 25000 software product evaluation characteristics and sub-characteristics for SMEs, Source: own.

The measurement parameters are based on the characteristics of pre-existing quality models which were described in the sixth chapter. A quality measurement procedure should be the external quality of software products.

In the **Figure 24**, the described relationship of the current model has the quality characteristics of ISO 25000. The proposed model is based on ISO 25000 specifically for the evaluation of the enterprise software of SMEs.

The **Table 12** describes measurement functions and quality measurement elements for chosen parameters. The formulas were based and modified from the

formulas used for ISO 25000 characteristics. Relationship with the ISO 25000 characteristics was described in **Figure 24**.

Name	Measurement function and QMEs:		Method
Coverage of SME's functional objectives by enterprise software	$x_{cov} = \frac{c}{s}$	s = Number of functional objectives of SME that expected to be covered by enterprise software. c = Number of functional objectives which are actually covered by enterprise software. The value can be in double format.	Measure functional coverage
Stability of the system	$x_{st} = 1 - \frac{1}{d}\sum_{i=1}^{d} v_i$ Where : $v_i = \frac{1}{k_i}\sum_{s=1}^{k_i} w_{s,i}$	v = sum weight of errors d = monitored days. k =number of incidents. w = weight of error per day	Measure errors
Usability	$x_{us} = \frac{c}{n * m * q}$	c = sum of answers scores n = number of interviewers q = Number of questions m = Max point of questions	Questionnaire

System **Integration**	$x_{int} = \frac{\text{Ps}}{\text{Pi}}$	Ps = Sum of integrated software pairs Pi = Number of software pairs which have to be integrated	Measure integrated pairs

Table 12 Parameters and formulas of the proposed method, Source: own.

The proposed quality measurement formula is:

$$\text{q} = \frac{x_{cov+}x_{st} + x_{us} + x_{int}}{y}$$

Where:

- x_{cov} = Coverage by enterprise software SME's objectives
- x_{st} = Stability of the system
- x_{us} = Usability
- x_{int} = Integration
- y = number of measured elements (number of x)

As can be seen, Coverage and Integration are based on the organization's expectations, whereas Stability and Usability are related to user experience.

There was a difference in scoring the organization's expectation and experience. Expectation can point out the absence of some needed features, while user experience is considered as what it is already available.

There was the used principle, which is described in SQuaRE as "every quality measure [that] employs its measurement function which normalizes the value within 0.0 to 1.0 and makes it interpreted that the closer to 1.0 is better" [44]. The following sections describe the functions and quality measure elements with some examples for four proposed parameters.

Coverage by enterprise software of SME's functional needs

The formula for coverage of SME's functional needs by enterprise software (explained in **Figure 1**) variables are:

- number of functional objectives of SME, which are expected to be covered by enterprise software (variable s) and

- a number of functional objectives which are covered by enterprise software (variable c).

The goal of evaluation of this parameter is to define the needed features of software for the organization and analyse how the software actually covers them. The issue is that definition of the features varies. Sometimes it is difficult for users to determine their needs, and even if they can, it is difficult to identify where that requirement might belong.

$$x_{cov} = \frac{\mathrm{c}}{\mathrm{s}}$$

s = number of functional objectives of SME should be covered by software;

c = number of functional objectives which are actually covered by software.

For example:

s = 15

c = 11

$$x_{cov} = \frac{11}{15} = 0.73$$

With the result being 0.73, it demonstrates that while most functional objectives of the organization are covered, there are still some functional objectives that are uncovered.

Stability of the system

Stability of the system in the wide sense is taken to mean the reliability, availability, as well as the maintainability of the system in question. These factors make the system stable, thus contributing to its stability. It should be noted, that the term "Stability" in context of this work is not related to the term "Stability" as defined in ISO 9126. According to Cambridge dictionary, "Stability is a situation in which something such as an economy, company, or **system** can continue in a regular and successful way without unexpected changes" [47]. This definition the best fits the Stability parameter that is being tested in this research work.

To analyse this parameter we track incidents that occur during operation of the enterprise software. Then, we analyse these incidents and define them as error, which

can be taken to be a fault that has occurred in the functioning of the system. Also, we analyse the log file of the software to include missed incidents, as all the incidents must be stored in the database.

In the INCIDENT_REGISTRY table (**Figure 37**) of the application database, incidents are the faults that occur during system operation. In ERROR table, incidents are classified into five levels with an increasing weight of incident from level to level, on scale from 0 to 1, where 1 meaning the failure (**Table 13).** Significant fault/error would mean a failure of the software, which would receive maximum points.

Levels of incidents (faults)	Weights
Fault level 1	0,2
Fault level 2	0,4
Fault level 3	0,6
Fault level 4	0,8
Failure	1

Table 13. Incident levels

It is important to have a database of enterprise software errors related to the organisation. The incidents can be related to:

- Data issues
- Application issues
- Hardware issues
- Security issues

The main table is the INCIDENTS REGISTRY, where the trackers register their occurred incidents. For the first round of measurement, the description of error should be written into the field marked UNKNOWN_ERROR, as the table ERROR is empty. After the monitoring period is over, we can use the UNKNOWN_ERROR field to classify incidents into errors. For the next round of measurements, we will have the "known errors" with the defined weight in the ERROR table. It allows us to avoid double-weighting. For the second measurement, we write DATE and choose the ID of the error from the ERROR table. If we cannot find an error in the ERROR TABLE, we write a short description of the problem in the UNKNOWN_ERROR field and leave the ERROR_ID empty. When the monitoring period is over, we repeat the operation of error classification.

The trackers can be the end-users or support-services. Also, we should use log files of software to analyse missed errors. It is often the case that SMEs users are not enough qualified. Therefore, they do not have a strict command to identify the errors. They can write description into the UNKNOWN_ERROR field when they have doubts.

The formula of system stability:

$$x_{st} = 1 - \frac{1}{d}\sum_{i=1}^{d} v_i$$

x_{st} = stability of the system

d = monitored days

v_i = sum weight of errors, with i = number of errors, calculated as:

$$v_i = \frac{1}{k_i}\sum_{s=1}^{k_i} w_{s,i}$$

Where:

k = number of incidents

w = weight of errors, (on the scale 0 to 1)

Example:

Incidents' weights grouped by days:

Day	Weight
1	0,5
2	0,7
3	0,2
4	0,5
5	0,2
6	0,4
7	0,2
8	0,1
9	0
10	0,2
11	0,6

12	0,2
13	0,4
14	0,5
15	1,1
16	0,4
17	0,5
18	0,2
19	0,1
20	0,1
21	0,3
22	0,3
Total	7,7

Table 14. Example of incidents calculation, Source: own**.**

Example (as per **Table 14**):

$$x_{st} = 1 - \frac{1}{d}\sum_{i=1}^{d} v_i = 0.74$$

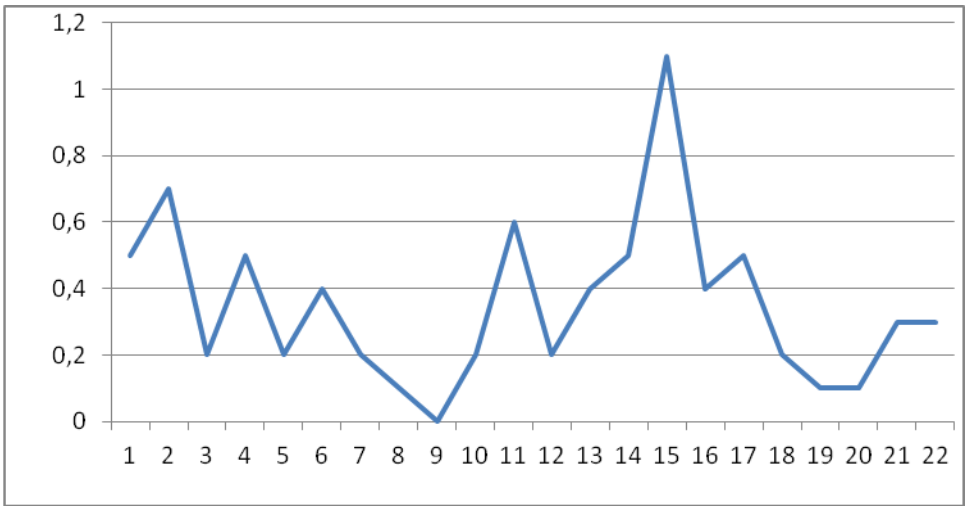

Figure 25: The figure shows distribution of incidents weights for each day, Source: own.

The following tables and figures provide us information about categories of problems and departments where problems are more frequently appear.

Departments		Categories	
Management	0,6	Data	1,9
Sales	2,5	Application	2,4
Accounting	1,9	Hardware	2,8
HR	1,8	Security	0,6
IT	0,9		
Total	7,7		7,7

Table 15: Sum of incidents weights by departments and categories, Source: own.

Figure 26: Sum of incidents weights by departments, Source: own.

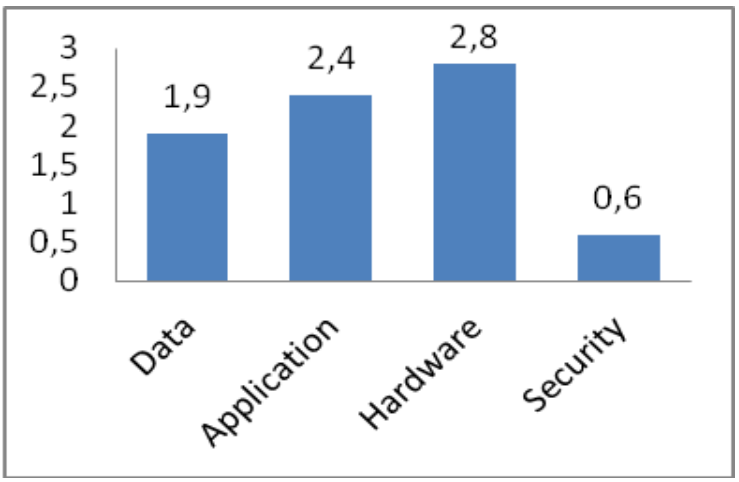

Figure 27: Incidents weights by categories, Source: own.

Usability

ISO 9241-11 emphasizes that the visual display's terminal usability is dependent on the context of use and that the level of usability that is achieved will depend on the specific circumstances in which a product is used. The context of use consists of the users, tasks, equipment (hardware, software, and materials), and the physical and social environments, which may all influence the usability of a product in a working system. Measures of user performance and satisfaction assess the overall work system. As such, when a product is the focus of concern, these measures provide information about the usability of that product in the particular context of use contextualised by the rest of the work system.

Name	ID	Description	Measurement function and QMEs	Method
Comfort scale	SCO -G-1	How comfortable is the user?	X = A/B A = questionnaire producing psychometric scales B = population average	Questionnaire

Table 16: Measurement example from ISO 25000 [44]

The **Table 16** shows example of measurement function for Comfort scale in ISO 25000.

The effects of changes in other components of the work system, such as the amount of user training, or the improvement of the lighting, can also be measured by user performance and satisfaction. However, these steps are not considered in this research.

While surveying the user experience, we consider the subjective opinions of employees.

