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Understanding the Quality of e-Services: Accessibility, Usability, Efficiency and Security.

Master’s Thesis (30 ECTS)

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Abstract:

With the fast evolution of technology during last decades today it is possible to develop and offer services (immaterial goods) through Internet, this concept is known as electronic services (e-services), its relevance due its benefits, getting results remotely, and the role they play on business, drive us to think about two points (1) what exactly ‘e-service’ is? and (2) How e-service could be efficiently used, accessed, and utilized? On the other hand what are the key components of e-service, regarding four dimensions: (1) Accessibility, (2) Usability, (3) Efficiency, and (4) Security? T his thesis presents a conceptual model in order to understand qualitative characteristics of e-services regarding (1) Accessibility, (2) Usability, (3) Efficiency, and (4) Security (AUES), for this goal a systematic literature review on ‘e-service’ conceptual definition with emphasis on AUES was performed. Presented conceptual model can be considered as reference to determine key components for additional or different dimensions to help in understanding the quality of different e-services. We conducted a series of tests in order to determine how conceptual model performs with selected Estonian e-services. Results show e-services key components dependability in AUES dimensions to understand quality on e-services working either directly with users or with other e-services.

Keywords:

E-service quality, security, accessibility, usability, efficiency, key indicators, qualitative characteristics, conceptual model

Lühikokkuvõte:

Tänu tehnoloogia kiirele arengule viimastel kümnenditel on tänaseks võimalik arendada ja pakkuda teenuseid (immateriaalseid tooteid) Interneti kaudu. Neid nimetatakse elektroonilisteks teenusteks (e-teenusteks) ning nende asjakohasus tänu eelistele, mille annavad vahemaast sõltumata saadavad tulemused, ja nende teenuste roll äritegevuses, juhivad meid kahe küsimuse juurde: (A) mida täpselt e-teenus endast kujutab ja (B) kuidas e-teenust kõige tõhusamalt kasutada, kättesaadavaks teha ja rakendada. Teisest küljest, mis on e-teenuse põhikomponendid, kui vaadata neid neljast aspektist: (1) kättesaadavus, (2) kasutatavus, (3) tõhusus, (4) turvalisus?

Käesolevas magistritöös esitatakse kontseptuaalne mudel, mis aitab mõista e-teenuse põhikomponente (kvaliteedi parameetreid) nagu (1) kättesaadavus, (2) kasutatavus, (3) tõhusus, (4) turvalisus (ehk lüh. ingl. AUES). Selleks antakse süsteemne ülevaade e-teenuse mõiste määratlemisest kirjanduses rõhuasetusega AUES-komponentidel.

Esitatud kontseptuaalne mudel võimaldab mõista kvalitatiivseid omadusi e-teenuseid nimetatud nelja parameetri (AUES) alusel ning nende parameetrite usaldusväärsust; ühtlasi aitab see soovitusliku baasina täita lünki e-teenuse mõistest aru saamisel ja selle kvaliteedi tajumisel.

Selleks et mõista, kuidas kontseptuaalne mudel töötab valitud Eesti e-teenuste puhul, viisime läbi rea katseid. Tulemused näitavad e-teenuse põhikomponentide asjakohasust AUES-est lähtuvalt, tuvastamaks kontseptuaalse mudeli rakendatavust, võimalusi ja piiranguid.

Võtmesõnad:

Kvaliteet, e-teenus, turvalisus, kättesaadavus, kasutatavus, tõhusus, põhinäitajad, põhinäitajaid, kvalitatiivsed omadused, kontseptuaalne mudel

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# Introduction

The fast growth of Internet has created great opportunities for businesses regarding electronic services offered via Internet (e-services), E-services are becoming increasingly important topic not only for determining either success or failure on electronic commerce (Yang et al., 2001), but also on providing users with experience on interacting with flow of information (Santos, 2003). Since early days of Internet, companies are continuously looking for new ways to improve services of their business having on mind the increase of customers.

Nowadays users have better access to information they need in a different-easy manner, they don’t have to wait too much time or to be physically at specific venue to get results about specific services they need either to use or to consume, they can perform transactions immediately through the use of e-services.

However there is no standard understanding about concept of e-service, different entities define it on both valid and different ways according to their interests and convenience, therefore perception about quality is also different, this means interests of stakeholders have priority instead of users satisfaction when they consume e-services.