The calculation formula is:

$$x_{us} = \frac{\mathrm{c}}{\mathrm{n} * \mathrm{m} * \mathrm{q}}$$

Where:

x_{us}- usability

$\mathrm{c} =$ sum of answers scores

$\mathrm{n} =$ number of interviewers

q = number of questions.

m = max point of questions. It is 10 here. Each answer can have a scores grade from 1 to 10.

Example:

As an example, we have 6 interviewers.

Interviewers	Suitability for the task	Self-descriptiveness	Controllability	Conformity with user expectations	Error tolerance	Suitability for individualization	Suitability for learning	Total
Int1	6	9	4	7	7	6	7	46
Int2	8	10	5	8	4	5	6	46
Int3	7	6	5	7	5	5	6	41
Int4	5	8	5	6	4	6	9	43
Int5	7	6	3	4	4	7	8	39
Int6	9	9	7	6	6	8	7	52
Total	42	48	29	38	30	37	43	267

Table 17: Example with interviewers, Source: own**.**

The seven selected indicators were chosen based on the manner in which they affect the usability of software. The grading scale for these indicators is 1-10, where 10 is the best result.

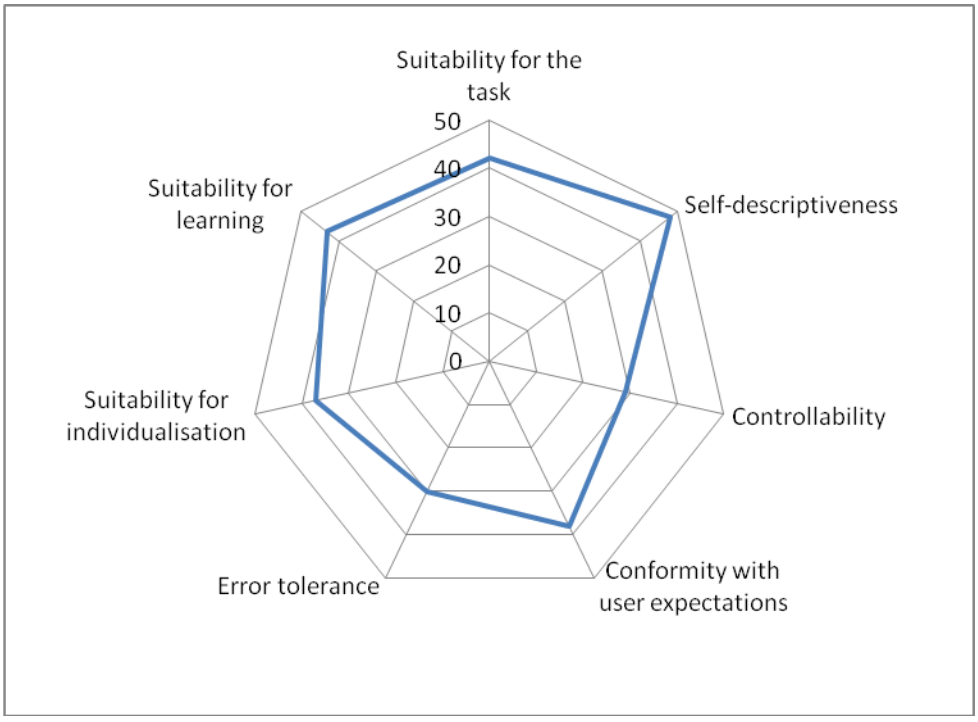

Figure 28: Grading by the interviewers of the indicators for Usability parameter, Source: own.

The **Figure 28** illustrates that the level of users' satisfaction with software's Usability parameter is more than half out of the total possible (60 is possible total in the example). Such a result would require further investigation and a detailed analysis of users' scores to identify the weaker areas of the system.

Integration

All the connections can be related to the enterprise software. The NAME in the **Table 18** refers to the specific task. As is shown in the table there can be internal and external connections. For example, if one functional task uses the results of another, then there should be integration. However, the integration does not mean a complete relationship. Users can rate the tasks from 0 to 1. Where 0 is not integrated and 1 is fully integrated. The tasks can also be not integrated, but easy to do further actions on other legitimate software or system. For example, software can have ability to export data to the format required in other software. In that case users can rate task relationship as 0,6.

#		Internal		External			
	Task	Name	Task	Governmental	Task	Non-governmental	Task
1	NAME		NAME		-		-
2	NAME		-		NAME		-
3	NAME		NAME		-		-
4	-		-		NAME		-
5	NAME		NAME		-		-
6	-		-		NAME		-
7	NAME		-		-		-
8	-		NAME		-		-
9	NAME		-		-		NAME

Table 18: Example of integration with other software and systems, Source: own.

The integration can be calculated with the formula below:

$$x_{int} = \frac{\text{Ps}}{\text{Pi}}$$

Where:

x_{int} = Level of system integration

Ps = Sum of integrated software pairs

Pi = Number of software pairs, which have to be integrated

Example (as per the **Table 18**):

Ps =6 (already integrated pairs)

Pi =9 (need to be integrated pairs)

$$x_{int} = \frac{6}{9} = 0.66$$

In this example, the level of interaction is more than a half out of the expected total. Further investigation is recommended, to analyse specifics of non-integrated pairs.

Finally, after all four parameters are defined, the average sum of quality system components can be found as follows:

$$q = \frac{x_{cov+}x_{st} + x_{us} + x_{int}}{y} = \frac{0.73 + 0.74 + 0.63 + 0.66}{4} = \frac{2.76}{4} = 0.69(0.7)$$

Comparing to the perfect behaviour for the enterprise (PBE)

$$PBE = \frac{x_{cov+}x_{st} + x_{us} + x_{int}}{y} = \frac{1 + 1 + 1 + 1}{4} = 1$$

Since the goal of each organization is to reach the maximum that is closest to PBE, the result shown above (q=0.7<1) tells us that there are some limitations in the enterprise's software operational process.

#	Organization	Enterprise software	Quality
1	Firm M	X	0.69(0.7)
…	…	…	…

Table 19: The result of exampled organization, Source: own.

7.3. Application to collect the data (short description)

In this part, the application which was created to collect the data in organizations is described. The application was created for the simplifying the data collection process that could be easily analysed afterwards.

The application is originally developed in Russian language and it works through the local network. The users enter the data and it automatically analyses them using proposed software evaluation method.

Working on the software product began with a preliminary development of its user interface. The program must perform several data entering interface.

In the beginning, there was the idea to use web interface and put it on the internet to have permanent access to data from the Czech Republic, where I was at that time. However, a problem occurred inhibiting one of the organizations ability to regularly access the internet. Thus, it was decided to use an application that will work on the local network. I used object-oriented programming to develop the interface of our database. The database is on MySQL. In order to track data input by users, I had installed web service in two organizations, which had an internet access. It gave me easy access to data through the net and allowed to track the data collection process. The third organization with no internet connection sent me its backup.

To open the application user has to get an access first (**Figure 29**).

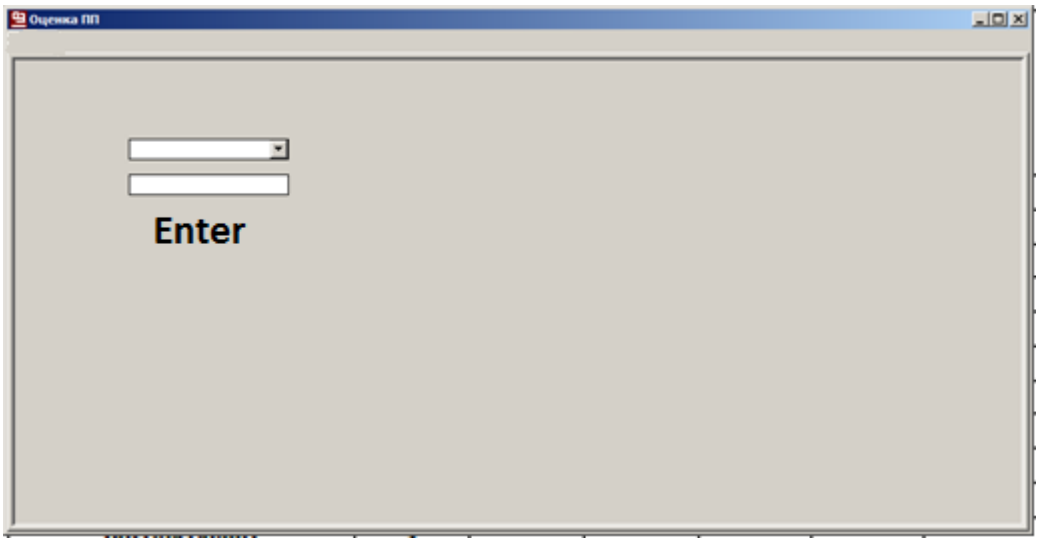

Figure 29: Access window of the application, Source: own.

The administrator, an author of this research, has the access window as in the **Figure 30**. In the first column of the administrator's window, the users can be added. For each user there fields with login name, password, position, access, and department. In the Access field, certain symbols can be typed, particularly: C, I, E, S. Each of the letters gives access to specific tab:

C – Coverage;
I – Integration;
E – Usability;
S – Stability;

For example, managers mostly will have an access to Coverage and Integration, while users will have an access to Usability and Stability. This is not a strict rule. The roles can be discussed and decided amongst the users through their own discretion.

On the right side of the window, there are the evaluation rounds. The administrator can stop current round and begin a new round whenever he decides to do so. It was suggested to keep one month for every round.

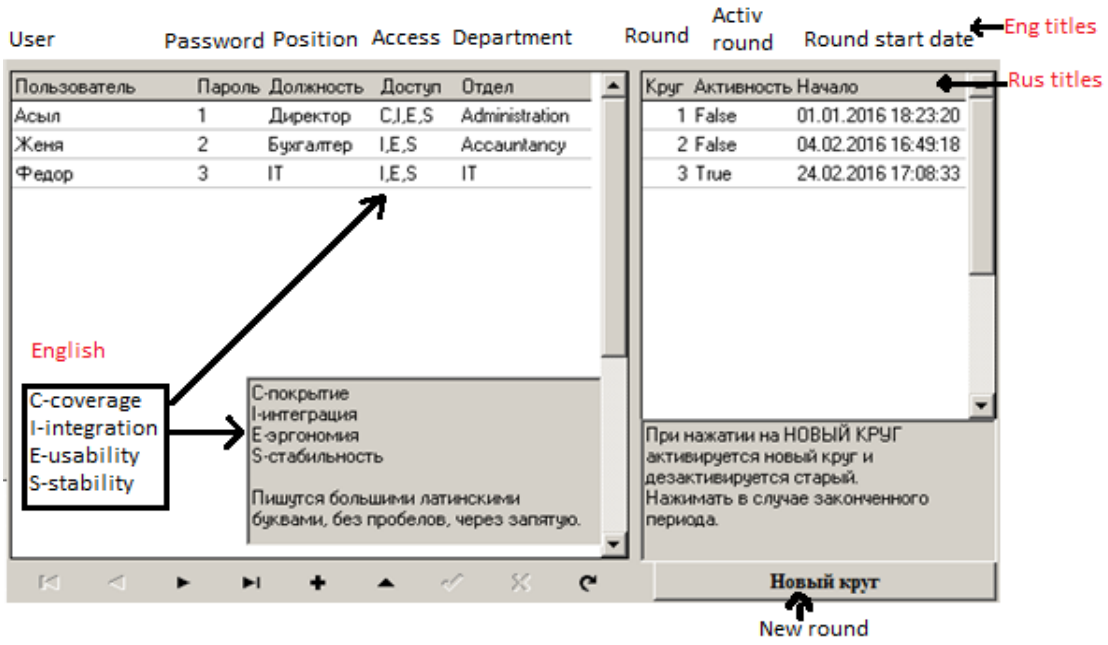

Figure 30: Admin window, Source: own.

Data input to the Coverage

In the **Figure 31**, the Coverage window can be seen (tab). On the top right, there is a link used where users can get information about what to do in this window. There are three fields has to be filled: process, weight (“covers?” field), and description.

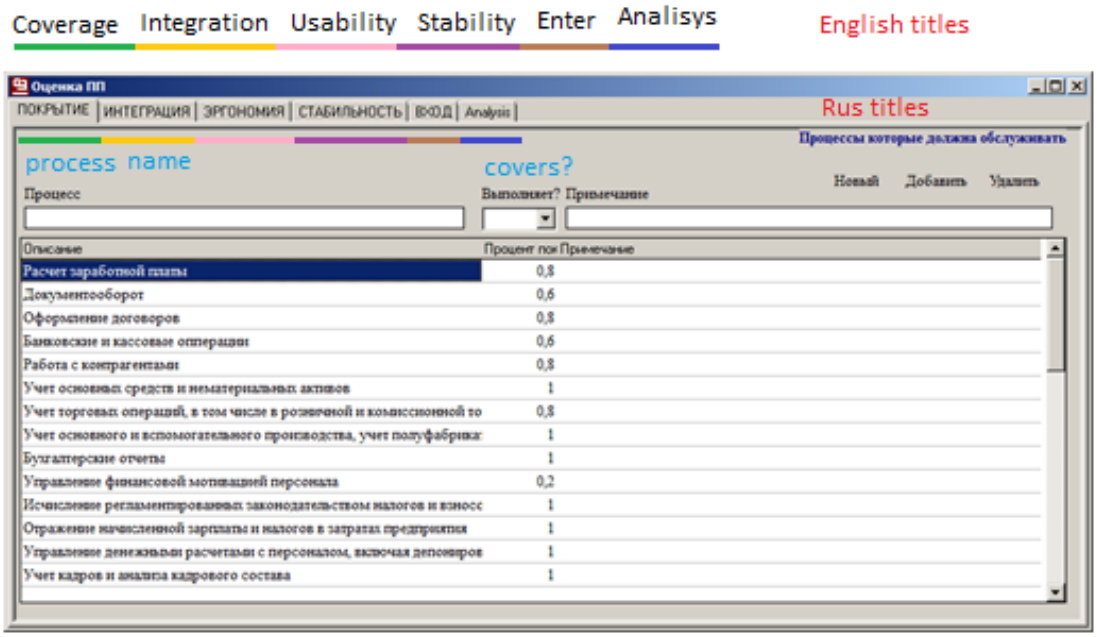

Figure 31 Coverage tab, Source: own.

The **Figure 32** is a description of the process.

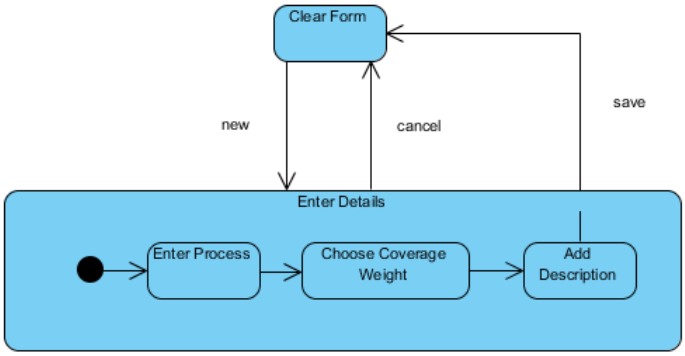

Figure 32: The process of data addition in the Coverage tab of the application, Source: own.

Data input in the Integration

In the **Figure 33**, the window of data addition into integration table can be seen.

There are also three fields has to be filled: task, concurrent application/system ("other software" field), and relation (yes or no, answer).

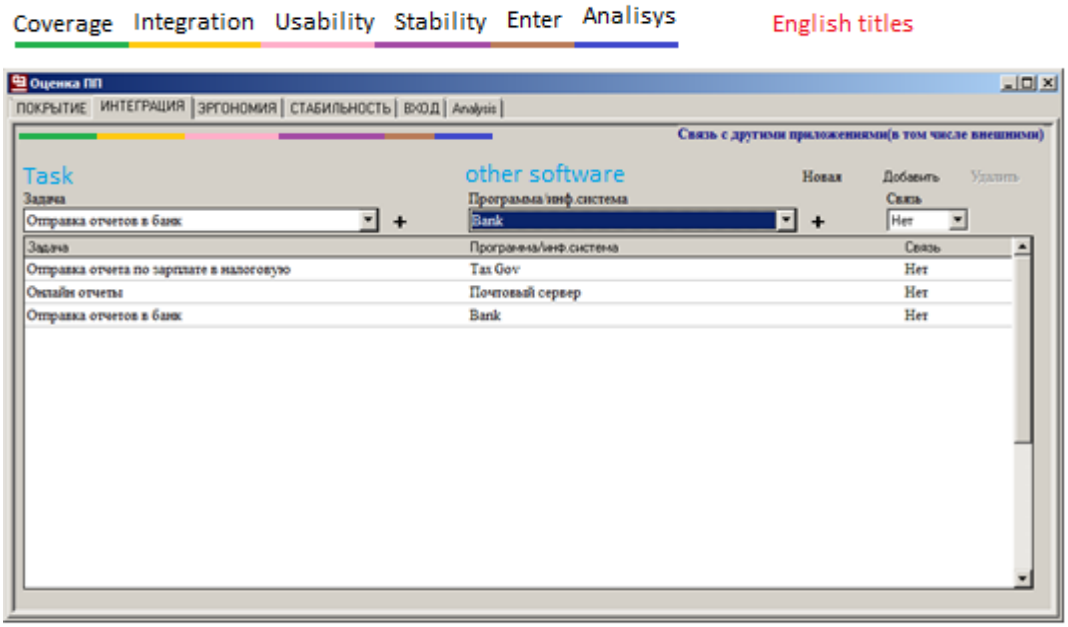

Figure 33: Integration tab, Source: own.

Data input in the Usability

The next part is where users can estimate the application by giving a score to the seven given parameters from 1 to 10 (10 – best). The seven parameters are

1. Suitability for the task
2. Self-descriptiveness
3. Controllability
4. Conformity with user expectations
5. Error tolerance
6. Suitability for individualization
7. Suitability for learning

They users allowed to miss some parameters if they think they are not ready or do not understand the question/answer.

The window for this part is shown in the **Figure 34**. On the top right, there is a link with an explanation about this page. The user can access that if he is unsure on what to do. In the window, there is a question and short explanation. There is a radio button with the scores. On the bottom left are the questions and the user's answers. The user can always go back and change the score using the arrows above the answering button.

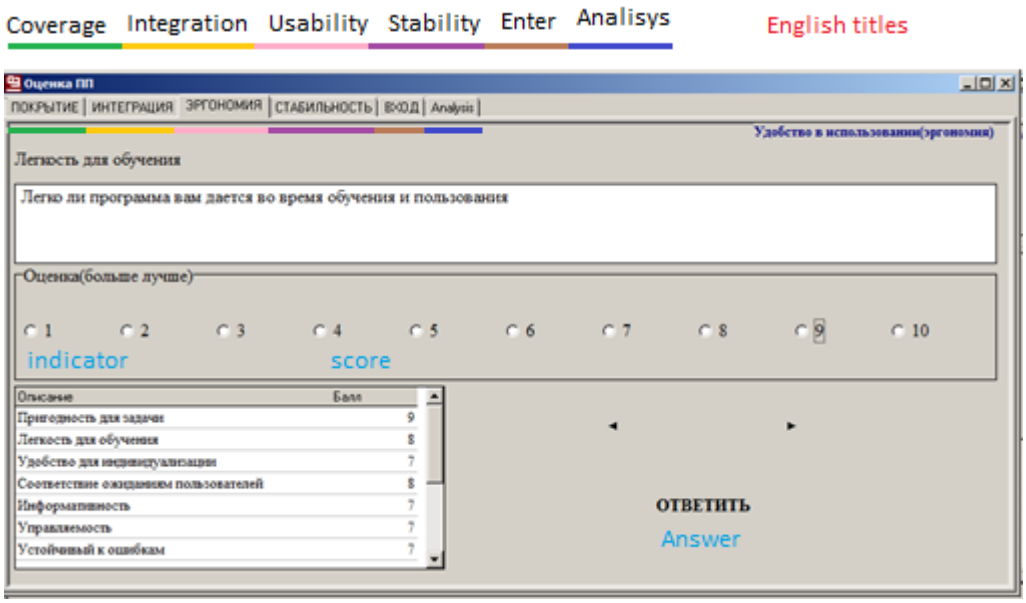

Figure 34. Usability tab, Source: own.

Data input in the Stability

This part is a familiar part for software maintainers. The goal of this part is to collect information about the incidents and errors, which happens during the software functioning.

In the beginning, it was planned to collect the data in three ways:

- User tracks the data
- IT assistant collects the data
- Use log files to the software

I used a combination of first and last points. Firstly, users track the data, and then I get the log files of the software and analyse what the users might have missed. The application always tracks errors that occur to it, but there is always a missed section, particularly when the user uses the application and faces the problems, which sometimes may not be recorded in the log files. This can be a fundamental problem with the understanding of the application.

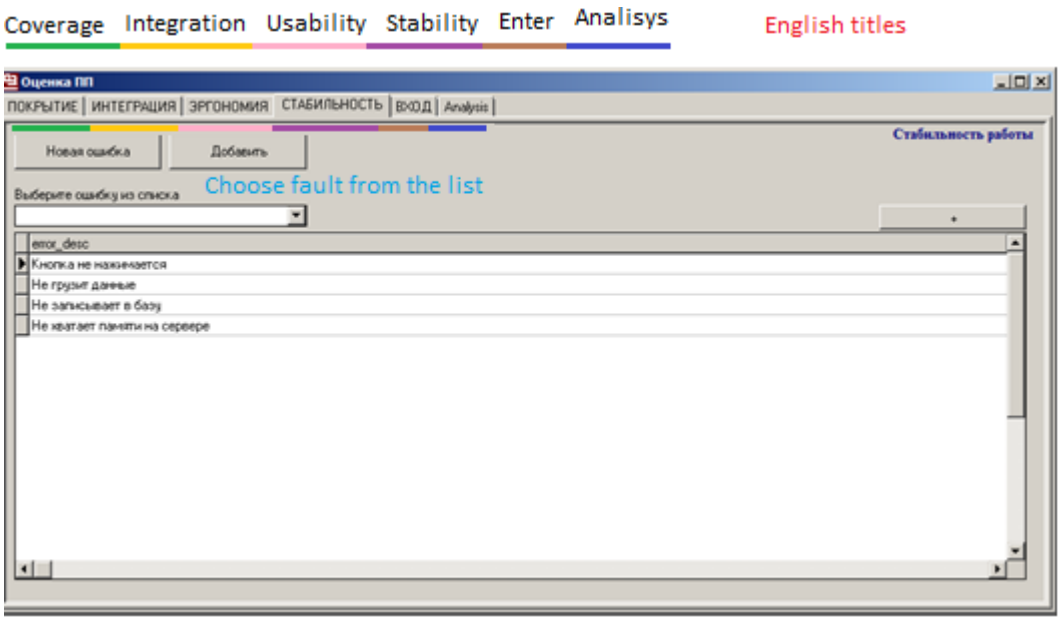

Figure 35: Stability tab, Source: own.