In this thesis work a conceptual model is presented in order to understand qualitative characteristics of e-services in four dimensions (1) Accessibility, (2) Usability, (3) Efficiency, and (4) Security; we will also understand concept of e-service, and specifically how e-services could be efficiently used, accessed and utilized.

To understand qualitative characteristics of e-services is the research objective. “What are the key e-service components regarding its Accessibility, Usability, Efficiency, and Security (AUES)?“ is our research question.

This work contributes to the State-of-the-Art with a conceptual model as a reference to understand qualitative characteristics of e-services on four dimensions: (1) Accessibility, (2) Usability, (3) Efficiency and (4) Security (AUES) and with a conceptual definition of e-services with emphasis on AUES.

Understanding e-service concept and its qualitative characteristics in four dimensions (AUES) through a model, gives the opportunity to combine different e-services to produce for example, new business artifacts for new business opportunities, increase users satisfaction, and give the chance to realize improvement areas on e-services.

## Organization of thesis

This thesis work is organized in the following chapters:

**Chapter 1.** Gives introduction and the organization of this thesis work.

**Chapter 2.** Presents the State-of-the-Art considering ten (10) topics and describes what is missing on it:

|  |  |
| --- | --- |
| 1. Services | 6. Information Technology Services (IT Services) |
| 2. Quality | 7. Electronic-Commerce (e-commerce) |
| 3. Quality of Service | 8. Electronic-Government (e-government) |
| 4. Electronic-Services (e-services) | 9. Electronic-Infrastructure (e-infrastructure) |
| 5. Quality of e-services | 10. E-services Providers |

**Chapter 3.** Focuses on understanding concept of e-service and four considered dimensions for this thesis work: (1) Accessibility, (2) Usability, (3) Efficiency and (4) Security represented with acronym “AUES”.

**Chapter 4.** Conceptual model is presented, its components and the set of key e-service dimensional components as well.

**Chapter 5**. Applying proposed conceptual model to selected Estonian e-services.

**Chapter 6.** Discussion about obtained results from experiencing with conceptual model on selected Estonian e-services.

**Chapter 7.** Results discussion, its interpretations, and set learning from the model and realizes its limitations when it is applied to Estonian e-services, future work and remaining questions are also presented here.

**Chapter 8.** Contains all the references used for this thesis work.

**Appendix** Contains a glossary with additional definitions in order to understand related terminology on this thesis work.

# The state-of-the-Art

The State-of-the-Art used in the thesis does mention about what has been understood as e-services during recent years and what has been done related to them, for that purpose ten topics were considered for this chapter:

|  |  |
| --- | --- |
| 1. Services | 6. Information Technology Services (IT Services) |
| 2. Quality | 7. Electronic-Commerce (e-commerce) |
| 3. Quality of Service | 8. Electronic-Government (e-government) |
| 4. Electronic-Services (e-services) | 9. Electronic-Infrastructure (e-infrastructure) |
| 5. Quality of e-services | 10. E-services Providers |

## Service

Services are intangible products such as accounting, banking, cleaning, consultancy, education, insurance, expertise, medical treatment, or transportation. Sometimes services are difficult to identify because they are closely associated with a good; such as the combination of the diagnosis with the administration of a medicine. No transfer of possesion or ownership takes place when services are sold, and they (1) cannot be stored or transported, (2) are instantly perishable, and (3) come into existence at the time they are bought and consumed[[1]](#footnote-1).

A service is a means of delivering value to customers by facilitating outcomes that customers want to achieve without the ownership of specific costs or risks[[2]](#footnote-2).

## Quality

There are several definitions and meanings for the concept of “quality” as discussed by Ojasalo (2006). Reeves and Bednar (1994) argue that, no universal definition of quality exists; there are different definitions appropiate for different circumstances. When quality is defined as coformance to specifications then objective and measurable standards are established [[1](#Juk10)]. Quality has been usually defined as meeting or exceeding customer expectations (Gronos, 1983; Parasuraman et al., 1985).

It is important to consider quality concept as the perception a customer has after receving the benefits or experiencing the performan of a service according to expectations perceived by the offering. The service provider can do efforts to give differentiated value through the offered service, but if the customer is not satisfied according to his perspectives, then quality is considered directly as low.