In the **Figure 35**, we can see the window for the stability section. Here, the user just chooses the incident or errors from the list. If he is unable find it on the list, he can add it using the + button on the right.

Finally, after all parameters are answered, the application performs an analysis of entered data, and provides the results in charts and tables (**Figure 36**).

As you can see in the **Figure 36**, there can be more than one round of measurement. The graphs are given in two ways: for every round individually, and for all of them comparatively.

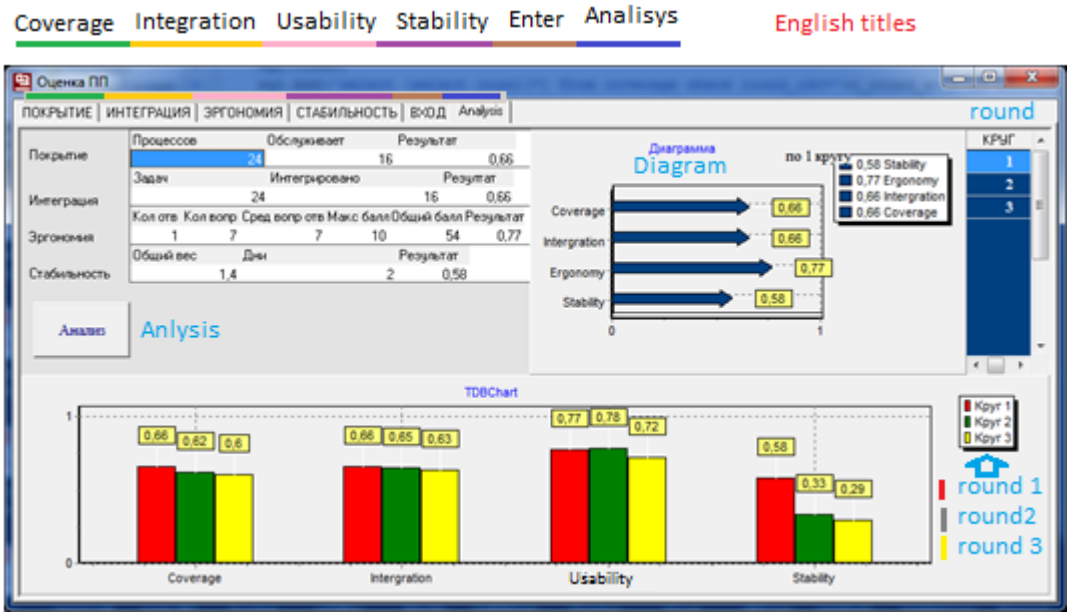

Figure 36: Screen of Application, Source: own.

Database for application

In the database, we have eleven tables. In the **Figure 37**, all the tables and relationship between them are described. There are four main tables: Incident registry (Stability), Usability, Coverage, Integration; and seven secondary tables.

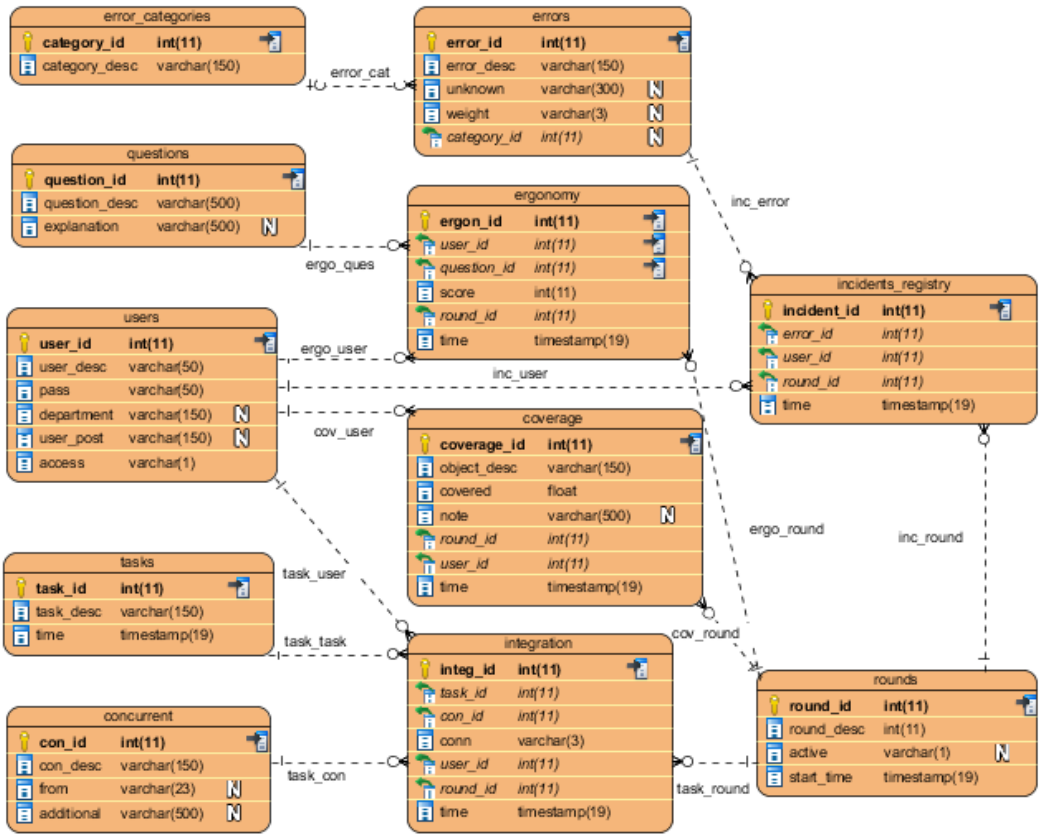

Figure 37: Structure of the tables, Source: own.

8. Experimental part

This chapter consists of the practical, or experimental, part of the paper where the survey was conducted for the purposes of propositioning a quality evaluation method to improve enterprise software use within SMEs in Kazakhstan. The results of the survey are discussed in detail in this chapter.

8.1. Survey results 1: Software evaluation by SMEs in Kazakhstan

The initial step of the experimental process was to clarify the SME's attitude towards enterprise software evaluation.

Table 20 shows us call statistics. One third of the organisations agreed to participate in the survey. Average speaking time with each person was about four minutes. Time which was spent in identifying the right person was not counted. Speaking time for main questions was less than three minutes. The same time was incurred when they were questioned and an elaboration of the questions was given.

Number of respondents answered	64
Number of organizations contacted	187
Average call time with participated respondents:	-00:04:03
Average time of answers to the main part of questionnaire:	-00:02:42

Table 20: Call statistics, Source: own.

The **Figure 38** shows that the most used software in the surveyed SMEs was the software for accountancy. The second place is taken by ERP. Hence, we can see that 11.5 % of respondents did not use any enterprise software.

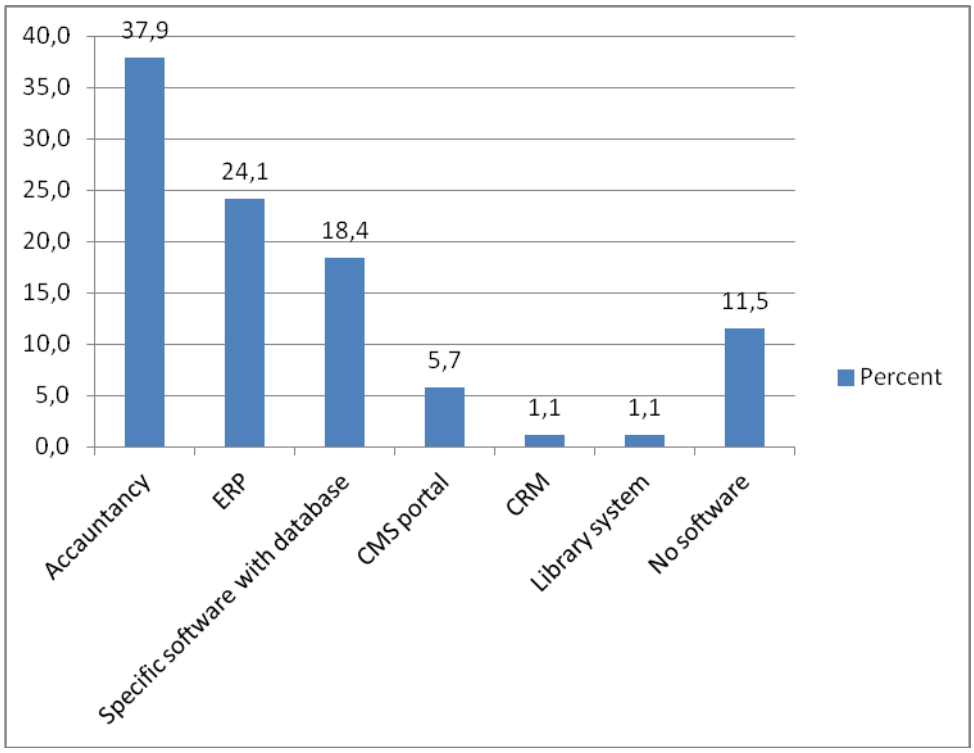

Figure 38: Software usage, Source: own.

The **Table 21** summarizes the feedback of the respondents on the fact if their organization does software quality evaluation, number of the unique software identified as well as respondents' estimates of their software in three given aspects: satisfaction, understanding and efficiency (on the scale from 1 to 5).

Evaluation	Organizations	Software	Satisfaction	Understanding	Efficiency
Yes	6	7	4,1429	4,4286	4,2857
No	49	70	4,1429	4,0429	4,1286

Table 21: Evaluation of software by the organizations, Source: own.

The results reveal that the understanding of the software is higher by 0.4 points in the organisations who does quality evaluation of their software (**Table 21**). Most companies who do not do any software evaluation considered this process as "not needed".

Selection	count
Top management	15
IT department	13
Working Department	13
Collective	23

Table 22: Software selection in the organizations

The **Table 22** describes the ratio of staff directly involved in software selection within the organizations. Most of the organizations in the list pointed that they collectively chose the software. However, on the other hand, we can see that the top management chooses which software to use in more cases than the department which directly works with that software or the IT department that will maintain that software. The latest may have unfair results in software satisfaction by its actual user.

8.2. Survey results 1: Discussion

According to results of the survey, the overwhelming majority of the small and medium enterprises use their software for accountancy needs.