## Service Quality

In the context of services, quality is often understood as subjective customer perception. Customer perceives quality as the result from how well expectations are met by experiences or performance given by the service. This is called disconfirmation (Gronroos, 1982; Parasuraman et al., 1988, Bitner, 1990, Bolton and Drew, 1991; Gummesson, 1991; Oliver, 1993). Disconfirmation paradigm suggest that when the performance is at the same level as expectations, then service quality is good or excellent. If the performance is at lower level than expectations, service quality is inferior or bad [[1](#Juk10)].

***S***ervices need to be described and understood both in terms of functional capabilities and service quality properties [[2](#kri13)]. Service quality combines several service properties as security, availability, response time, etc., and generally are seen as distinctive success factors for service providers. Quality is used in order to define contract between a service user and the service provider, this is to have a guarantee that needs are met. On the other hand service quality has been defined as a set of non-functional attributes of contextual entities considered as relevant to the service-user interaction. Service quality could be classified as Quality of Execution (QoE) and Quality of Service (QoS) which can be measured for example with execution time, and are supported typically with Service Layer Agreements (SLAs) containing more information than Quality-based Service Description in terms of supporting the service ‘is-active’ activity. On the other hand QoE do measurements in a subjective way, for example usability or reputation, both QoE and QoS give a perception to users.

According to Kritikos in [[2](#kri13)], service quality can play significant role during several phases of the service life cycle. Security Quality Models are used to describe concrete properties regarding quality, and can be used by another quality document types to make use of service quality capabilities or requirements. It is worth to mention that the most common SLA components are (according to Paschke et al., 2006): contract validity period, involved parts, service definition and action guarantees. Service definitions specify the service characteristics, components and observable parameters.

It is generally agreed that service quality is multi-level and multi-dimensional concept that means different things to different people [[3](#JSa03)].

/\*papers 11 y 20 para el diagrama de Service quality model\*/

## Definitions of E-service

According to the Ruyter et al. (2001, p. 186) an e-service is an interactive, content-centred and internet-based customer service driven by the customer and integrated with related organisational customer support processes and technologies with the goal of strengthening the customer-service provider relationship.

An e-service is any asset that is made available via the Internet to drive new revenue streams or create new efficiencies. /\*ref?\*/

E-service is the result of automation, enhancement and integration of the business processes of the traditional services that are moving towards demand on internet. /\*ref?\*/

Having e-services oriented to the customer needs will have some positive impacts on a given organization, which include the improvement of the organization performance and satisfaction on the clients [[3](#JSa03)].

To evaluate an e-service it is necessary to combine efficiency and effectiveness evaluation dimensions and measures from several existing frameworks, and adapt them to the particular objectives, characteristics, resources and capabilities of the particualer e-service [[4](#ELo12)].

## ISO/IEC 25010

International Organization for Standarization (ISO) and International Electrotechnical Commission (IEC) standard, series 25010 is known as ISO/IEC 25010 which is an evolution of ISO/IEC 9126 [[5](#BSI11)],

The quality models in this international standard can be used to identify relevant quality characteristics that can be further used to establish requirements, their criteria for satisfaction and the corresponding measures. This standard can be used in conjunction with ISO 9001 (which is concerned with quality assurance processes) to provide:

* Support for setting quality goals
* Support for design review, verification and validation

/\*here goes the figure of families standards\*/

**ISO/IEC 2501n** – Quality Model Division. The international standards that for this division present detailed quality models for computer systems and software products, quality in use, and data. Practical guidance on the use of the quality models is also provided.

## E-services Quality (e-SQ)

The concept of e-service quality (e-SQ) is derived from the quality of traditional services [[6](#Moh)]. According with Teimouri et al. [[7](#Had14)] in the past, term of service quality was one of the key factors for succes on unit. But now with the rapid growth of online businesses, this term has begun to call as e-service quality which shows the quality of services in electronic business and marketing.

Some characteristics of quality have been studied but, there is no model aligned with the ISO/IEC 25010 standard which defines three main characteristics about quality: Usability, Safety and Flexibility [[8](#May)].

According to [[8](#May)] the main purpose of a software quality model is to specify and assess the level of quality of a product through internal measures of inherent properties of the software, and through external measures of the behavior of the systems of which the software is part.