The main part of the survey provides information that a vast majority of SMEs in Kazakhstan practically do not evaluate their software. Even if there is no statistically significant difference between two groups, the results show that software users in the companies that do the evaluation perform a higher understanding of their software compared to those who do not do evaluations.

Another important outcome of the survey is that organisations who evaluate their software do not use international standards. Furthermore, most of the organizations use their own staff and own methodology to run the evaluation process. Indeed, no one from the list of respondents used external specialists to evaluate their software or information systems. These facts may be a source of a low and biased evaluation results about the software's quality.

8.3. Survey results 2: Enterprise software support in SMEs of Kazakhstan

The objective of the second step was to assess the satisfaction of the users with the enterprise software support in the SMEs in Kazakhstan.

In the **Table 23**, the respondents are categorized by the types of software support services. Despite the fact that enterprises were chosen randomly, the distribution of organisations by support types turned up to be almost identical. The number of software decreases from organizations of Type X to the organizations of Type Z. This is due to the size of the companies. The majority of the respondents of Type Z are small enterprises, whereas Type X are predominantly medium-sized enterprises.

Types	Description	Number of organizations	Number of software
Type X	With IT department or person in charge	18	31
Type Y	With contract of external support	19	27
Type Z	With not defined IT support	18	21

Table 23: Types of software support, Source: own.

Next, the respondents were divided into two groups based on their employment position: Group A - managers and Group B –ordinary employees. the number of people in Group B was almost double bigger than the number of people in Group A due to the usual number of managers in the companies being less than employees (**Table 24**).

	Description	Number of surveyed
Croup A	Managers	18
Group B	Employees	37

Table 24 Groups of surveyed, Source: own.

Each Group in a different Type of organization has been asked to rate their satisfaction with the enterprise software by rating the following indicators: satisfaction by software, understanding the software, and efficiency of the software.

The results were as follows: the highest mean for each indicator in Type X was for Group A; all indicators for Group B received were higher than Group A in Type Y; and the third Type Z software support for Group B has shown the lowest rate under the "Understanding the software" indicator (**Table 25**, **Table 26**, **Table 27**).

	Group A	Group B

	Mean	Mean
Satisfaction by software	4.31	4.06
Understanding the software	4,38	4,19
Efficiency of the software	4,31	4,13
	4,33	4,13

Table 25: Results of Type X, Source: own.

	Group A Mean	Group B Mean
Satisfaction by software	4,10	4,12
Understanding the software	4,10	3,94
Efficiency of the software	4,20	4,06
	4,13	4,04

Table 26: Results of Type Y, Source: own.

	Group A Mean	Group B Mean
Satisfaction by software	4,17	4,13
Understanding the software	4	3,87
Efficiency of the software	4,17	4,07
	4,11	4,02

Table 27 Results of Type Z, Source: own.

According to the t-test, Type X had a significant difference between two groups. As for other two Types, there were no significant differences obtained. Summarized t-tests and p-values are shown below (M - managers, E – employees).

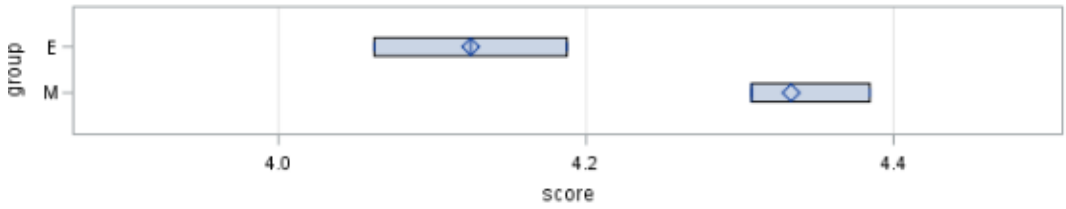

Figure 39: Result of Type X, t-test, Source: own.

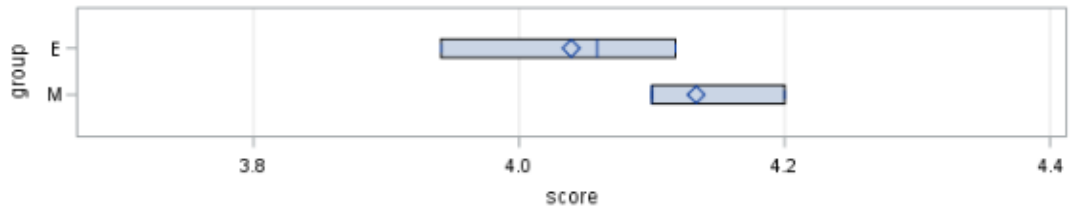

Figure 40: Type Y, t-test, Source: own.

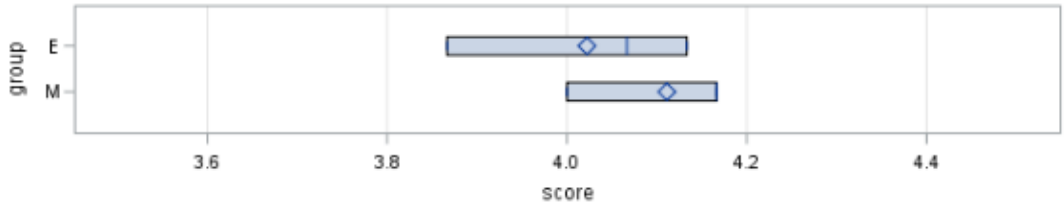

Figure 41: Type Z, t-test, Source: own.

	T-statistics	P-value	Results
Type X	4,706789709	0,00926168	Significant
Type Y	1,52699788	0,22420248	Not significant
Type Z	0,911857756	0,413428047	Not significant

Table 28: The result of t-test for Group A and B, Source: own.

The ANOVA test results for the means variations of the three Types of software support (X, Y, and Z) were not statistically significant.

F Value	**F Critical**	**P-value**
1,57	9,55	0,34167687

Table 29: ANOVA of three Types, Source: own.

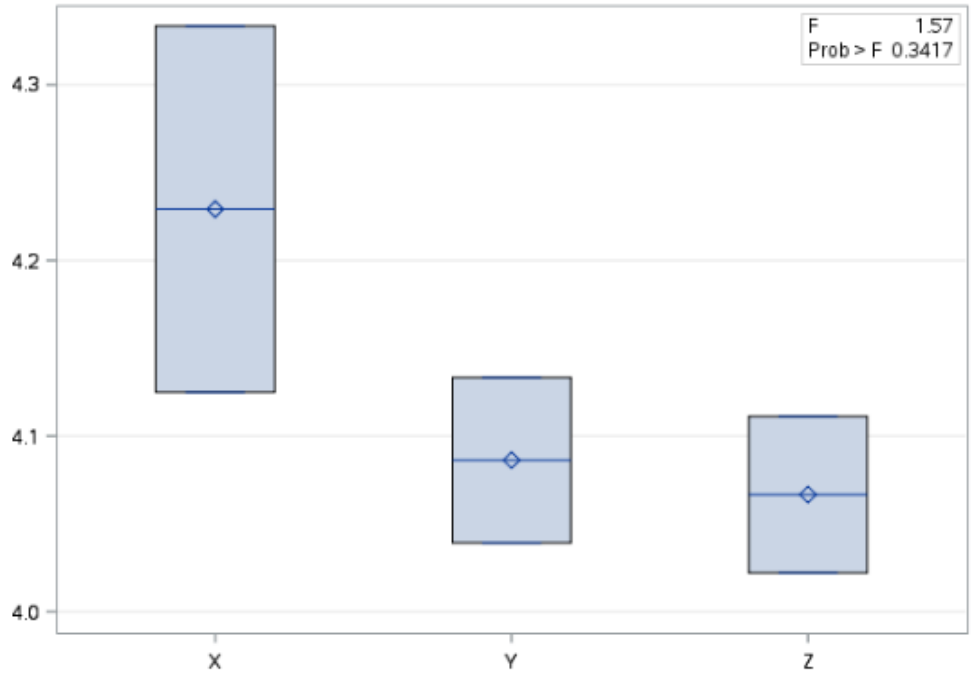

Figure 42: Comparison of three Types of support, Source: own.

In **Figure 42** we can see that Type X has wider evaluation variations and higher rates than the other two. Furthermore, it can be seen from the **Figure 42** that Y and Z Types of support had close rating levels.

8.4. Survey results 2: Analysis of data

One of the preliminary findings of the current study has shown that there was a significant variation in results between two groups for one of the three types of software support. However, despite the fact that there was some variation of the rates provided by two groups, this statistical difference is not considered significant for the three types of support.

It can thus be seen from the results of the survey that the difference between the three Types of support services is not significant.

The Type X software support, which stand for an organization with IT department or person in charge, had the highest rate. This demonstrates that the company's staff has regular access to the IT professionals and can receive their assistance at any time without deviating from the daily workload, thus contributing to higher productivity and better work performance. Despite the overall higher rating for Type X, the managers (Group A) performed significantly higher ratings than the

employees (Group B). This is further confirmed by the t-test results. One of the explanations could be in their decision-making position in the software procurement process. In addition, the managers have a main role in the selection regarding the type of support service.

The almost identical rating for Types Y and Z shows that there are no significant differences; regardless of whether a company has a defined outsourcing IT contractor or just receives non-specific external IT support. The only deviation in results for these two Types may occur due to the Type Z software support mainly consisting of smaller enterprises, whereas Type Y is representing more medium-sized enterprises.

Overall, it can be observed that almost all respondents were satisfied with their software. There were only few respondents who rated the proposed indicators below the passing grade of three out of five.

8.5. Survey results 2: Discussion

The 2015's currency devaluation and following economy downturn has greatly reduced financial capabilities of many companies in Kazakhstan. Currently, with the onset of problems within the Kazakhstan economy, many companies are looking for a way to reduce costs. The survey shows that the assessment of the differences between the internal, external and non-defined software support is not generally large. However, among three types of support, those organizations with on-going support are more satisfied. Thus, the use of internal IT support implies that these companies spend more money than the respondents with no permanent support.

This study can assist small and medium enterprises in determining what kind of support service they may prefer. The main factor regarding the choice of the Type of support software is the cost involved. Furthermore, for some companies, due to their size and the inconsistent use of software applications, there is no need for constant support of their applications. Correctly selected support can help a company find a balance between cost and quality. Indeed, it should be understood that in some cases, in the pursuit of savings, quality of work may suffer. Companies that constantly need support can seriously disrupt their business processes by trying to reduce costs through savings from IT maintenance. Thus, this study attempted to develop a new, cost-effective method of software quality evaluation method that was implemented and tested in three SMEs in Kazakhstan from July 2016 to March 2017.

8.6. Applying measurement method in the organizations

The second stage of the research was to develop an optimized cost-effective quality evaluation method that was then implemented in the pre-selected SMEs and tested. This part represents organisations that participated in research and displayed some analysis.

Identifying and getting to an agreement with suitable organization took about five months. Each organization agreed to present three rounds of evaluation. One round can take from one to three months.