Based on [[8](#May)] we remark eleven (11) important facts about Quality:

1. Quality is important prerequisite for success.
2. According to ISO, there are various perspectives of quality: internal, external and in use.
3. Success on accuracy on content and useful services tailored to users according to their requirements.
4. Success factor is to warranty the levels of quality on software products.
5. It is no longer sufficient to simply provide technically excellent software products.
6. ISO defines several perspectives in order to analyze the level of quality.
7. Relevant literature has not dealt with quality in use in sufficient depth.
8. When users do not feel safety it is difficult for them to achieve their goals. If they are not satisfied they may easily decide to use another different solution.
9. Assessing the quality in use allows owners to estimate how usable a product might be and the user's satisfaction.
10. To assess quality in use, it is first necessary to define a model, taking into consideration an ISO standard, for example.
11. Perception of quality in use must be measured in terms of results on using a software, not properties of the software itself.

Quality of e-services has increasingly attracted the attention of researchers after 2000, the existing research on this area is mostly focused on identifying quality dimensions of e-services without any deeper attention to the mechanism that explains quality perception [[1](#Juk10)].

According to Ateeq, Kamil and Basri in [[6](#Moh)] e-service quality can provide organization competitive advantages in the online environment.

The term of “e-service quality”can affect the success of online businesses. This can potentially increase attractiveness, hit rate, customer retention, stickiness, and positive word of mouth and can maximize the online competitive advantages of e-commerce [[3](#JSa03)].

E-service quality is defined as the overall consumer evaluations and opinions regarding the excellence of e-service delivery in the virtual marketplace [[3](#JSa03)]. Collier and Bienstock claimed that e-service quality refers to the perception of the user of the outcome of the service delivery along with service recovery perceptions, if service failures happened [[9](#JEC06)]. E-service quality in return can be considered as the key determinant to the success of online organizations [[10](#JHK09)] and [[11](#RVi02)]. Many online organization businesses, related to this, became unsuccessful due to poor e-service quality [[12](#GGL05)].

All in all, there is a variety of e-service quality dimensions that have positive and significant impacts of perceived quality on online users [[12](#GGL05)].

Companies can use e-service quality as a competitive advantage in competitive marketplace. High e-service quality provide long-term benefits to a company [[3](#JSa03)].

Accurate measurement of the quality of e-services is a complex process due to the nature of the service because it is immaterial and untypical product. It has been indicated through the literature that there is a lack of universal set of definitions, model and dimensions for service quality measurement [[13](#NSe06)].

Many researchers are conducted to measure e-SQ, but no inclusive scale has been developed defining the dimensions and the attributes properly. This leads to confusion when organizations are trying to improve e-services [[14](#VAZ02)].

Some researchers utilized the conventional SERVQUAL scale of service quality to measure e-services, but, it has been found inadequate in evaluating e-SQ. This is because e-service varied from traditional service in three aspects namely: sales staff absence, lack of conventional tangible element and customers self-service. In view of this, ti is obvious that the SERVQUAL in not adequate for measuring the quality of e-service, and it is necessary to develop a tool for measuring e-SQ [[15](#HLi091)] and [[16](#LiH08)].

Different authors have defined dimensions for evaluation the e-SQ as Zeithaml et al. (2001) defined eleven dimensions (flexibility, reliability, access, ease of navigation, efficiency, responsiveness, personalization, assurance/trust, site aesthetics, price knowledge, and security/privacy) [[17](#Zei01)], Cox and Dale (2001) defined 6 dimensions (website appearance, accessibility, communication, credibility, availability and understanding) [[18](#Cox01)], Yang et al. (2003) posposed eight dimensions (prompt delivery, credibility, ease of use, reliability, convenience, communication, accessibility and competence) [[19](#ZYa03)], Raman et al. (2008) proposed six dimensions (appearance, ease of use, customization, reliability, communication and incentive) [[20](#MRa08)].