The organisations selected for the research were operating in Kazakhstan. Two organizations are the participants of the survey taken before. The choice of organizations was based on the procedure of approaching a contact person within that organization, determining (if they have required software) if the organization was appropriate to study, and subsequently requesting permission to run the research in that organization. In exchange for access to certain firms and discussion of their processes, which required commercial confidentiality, I have agreed to hide their real names. Therefore the firms will be represented by abbreviations. The various types of firms were studied in order to increase the number of practices chosen by a variety of organizations. Short description of the organisations are presented in Annex 1. It should be noted that all three organisations used 1C Enterprise (1C ERP), which has the following functional modules[48]:

- Customer relationship management
- Sales and distribution management
- Retail management
- Supply Chain management
- Material resource planning
- Production management and planning
- Project management
- Quality management
- Maintenance and repair management
- Fixed Assets management
- Cost accounting and Controlling

- Fiscal accounting and tax reporting
- HR management & payroll calculation
- Finance management & IFRS reporting
- Budgeting and Treasury management
- Document management system

It is not necessarily, though, that each organisation had the same modules set in their 1C Enterprise.

8.7. Results from organizations

The participants were from different regions of Kazakhstan. The first organization, named OIT, from the table in Annex 1 is from Almaty region, one of the most developed regions of the country. The company operates in the IT industry specializing in providing internet to clients. It is a small enterprise with eleven employees in total. The results from OIT are shown in the **Figure 43**.

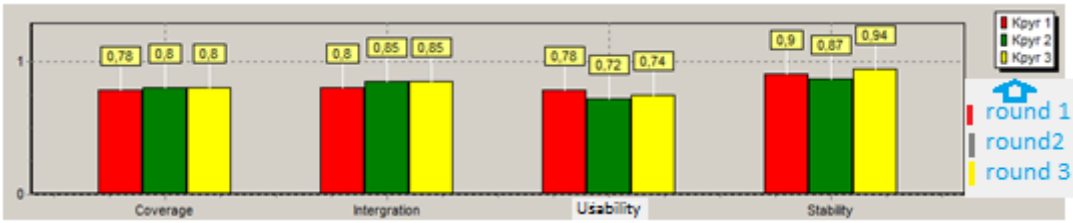

Figure 43: Analysis tab of first organization (OIT), Source: own.

Their results for three rounds of the evaluation showed that they estimated the behaviour of their software quite highly. Most of the values are around 0.8 (on the scale 0 for the lowest and 1 – for the highest performance). The performance of Stability was estimated higher than other measures. In contrast, the Usability showed a smaller result. In the Coverage, they indicated 24 needed processes and the software covered 19.4 of it. Unfortunately, there were very few records regarding Integration. Accordingly, the result of 7 tasks needed only 6 were solved, with the integration section facing some difficulties. This will be discussed at the end of this chapter.

Second participant, OED, is the medium organisation based on the number of employees, but was in fact small in organization assets. It is a college, which operates in the education area providing services for students.

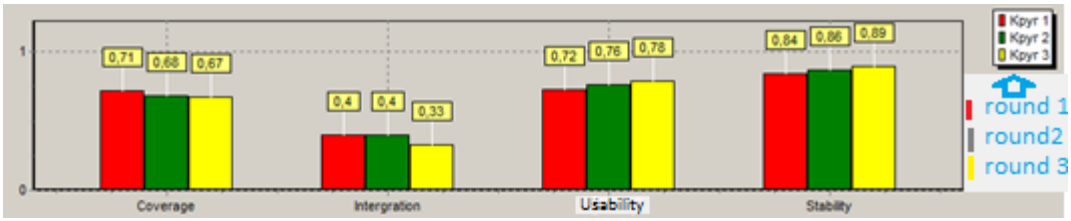

Figure 44: Analysis tab of the second organization (OED), Source: own.

Their estimation results (**Figure 44**) were lower than first organization had. Similarly, to OIT, they estimated stability to be very high. However, they estimated their integration almost two times lower than the first organization. The other indicators performed better. In particular, estimation of usability goes up with every subsequent round.

In the last round, the number of needed processes was 38 and estimation of their coverage was 25.6, which gave a result of 0.67. While not a bad result, it is not a desirable one either.

The third organisation, OAG, is from the agriculture industry. The number of employees was similar to OED, but its assets matched the requirements of a medium organisation. The organization is mainly focused in animal breeding, as well as engaged in plant growing on the side.

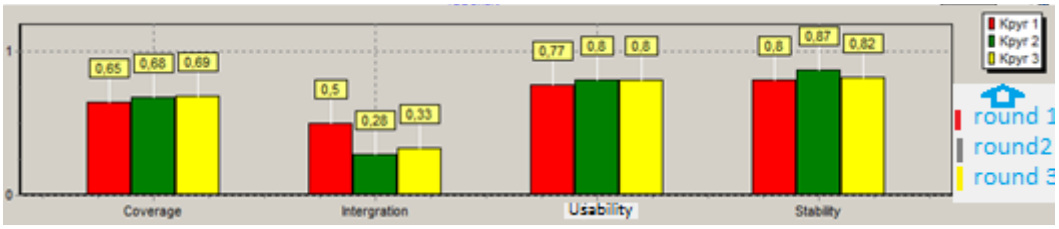

Figure 45: Analysis tab of the third organization (OAG), Source: own.

The **Figure 45** describes results received from OAG. The first thing to notice is that the results from the figure were very similar to second organization's results. However, it should be noted that we had more entered data from this organization. For example, there were 93processes added, which is three times more than from the second organization. Furthermore, all the users entered the data in every round, whereas in OED some users stopped entering data after the first round.

Overall, the results given from the organisations indicated that they are mostly satisfied with their enterprise software.

Organizations	OIT		OED		OAG	
Round	Count	Average	Count	Average	Count	Average
1	21	0,78	16	0,71	31	0,65
2	3	1	19	0,66	25	0,74
3	-	-	3	0,53	37	0,7

Table 30: Processes entered by rounds, Source: own.

The **Table 30** shows how many processes the organisations entered into the database and the mean for the processes in every round. All the responses were above average.

According to discussion with organisations' representatives, the Coverage part was the essential one. As was expected, the number of needed coverage functions increased according to the size of organizations. The first two organizations filled out needed-functions in the first two rounds. The last organization filled it consistently.

In, the **Table 31**, data from Integration part is represented. This part is fairly questionable. Despite the fact that the organizations insisted on the importance of this part, there were quite a few responses from the people responsible. Collected responses revealed less satisfaction with this parameter.

Organizations	OIT		OED		OAG	
Round	Yes	No	Yes	No	Yes	No
1	4	1	2	3	2	2
2	2	-	-	-	-	3
3	-	-	-	1	1	1

Table 31: Integration pairs, Source: own.

Despite the relatively poor data for the Integration part, the results revealed some interesting outcomes about the way the respondents filled in the information. For example, the OIT filled the integration fields with more advanced terms, while the others mentioned only reports and other simple requirements to their enterprise software such as, reports to tax-officials. OIT on their end pointed out some universal integration instruments, for example, as an important factor. The main reasons could be that OIT is based in more advanced region of the country as well as an operating in the information technologies industry.

	Organizations					
Round	OIT (3 participants)		OED (5 participants)		OAG (5 participants)	
	Sum	Mean	Sum	Mean	Sum	Mean
1	110	7,8571	252	7,2	271	7,7429
2	94	7,2308	160	7,619	283	8,0857
3	156	7,4286	165	7,8571	281	8,0286

Table 32: Usability comparison for all organizations, Source: own.

In the **Table 32**, the results from the usability section, where end-users estimate software they use, can be seen. The average number is good for all of the organisations. The Usability part was filled by the organization's end-users. Overall 13 people from three organizations participated in the estimation. Most of the results showed response rating improvement with every round, except OIT, where mean results were gradually decreased at each round. To clarify certain issues, a small discussion was set up after all three rounds took place. In the discussion, respondents explained that the score increased or decreased due to additional experience gained with the software.

	Organizations					
	OIT		OED		OAG	
Round	Days	Average	Days	Average	Days	Average
1	27	0,9	40	0,84	44	0,8
2	27	0,87	21	0,86	35	0,87
3	27	0,94	25	0,89	30	0,82

Table 33: Comparison of incidents from three organizations, Source: own.

The **Table 33** describes the results duration of incidents registration and the average results for the organizations. The stability section showed the highest response from all three organizations. As was mentioned, the Reliability part received the highest results. These days, most of the commercial enterprise software works with minimal errors due to a better development process, but incidents still do happen. The reasons vary. In our case, we have seen some incidents, not because of the fault of the software,

but also due to poor understanding of the software by users. Furthermore, there were some errors related to the environment. For instance, in one of the organizations there were many errors associated with the network as the organisation had a poor network infrastructure.

8.8. New method discussion

The method will thus certainly have a positive impact to organisations because it is based on their expectations and the needs of users in the organization. It highlights that organisations decide what they need, not the vendors or developers. In many cases, vendors sell products with many non-needed functions, which takes a place in both the hardware and memory, and the non-used functions can have influence in the quality evaluation process. Such occurrences must be avoided when organisations want to evaluate their software and get a more accurate result for their organizations' systems.

For the enterprise, the introduced method would bring benefits through the possibility of learning and understand their enterprise software in the process of evaluation. Organizations can determine their requirements not only in the beginning, but also in the process of evaluation, thus granting them flexibility.

The main advantage of this method is that organizations do not need to describe all the processes. They can just specify the processes which they need at this moment and over the time, if the problem is not solved, it will stay in the list as non-solved, and it will not give any additional credit to software.

The experience and suggestions of three organisations were taken into account in the building of this method. The figure from the organisations show that the organisation from developed areas had less problems with defining their goals in the first month, whereas organization from rural zones had issues with that task.

8.9. Study limitations

Before moving to the conclusion of the research, the limitations of the method should be explained. The main limitation of the research is a small number of actual participants both in the survey and in the final stage, when the new quality evaluation method was tested. Moreover, the organizations that participated in the research were volunteers, so the results from them really depended on what they wished to share. Another possible limitation is that the method can be only beneficial for the small and

medium enterprises as the larger organizations have requirements that are more comprehensive and this method can be not sufficient for them. On the other hand, taking into account the small population of the case study's country, Kazakhstan, the number of respondents tend to be representative sample, and the domination of the SMEs over the large enterprises makes the study reasonable addition to the existing empirical studies as well as provide a cost-and-time effective method to evaluate the software performance.

9. Conclusion

The main goal of the current work was to propose a time-and-cost effective quality evaluation method optimize the functionality of enterprise software packages in small and medium enterprises during the operational phase of the software life cycle.

An importance of such work arisen from the observation that enterprise software is attracting an increasing number of organisations due to their usability, simplicity, and effectiveness. However, SMEs often do not understand their enterprise software in depth due to personnel knowledge limitations. Sometimes, they consider existing functions as non-existing. Moreover, an enterprise software evaluation is rarely used in SMEs after acquisition, at the operational phase. Furthermore, most of the existing evaluation methods require a large range of inputs; for example, training staff or the hiring consultants or the purchasing of additional tools.

Overall, the literature review and overview of the current situation related to the topic of the research has shown that there are several gaps that need to be addressed. First, to date, most of the works are focused on software process evaluation and only few analysed software product evaluation with a specific focus on operational phase of the software lifecycle. Second, very limited number of papers were looking at software evaluation methods for SMEs. Third, geographical coverage of the studies, no literature was identified that would be looking at the problems of software evaluation in Kazakhstan, rapidly growing economy with a high technological potential.

In order to address stated issues with software evaluation in SMEs, the current research first analysed the existing models and standards for software quality evaluation. The current method took a modified version of some features, which would be most appropriate and feasible for SMEs, from the well-established and overarching standard for quality evaluation, ISO 25000 (SQuaRE). Then, the empirical part of the research was performed in two stages. The first stage was to run a survey to analyse the current situation of the software evaluation in operational phase by SMEs, as well as evaluate enterprise software support in SMEs in Kazakhstan.

The survey results revealed that most of the software of SMEs in Kazakhstan are used to support accountancy processes. However, only around 11% of the surveyed SMEs reported that they evaluate the quality of their enterprise software. Expectedly, it was found that respondents who evaluate their enterprise software find themselves able to better understand key features and specifics of their software. The survey

highlighted the problems of software quality evaluation in the SMEs of Kazakhstan. Most of the respondents considered the software evaluation as “not-needed”.

The second stage of the research aimed to design a new evaluation method that would satisfy overarching questions: Does the software, which organisations utilize match its expectation? Are users satisfied with the software they using?

The proposed evaluation method took an optimized form of the ISO 25000, considering specific characteristics of SMEs. The method was tested in three SMEs in Kazakhstan, all from different industries and regions of the country, and was tested during nine months in total, including answers awaiting periods (July 2016 – November 2017). The main outcomes of the tested method were:

1. Among four parameters of the method, the results for **Stability** parameter demonstrated at least small improvement in each round in all three organizations;
2. The **Integration** parameter had mixed results, which, however, cannot be interpreted precisely due to the limitation of the data input by the users for this parameter;
3. The **Coverage** had a good result in all three organizations in each three rounds. With some peculiarity in the pattern though, two organizations, IT and agriculture, showed constant improvement in each round, except the educational organization, which had slight decrease in the second and third round. This can be explained that understanding of the software requirements relevant to the Coverage parameter was not clear by the users at the beginning of the test and improved by the end of each round. Thus, gaining the new knowledge actually decreased their ratings.
4. **Usability** parameter had mixed results across three organizations, with steady improvement in education and agriculture, and some decline in rating of the usability parameter in IT organization. The latest result may reflect a time limitation of the testing period of the method, which lasted, as it was mentioned, only three months. Prior the test, it was expected that the Usability parameter will show a stable result and the decline could alter after a longer period only, with respect to aging of the software.

The optimized evaluation method helped the users from the test-organizations to understand in-depth specifics of their software. The participants reported that after

each evaluation round they could identify the features of the software that they already had but never used, advance their skills to employ some features of the software that they already were familiar with, as well as specify additional features that they may need in future to enhance performance of their work. Additionally, the method provides a history of usage of the software that can be beneficial in the future selection software for the organization. Thus, a group of organisations with enterprise software acknowledged the benefits from the tested evaluation method, which was optimised specifically to the SMEs needs, and changed their corporative strategy to adopt the software evaluation practices in the future.

Some limitations, such as small survey sample and limited number of test-group should be noted, however, taking into account the small population of the country and little number of those who actually evaluate the software in the surveyed sample, the results considered to be significant and valuable. The further work under this research could involve a larger focus group by increasing the number of countries and organizations in the analysis, as well as designing the evaluation method at the operational phase for the large enterprises, adding additional parameters and increasing the testing period. Moreover, it was suggested by the organizations in the testing group to prepare a practical guide for the software quality evaluation for the SMEs in Kazakhstan in state languages, Kazakh and Russian.

References

1. Kataev, M., et al., *Enterprise diagnostics for evaluation of enterprise business processes.* Journal of Industrial Integration and Management, 2016. **1**(02): p. 1650008.
2. Keil, M. and A. Tiwana, *Relative importance of evaluation criteria for enterprise systems: a conjoint study.* Information Systems Journal, 2006. **16**(3): p. 237-262.
3. Shin, I., *Adoption of enterprise application software and firm performance.* Small Business Economics, 2006. **26**(3): p. 241-256.
4. Olson, D.L., B. Johansson, and R.A. de Carvalho, *A combined method for evaluating criteria when selecting erp systems*, in *Re-conceptualizing Enterprise Information Systems*. 2012, Springer. p. 64-74.
5. Sykes, T.A., V. Venkatesh, and J.L. Johnson, *Enterprise system implementation and employee job performance: Understanding the role of advice networks.* Mis Quarterly, 2014. **38**(1).
6. Wang, C.-H. and S.-Y. Chou, *Entities' representation modes and their communication effects in collaborative design for SMEs.* The International Journal of Advanced Manufacturing Technology, 2008. **37**(5-6): p. 455-470.
7. European Union Commission, *Commission recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises.* Official Journal of the European Union, 2003. **46**: p. 36-41.
8. The Government of Kazakhstan, *Entrepreneurial Codex of the Republic of Kazakhstan*. 2016: G.o. Astana, Akorda p. 286
9. Porter, M.E., *Competitive Advantage: creating and sustaining performance*. 2008: Amazon Digital Services, Incorporated.
10. Cardona, M., T. Kretschmer, and T. Strobel, *ICT and productivity: conclusions from the empirical literature.* Information Economics and Policy, 2013. **25**(3): p. 109-125.
11. Carroll, N., E. Whelan, and I. Richardson, *Applying social network analysis to discover service innovation within agile service networks.* Service Science, 2010. **2**(4): p. 225-244.
12. Middlemiss, J., *CIO challenge.* Wall Street & Technology, 2004. **22**(7): p. 40-41.
13. IEEE, *Standard Glossary of Software Engineering Terminology*. 1990: New York, USA.
14. Singh, R., *International Standard ISO/IEC 12207 software life cycle processes.* Software Process: Improvement and Practice, 1996. **2**(1): p. 35-50.
15. Lientz, B.P. and E.B. Swanson, *Software maintenance management.* 1980.
16. Pigoski, T.M., *Practical software maintenance: best practices for managing your software investment*. 1996: Wiley Publishing.
17. Hirschheim, R., A. Heinzl, and J. Dibbern, *Information Systems Outsourcing: Towards Sustainable Business Value*. 2014: Springer.
18. Grover, V., M.J. Cheon, and J.T. Teng, *The effect of service quality and partnership on the outsourcing of information systems functions.* Journal of Management Information Systems, 1996. **12**(4): p. 89-116.
19. Dibbern, J., et al., *Information systems outsourcing: a survey and analysis of the literature.* ACM SIGMIS Database: the DATABASE for Advances in Information Systems, 2004. **35**(4): p. 6-102.
20. Kavčič, K., *Strategic management of outsourcing*. 2014: Univerza na Primorskem, Fakulteta za management.

21. Taldau, *Economic and Financial Data for Kazakhstan* 2015. Available from: http://stat.gov.kz/faces/standartPage/standartsNational?_adf.ctrl-state=8ejyf15_4&lang=ru&_afrLoop=8442765472444144&page_id=standartPage#%40%3F_afrLoop%3D8442765472444144%26lang%3Dru%26page_id%3DstandartPage%26_adf.ctrl-state%3Dfpd70wh3k_9
22. Committee on Statistics, *The current legal entities by activity*, in *Secondary The current legal entities by activity*. 2016, Ministry of National Economy of Kazakhstan: Astana, Kazakhstan. Available from: http://www.stat.gov.kz/faces/wcnav_externalId/homeNumbersBusinessRegisters?_afrLoop=30717440052517668#%40%3F_afrLoop%3D30717440052517668%26_adf.ctrl-state%3Dayafrxpjl_50 Access Date: 12.05.2017.
23. Panorama Consulting Solutions, *Report on ERP systems and enterprise software.* Panorama Consulting Solutions, 2016.
24. Profit.kz, *SAP потратил 25 млн евро на локализацию.* Profit Kz news, 2013. Available from: http://profit.kz/news/11270/SAP-potratil-25-mln-evro-na-lokalizaciu/
25. KZnews, K., *Oracle расширяет присутствие в Казахстане* 2013. Available from: https://kapital.kz/business/22425/oracle-rasshiryaet-prisutstvie-v-kazahstane.html.
26. The National Agency for Technological Development, *Report on trends in innovation in the Republic of Kazakhstan and the world*, Bax, Editor. 2013, Ministry of Industry and Trade of the Republic of Kazakhstan.
27. Eurostat, *Eurostat Pocketbooks/Science, Technology, and Innovation in Europe*, in *Secondary Eurostat Pocketbooks/Science, Technology, and Innovation in Europe*. 2013. Access Date: 18.05.2016.
28. United Nations, *E-Government for the Future We Want*, in *United Nations E-Government Survey 2014*. 2014.
29. United Nations, *Public Administration Country Studies. UN E-Government Survey, Economic and Social Affairs.* . 2014. Available from: http://unpan3.un.org/egovkb/Reports/UN-E-Government-Survey-2014. Access Date: 14.08.2017.
30. Wagner, S., *Software Product Quality Control*. 2013, New York: Springer.
31. Garvin, D.A., *What Does "Product Quality" Really Mean?* . Sloan management review, 1984. **25**.
32. Boehm, B.W., J.R. Brown, and H. Kaspar, *Characteristics of software quality.* 1978.
33. *Quality Models in Software Engineering*. 2013; Available from: https://msritse2012.wordpress.com/2013/01/27/quality-models-in-software-engineering/.
34. Boukouchi Youness, M.A., Benlahmer Habiband Moutachaouik Hicham,, *Comparative Study of Software Quality Models.* International Journal of Computer Science Issues, 2013. **10**(6).
35. Vaníček, J., *Information systems quality rating.* Prague, Česká zemědělská univerzita v Praze, 2010. **1**: p. 70.
36. CMMI Product Team, *CMMI® for Development, Version 1.3, Improving processes for developing better products and services.* no. CMU/SEI-2010-TR-033. Software Engineering Institute, 2010.
37. ISO/IEC, *ISO/IEC 25010. Systems and software engineering -Systems and software quality requirements and Evaluation (SQuaRE) - System and software quality models*. 2011: ISO/IEC.

38. Vaníček, J., *Software quality measures validation in the Czech Republic.* Agriculture Economics, 2007. **53**: p. 3.
39. Pfleeger, S.L., *Software Engineering: Theory and practice.* Upper Saddle River, N.J Pearson Prentice Hall 2001.
40. ISO/IEC, *IEC 9126, Software Product Evaluation–Quality Characteristics and Guidelines for their Use.* International Organization for Standardization, 2001.
41. ISO/IEC, *ISO/IEC FDIS 9126-1, Information technology—Software product quality, Part 1: Quality model.* ANSI, ISO/IEC JTC 1., 2000.
42. ISO/IEC, *Technical Committees.* 2017. Available from: https://www.iso.org/technical-committees.html.
43. ISO/IEC, *ISO/IEC JTC 1/SC 7 Software and systems engineering.* 2017. Available from: https://www.iso.org/committee/45086.html.
44. ISO/IEC, *ISO/IEC 25022, Systems and software engineering - Systems and software Quality Requirements and Evaluation (SQuaRE) – Measurement of quality in use.* Japan, ISO/IEC JTC 1/SC 7, 2012.
45. ISO/IEC, *ISO/IEC 15939, Systems and software engineering — Measurement process.* ISO/IEC Standard, 2007. Available from: https://www.iso.org/standard/44344.html Access Date: 03.06.2015.
46. ISO/IEC, *ISO/IEC 25012, Software engineering — Software product Quality Requirements and Evaluation (SQuaRE) — Data quality model.* ISO/IEC JTC 1/SC 7, 2008.
47. Cambridge Dictionary. *Cambridge dictionaries online*. 2018 21.10.2018]; Available from: https://dictionary.cambridge.org/dictionary/english/stability. Access Date: 21.10.2018.
48. 1C: ERP 2. *Main 1C functional modules* 2018 20.10.2018]; Available from: http://up2erp.today/en/. Access Date: 20.10.2018.