Some other author have defined measurement instruments with dimensions, Parasuraman et al. (2005) developed E-S-QUAL with four dimensions (efficiency, availability, fulfillment, and privacy), Yoo and Donthu (2001) developed SITEQUAL with four dimensions (ease of use, aesthetic design, processing speed, and interactive responsiveness), Wolfinbarger and Gilly (2003) proposed eTailQ with four dimensions (reliability, website design, security and customer service) [[21](#Wol)], Lociacono et al. (2002) developed WEBQUAL composed of twelve dimensions (information, visual appeal, response time, interaction, trust, design, intuitiveness, innovativeness, flow-emotional appeal, integrated communication, business processes, and substitutability) [[22](#VAZ021)] and [[23](#BVa)], Bressolles (2008) developed NetQual with five dimensions (information, ease of use, reliability/fulfillment, security/privacy and site design) [[24](#GBr08)].

Table 1 Common e-SQ measures and their dimensions, taken from [[40](#Iha14)]

|  |  |  |  |
| --- | --- | --- | --- |
| No. | INSTRUMENT | DIMENSIONS | |
| 1 | E-S-QUAL | 1. Efficiency | 3. Fulfillment |
| 2. Availability | 4. Privacy |
| 2 | WebQual | 1. Fit to task | 7. Visual appeal |
| 2. Interaction | 8. Innovativeness |
| 3. Trust | 9. Flow-emotional appeal |
| 4. Response Time | 10. Integrated communication |
| 5. Design | 11. Business processes |
| 6. Intuitiveness | 12. Substitutability |
| 3 | WebQual 4 | 1. Usability | 3. Interaction |
| 2. Information |  |
| 4 | e-TailQ | 1. Website design | 3. Fulfillment/Reliability |
| 2. Customer Service | 4. Security/Privacy |
| 5 | SITEQUAL | 1. Ease of use | 3. Processing speed |
| 2. Aesthetic design | 4. Security |
| 6 | NetQual | 1. Information | 4. Security/Privacy |
| 2. Ease of use | 5. Site design |
| 3. Reliability/Fulfillment |  |

In general, the literature indicated that five dimensions are repeated systematically: information, website design, ease of use, security/privacy and reliability [[25](#Bre11)]. Eventually all the scales and measurements are different in their dimensions and attributes. On the other hand most researchers have focused on limited variables set instead of a full view of e-SQ [[14](#VAZ02)].

## IT-Services

An Information Technology Service (IT-Service) is a ready-to-use deliverable that is of value to the customer, allowing to do business without worrying about underlying technology or Information Technology infrastructure[[3]](#footnote-3).

A quality measurement framework focused on IT-Service concept is useful when organizations take into consideration the linked interactions between their measures and corresponding evaluation, this due the understanding of the interrelated work among a system elements is important to aware how other elements are affected [[26](#Mar14)]. This approach is not applicable when organizations consider each system element as isolated and completely separated units, being that coherency wouldn't be part of reaction to risks and changes. Proposed measurement elements could be used in order to understand improvements and quality on services in three different contexts: simple, complicated and complex.

Based on [[2](#kri13)] and [[26](#Mar14)], five (5) important facts about IT-Services are considered:

1. Quality on IT Service is highly dependent on the expectations from customers.
2. IT Service quality measurement framework is intended to understand the various dimensions of IT Service Quality.
3. When service providers attempt to standardize operations and make processes replicable the service providers often look their organizations as separated units instead of the entire system.
4. Continuous improvement on quality of services increases customer satisfaction, this is vital for companies in order to survive on the market. Nowadays quality has become important and recognized, nevertheless, what remains understudied are both its concrete conceptualization and measurements.
5. Comprehensive view of the quality of service offering on both intrinsic and extrinsic quality attributes that contributes to customer satisfaction is necessary.

## E-commerce

Definition for e-commerce has been defined as the buying and selling of products and services by businesses and consumers through an electronic medium, without using any paper documents. E-commerce is widely considered as the buying and selling of products over the Internet, but any transaction that is completed solely through electronic measures can be considered as e-commerce. E-commerce is subdivided into three categories: business to Business or B2B (for example Cisco Networks), Business to Consumer or B2C (for example Amazon), and Consumer to Consumer or C2C (for example eBay)[[4]](#footnote-4)

Online environment has the power of “fast shifting” to consumers in order to switch to a new provider with a click of a mouse. Online customers expect fast, friendly and high quality service. According to Zhao and Gutierrez (2001) users want choice, convenience, and a responsive service with special touch.

Companies need to focus on e-services supported by appropriate technology in order to maintain customers, improve operational efficiencies and boost revenues from e-commerce. In a market where there are so many players, companies need to be customer-centric. Success for a company is measured by how effectively it interacts with its customers.

Important points about e-commerce are:

1. Business to Consumer (B2C) e-commerce is still new and unproven to many customers.
2. A proactive strategy to develop and implement e-services is important requirement in B2C e-commerce.
3. Adopting new technologies to offer e-services to help, to assist customers during search process, comparison-shopping, to find quick answers, etc., and assure trust and secure transaction, lead to get more customers.
4. Applying new tools and techniques can increase e-Services quality.
5. To increase customer base in e-commerce it is important to implement and continuously review the quality of e-services.
6. It is important to identify the value of each e-service in B2C e-commerce.

Service quality is one of the key factors in determining the success or failure of e-commerce [[7](#Had14)].

## E-government

In [[6](#Moh)] is mentioned that e-government is introduced by many governments with attempt of increasing effectiveness and efficiency. For example, citizens and businesses can get information about government policies and regulations and apply for government benefits from anywhere at any time by using e-government services. Electrocnic government can be used as a tool to improve the transparency of government, leading to more accountability and less depravity. In [[27](#AAl08)] is mentioned the successful rate of e-governement projects has been estimated to be low, approximately 35% of e-government projects in developing countries are failed; almost 50% are partially failed, and only 15% are successful. Studies in e-commerce domain indicate that the lack of electronic services quality (e-serice quality) can cause the failure of projects [[3](#JSa03),[28](#Owe13)] and [[29](#HLi09)].

Since the beginning of human civilization provision of services has been important, especially on how those are delivered. When users get a product they do evaluations according to several factors, style, texture, tags, etc. But when services are purchased, aspects to evaluate become intangible (Parasuraman, Zeithaml and Berry, 1985). Customer perspective about quality of service is fundamental to measure users satisfaction. One of the most recent models which allows to measure the quality of traditional services from two perspectives (Consumer and Marketer) was created as conceptual model in 1985. Parasuraman et al. improved and compacted the conceptual model from 10 dimensions (where Accessibility and Security were considered) to 7 dimensions (where none of the 4-dimensions from this thesis work were considerd). Conceptual Model for e-government services does not consider any of the 4-dimensions (AUES) although it was based on improvements of Parasuraman et al. model. During 2010 (Sá, F., et al. 2014) Alanezi, Kamil and Basri did a proposal to measure quality of e-government services, here Security was considered as part of its conception.

E-government service portals need to understand user needs more than government's perspectives or interests. This is a challenge, that's why it's important to have standardized framework that makes architecture of government service portals as clear as possible, the easier is to find information from user’s perspective the better. According to Sarantis, D., et al. (2009) standard frameworks for electronic governments service portals are still in early age; available technologies are used on advanced profitable products. Considered potential and capabilities of having an applicable, sustainable and ever-expanding framework are guidelines (of the framework), to design, development and operation of portals in central, regional and other levels of government. A general accepted definition for government portal and its characteristics definition, is still pending, therefore concept of a portal has not yet been standardized and as a result each entity which implements their own designs, set its own functionality and technical specifications and put own needs before other more important, which are from customers, citizens and businesses. There are implemented e-government services which are not well-designed or not promoted with agencies that provide them.

Based on [[30](#Dem09)] we consider seven (7) important facts about e-government:

1. Users expect quality services, the online dimension is no exception.
2. Quality of services should be analysed and accounted for, in order to maximize and to develop strategies that improve offered services, increasing the satisfaction levels of their consumers.
3. A consumer will always evaluate the service on several factors.
4. The perspective of user concerning the quality of the service is fundamental to measure satisfaction.
5. It is important to have a model to measure quality of services.
6. A one-stop-shop entry point to government information and services is a significant advancement in the maturity of e-government.
7. E-government services are not either well designed or not suitable promoted.

Difficulty to find the needed information and services, complexity to access and use of e-services, the need for a better helpregarding the e-service provided on the web site, and the content understandability are some issues that might create the need of a quality of e-government esrvice [[31](#CHa07)].