List of abbreviations

ASW	Application software
CMMI	Capability Maturity Model
COQUAMO	Constructive Quality Model
DB	Database
DBMS	Database Management System
EMISQ	Evaluation Method for Internal Software Quality
ERM	Enterprise Risk Management
ERP	Enterprise Resource Planning
ESPIRIT	European Strategic Program on Research in Information Technology
ICT	Information and Communication Technology
IEC	International Electro technical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
JSC	Joint Stock Company
SAP	Application - Product in data processing
SMART	Specific, Measurable, Assignable, Realistic, Time-related
SME	Small and Medium Enterprises
SQUID	Software Quality In Development
TP monitor	Teleprocessing monitor
IDC	International Data Corporation

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Annex 1

Organizations participated in software evaluation.

#	Name	Industry	Employees	Persons involved in research	Enterprise software	Test applying date
1	OIT	IT	11	3	1C Enterprise	07-2016 to 10-2016
2	OED	Education	55(approx)	5	1C Enterprise	08-2016 to 11-2016
3	OAG	Agriculture	70(approx)	5	1C Enterprise	12-2016 to 03-2017

Annex 2

List of respondents participated in survey

NAME	REGION	INDUSTRY	ADDITIONAL
Agromean	Almaty region	Agriculture, forestry and fisheries	Agroproducts
Zernovoi Pul Kazakhstana TOO	Kostanay region	Agriculture, forestry and fisheries	Grain storage
Lugovskoi Konny Zavod TOO	Zhambyl region	Agriculture, forestry and fisheries	Agro farm
AVGRUPP	Karaganda region	Manufacturing	Production of food
Kondiz TOO	East Kazakhstan region	Manufacturing	Confectionery
3D Decor TOO	Astana city	Manufacturing	Outdoor advertising
ADS Union	Karaganda region	Manufacturing	Metalworking
GOSS Trade	Almaty city	Manufacturing	Manufacturing sales of cotton products
Geo Engeneering	Karaganda region	Mining and quarrying	Geodesys
360 Professional LTD	Astana city	Constrtuction	Construction and materials
ABS Group	Astana city	Constrtuction	Constructing
Absalut Ecology	Karaganda region	Constrtuction	Development and construction of industrial plants for cleaning emissions
ADC-System	Almaty city	Constrtuction	Construction and repairs

AIG company TOO	Almaty city	Constrtuction	Channel washing cars, roller, pump stations, pumps for dewatering equipment for pipe rehabilitation
Ala Carte Kazakhstan	Almaty city	Constrtuction	Half-timbered houses, terraced Floor, decking, decking, bioclimatic architecture, building houses, glued beam houses, eco-construction
Academy Design Plus TOO	Almaty city	Constrtuction	Construction and repairs
Alem Sauda LTD TOO	Almaty city	Constrtuction	Rental of machinery, sales of machinery, dump trucks, excavators, graders, loaders, loader-excavator, bulldozers, cranes, trawls, trucks, motor graders, road rollers, working pits, excavation, trenching, road construction, road maintenance
Alian-Market TOO	Almaty city	Constrtuction	Sale of building materials

Almat Construction TOO	Almaty city	Constrtuction	residential containers, residential trailers, modular buildings, modular unit containers, wagons shower, lavatory, a mobile clinic, mobile bath, sauna, mobile, insulated containers
Aman Sheber TOO	Almaty city	Constrtuction	Construction and repairs
Key Solution TOO	Almaty city	Constrtuction	As a representative of a major European architectural bureau in Kazakhstan, offers services in designing private houses.
Maxilive	South Kazakhstan region	Manufacturing	Manufacturer of aluminum profiles and structures in the Republic of Kazakhstan and Central Asia with a complete, closed-modern technological cycle of production, carrying out decoration and

			anodized aluminum on the Italian technology.
Siphome TOO	Almaty region	Constrtuction	It specializes in the construction of houses on the Finnish technology.
Ref Cargo Trans	Karaganda region	Transportation and storage	Trucking, cargo from 1 cubic meter, cargo up to 120 cubic meters
Kar Spec Service	Karaganda region	Wholesale and retail trade, repair of motor vehicles and motorcycles	The company operates in the market of equipment and parts. It is the official dealer of companies SDLG, XCMG, Changlin, Lonking in Karaganda region.
Delta Equipment	Karaganda region	Wholesale and retail trade, repair of motor vehicles and motorcycles	We supply genuine spare parts for equipment for cranes, for asphalt.
Cmu-Trans-Service	Karaganda region	Transportation and storage	It offers services in the organization of cargo transportation from 1 cc / m to 120 cu / m cities of Kazakhstan, the

			CIS countries, the European Union.
007 Avtokompleks	Karaganda region	Other activities	Dry cleaning machines, car polishing, preparation of the car for sale, car electrician, motor oils, gas engine oils, gear oils, hydraulic oils, greases, pastes, functional fluids, service products, aerosols, alarm installation
4x4 IP	Almaty city	Wholesale and retail trade, repair of motor vehicles and motorcycles	Performs repair FIELDS VAZ 21213, 21214, 2123. Complete repair of chassis, assemblies manual transmission, gear (axles).
Almaty International Logistic Park	Almaty city	Transportation and storage	AILP Group specializes in creating logistics infrastructure
Merkury	Astana city	Accommodation and food services	Accomodation
Koktobe	Almaty city	Accommodation and food services	Accomodation and restourant

Elcom-Service	Karaganda region	Wholesale and retail trade, repair of motor vehicles and motorcycles	Copiers, printers, scanners, computers, laptops
5-Element	Zhambyl region	Other activities	Advertising and production agency
Pardes TOO	Akmola region	Wholesale and retail trade, repair of motor vehicles and motorcycles	Products and services security systems: video surveillance, fire alarm, access control, automatic gates, sectional, barriers, alarm systems, intercoms, fire-fighting equipment, GPS-monitoring
Profy-style	South Kazakhstan region	Wholesale and retail trade, repair of motor vehicles and motorcycles	Cosmetic products
Information Technologies Invest Group TOO	South Kazakhstan region	Information and communication	IT-services
1000 VOLT	East Kazakhstan region	Wholesale and retail trade, repair of motor vehicles and motorcycles	
Phyto-Apipharm	South Kazakhstan region	Wholesale and retail trade, repair of motor vehicles and motorcycles	Cosmetic balms, honey balms, salves, oil, mineral-sorbents, antiulcer

			Phyto, Phyto tonic, anti-Phyto
B2B-Service	Almaty city	Wholesale and retail trade, repair of motor vehicles and motorcycles	It specializes in the wholesale and retail office products. Internet-shop provides on-line sale of office products in the region
Berghoff-Central Asia	Almaty region	Wholesale and retail trade, repair of motor vehicles and motorcycles	Distributor Bulgarian company BergHOFF Worldwide "in Kazakhstan. The company is engaged in the development and production of kitchen and tableware
Best	Astana city	Education	Language school
Centrasia Trade TOO	West Kazakhstan region	Wholesale and retail trade, repair of motor vehicles and motorcycles	Emergency and rescue equipment, ship equipment, berthing, mooring equipment, aids to navigation, marine chemistry, marine agency, marine geophysical research equipment, fire

			equipment, rescue equipment, marine engines, marine diesel generators, fenders, bollards, buoys, marine navigation aids , charts, rigging, anchor ropes, tow ropes Deltex, corrosion inhibitors, paints and varnishes, water treatment products, products for tank cleaning
Ceravit-Ceramiks	Almaty city	Wholesale and retail trade, repair of motor vehicles and motorcycles	Salon furniture, paintings, rugs, children's furniture, home textiles, design services for interior design
Central Asia Company	Almaty region	Wholesale and retail trade, repair of motor vehicles and motorcycles	The company is engaged in wholesale deliveries of technological materials and equipment for the metallurgical, oil and gas industry

Alakhan Sat	Kostanay region	Information and communication	It provides services to access the Internet
Isker Media	Almaty region	Information and communication	Publisher "Isker Media" offers media projects financial and economic issues: the interactive information and analytical resource www.and.kz, the business newspaper "Biznes & Vlast" business magazine "The Real Business of Kazakhstan"
Profi Escort IP	Kostanay region	Information and communication	It provides services for automating business processes
East House IP	Astana city	Real estate operations	Real Estate Company, provides services for the design of real estate transactions.
Linsat	Karaganda region	Real estate operations	Provides a full range of services for the sale, purchase, exchange, lease of houses, apartments and commercial properties in the

			city of Karaganda, Karaganda region, as well as the purchase and lease of real estate in Turkey, Bulgaria, Thailand, Italy, France, Switzerland, Spain, Monaco, United Arab Emirates and other countries.
Rent Realty	Almaty region	Real estate operations	Real estate agency, rent of commercial real estate, luxury real estate, commercial real estate, real estate services, real estate, real estate management
Rest Property	Almaty city	Real estate operations	Estate Agency with more than 10 years of experience in the Turkish market as well as the developer, which offers apartments in residential complexes on the Mediterranean coast: Antalya and Alanya

Soglasie Ltd	Almaty city	Real estate operations	Evaluation of real estate, movable property appraisal, assessment of securities, valuation of collateral, equipment evaluation, assessment of construction in progress
Valuers	Aktobe region	Real estate operations	Estimation of the real estate, Assessment of movable property, valuation of intangible assets
Golden Age	Almaty city	Financial and insurance activities	The main activity is the issuance of short-term loans on the security of the population
Grandes Ksj AO	Almaty city	Financial and insurance activities	The company provides services for life insurance in the form of compulsory and voluntary insurance.
Dent-Lux AO	Almaty region	Health and social services	The network of dental clinics in Kazakhstan

Ls-Clinic	Almaty city	Health and social services	Private medical clinics, providing medical and diagnostic assistance to the population.
Local History Museum	West Kazakhstan region	Arts, entertainment and recreation	Museum
Jailau	Kostanay region	Arts, entertainment and recreation	Sanatorium
Academia Rosta	Astana city	Education	It works in the sphere of additional vocational education, providing training in various fields and professions that are in demand in today's job market.
College K.Nurgalieva	East Kazakhstan region	Education	Training, specialty Production of building components and structures, training, specialty Traffic, training in law, education, specialty Organization of service hotel management, training, specialty Accounting and Auditing, training,

			degree in Economics, teaching in the specialty Tourism, specialty training Computing equipment and software
Medical College Astana akimat GKPP	Astana city	Education	Nursing, medical, pharmacy, dentistry
Kazakh secondary school #38	Aktobe region	Education	Education