Generally, e-government service quality refers to the degree to which an e-government website could facilitate the competent delivery of efficient e-services to help citizens, businesses and agencies in achieving their governmental transactions [[32](#CWT)].

Quality of e-government services can be considered as the driving force to improve e-government efficiency and increase satisfaction on citizens [[6](#Moh)].

It is believed that the success of governmental organizations will depend on the quality of e-government services provided to citizens. Therefore, by understanding the dimensions of quality e-government services enhancing satisfactionson users and gaining user trust, government service managers and governmental organizations should be able to reduce some risks (e.g. investing valuable resources in e-service quality characteritics that may not work effectively) [[6](#Moh)].

One of the main obstacles in an online environment development is the lack of confidence stimulated by the deficiency of security and privacy [[33](#ECr07)].

## E-infrastructure

Interoperability in e-government has been recognized as key factor in the quest for administrations at national, local and international level to achieve the provision of one-stop services to citizens and businesses (Charalabis, Panetto, Loukis, & Mertins, 2008)

Deployment of information systems over the last 30 years has resulted in the need for opening up and connection closed applications. Such an interoperable, networked and heterogeneous structure is called information infrastructure [[28](#Owe13)]. E-infrastructures usually take place when various applications merge allowing dissimilar applications to be linked into networks. E-infraestructure design never starts in a green-field situation, this means that the central problem is how to integrate existing applications, which are locally controlled by different organizations into an interoperable distributed e-infrestructure of IT capabilities, there is no concrete way to accomplish this. Interoperability in e-government shoud enable efficient information exchange between applications from different agencies in order to provide high quality services to both, businesses and citizens. E-infraestructures are not designed by an omnipotent design and the e-infraestructre emerges from e-infraestructure growth.

Based on [[28](#Owe13)] we consider five (5) important facts about e-infrastructure:

1. Interoperability should enable efficient information exchange between applications from different agencies with help of IT-Services.
2. Interoperability is accomplished by e-infrastructure. Knowledge of how to develop e-infrastructures in the public sector is still limited.
3. The initial problem of starting-up development of e-infrastructure is bootstrapping.
4. Success in e-government requires working together across traditional boundaries to improve services significantly and to reduce operating costs.
5. Central problem is how to integrate existing applications, which are locally controlled by different organizations into an interoperable distributed e-infrastructure of Information Technology (IT) capabilities (Edwards et al., 2009). How to accomplish this is still limited.

## E-services Providers

Around trust and trustworthiness there have been several researches. A trustworthy service is considered to have as minimum a set of elements, those are: preserve and respect the privacy concern of its users, be reliable and be delivered with the top level business integrity. Continuous growth of e-services economy is a trigger for stakeholders to adopt trustworthiness as critical component on offered e-services. Eight elements fundamental for trustworthiness of e-services are identified; only two are related not directly with the 4-dimensions concerning this thesis (‘Privacy’ and ‘Third parties’, both related to Security dimension). According to Ostasius, E., & Petraviciute, Z. (2010), there should be a developed tool for the quantitative assessment of trustworthiness, having two parts, one for evaluating the e-service provider and another part to assess the e-service provider from the user's perspective.

Different maturity, complexity and rapid growth of new e-services promote assessment and comparison with each other [[34](#Egi10)]. Talking about services for the public sector, there is a model, which assist authorities to evaluate maturity and complexity level of provided e-services. Some studies with their methodologies of measuring sophistication level have ranked countries for e-government implementation; they bear basic features in common and are based on the stage models of sophistication. According to Al-Dabbous, N., et al. (2011) demand of high quality e-services means to have a complex providing system, and contrary, the higher sophistication level means the simpler e-service from the user point of view.

Based on [[34](#Egi10)] we remark fourteen (14) important points about e-services providers:

1. Assessment and comparison on new e-services takes place as the number of new e-services growth.
2. Having a model is useful on evaluating the maturity and complexity of e-services.
3. A model has to have measures on its methods.
4. On evaluating e-service, main aspects and characteristics should be identified.
5. The higher sophistication level means the higher maturity of the e-service, the higher sophistication causes the higher service level.
6. Evaluation of e-service maturity means also the evaluation of the system complexity.
7. For construction of the evaluation criteria is recommended to use Model for Service-Oriented Architecture, service categorization, and elements of the e-service model.
8. It is important to consider a quantitative assessment of the trustworthiness level of e-service provider.
9. There are eight fundamental elements affecting the level of trustworthiness of e-service: service personnel, information and communication, technology, policies and plans, service level agreements, privacy, accountability and third party.
10. Result of assessment indicate areas of weakness and strengths.
11. Measures of performance, productivity and success have to be related to the degreee of service users' trust and satisfaction with the provided services.
12. Organizations have to be aware of ethical responsibilities associated with offered services.
13. A trustworthy service must: be secure, preserve and respect the privacy concerns of its users, be reliable, and be delivered with the highest business integrity.
14. A secure service preserves and enforces the confidentiality, integrity and availability of information while in storage, or being processed or transmitted.

For online suppliers e-service quality can create distinctiveness, and this is specially useful for small companies [[3](#JSa03)].

## Online environment vs. Traditional business

The differences between online environment and traditional business unit are as follows [[35](#RLa10)]:

* Convenience and efficiency: consumers using the online environment have the convenience of sving time and effort in comparing the price (and some technical features) of product more efficiently [[3](#JSa03)].
* Safety and confidentiality: participation in the online environment involves users in distinctive issues regarding privacy, safete and confidentiality.
* Absence of face-to-face contact: the absence of person to person interaction means that the traditional concepts and ways of measuring service quality, which emphasis the persoanl interaction of the conventional service encounter, are inadequate when applied to e-service quality.
* Co-production of service quality: customer in online environment play a more prominent role in co-producing the delivered service that is the case of traditional context [[36](#MFa07)].

## Chapter summary

Based on previous section of this chapter the State-of-the-Art about e-services and its quality can be summarized as follows.

There are many and different studies for measuring e-service quality, but there is no e-service concept definition as reference, on the other hand all the studies propose different dimensions for evaluating e-service quality, but there is no proposed reference considering which are basic and common dimensions for understanding the quality of e-services.



Figure 1. The e-services State-of-the-Art meta-model

In the State-of-the-Art of e-services and its quality there are many and different models suggesting different dimensions, and measurement instruments (Table X) for saying how good, bad, high or low is the quality of e-services, all of them are reinventing the wheel and suggesting in different ways how to do the same idea “how to evaluate and meassure the quality of e-services according with the perspective of its authors”, but what is missing on the State-of-the-Art is a model which suggests the reference starting point in terms of dimensions and key components for undestanding the qualiy of e-services. Since the quality and context for all the different types of e-services are different it is not possible to have the most generic way to measure the quality of any kind of e-services, but it is possible to understand the qualitative characteristics of e-services as starting point on the quest and definition for evaluating the quality of e-services.

# The e-service concept and four dimensions

On this chapter, four (4) dimensions considered for this thesis work are presented Accessibility, Usability, Efficiency and Security (AUES), and a concept definiton of e-service in terms of AUES. An hypothesis per each dimention is set in order to establish a conclusion after applying the proposed conceptual model to selected Estonian e-services.

## Four dimensions for e-services (AUES)

E-services aim to offer to their users various electronic resources and capabilities to execute electronically various tasks and transactions. These include search for products and services, transaction with banks and government agencies, and acquisition of new knowledge and skills. They can do these on a 24-h basis from their homes or offices [[4](#ELo12)].

It is referenced on [[4](#ELo12)] that despite the high investments that have been made for setting up and running e-services, for most of them, usage is below expectations and users are not satisfied with their quality (European Commision 2008, sumak et al. 2009), so they need improvements in order to reach higher levels of maturity.

Many e-services have been developed and are currently used by individual and organizations, however their usage and quality typically are below the expectations of users. Diversity on businesses has created a different kind of e-services, therefore is common to find different dimensions to understand e-services quality.

On this thesis work four dimensions are proposed for understanding the quality of e-services: (1)Accessibility, (2)Usability, (3)Efficiency, and (4)Security, shown in Figure 2.



Figure 2. Four Qualitative dimensions for e-services

We define each dimension and set an hypothesis for each one as follows:

### Accessibility dimension

According to Kim et al., on system availability dimension of E-S-QUAL is a significant element to ensure that techinical functionality of the website is properly working which may direct to high user satisfaction and good productivity [[37](#MKi061)].

H.A.: Accessibility dimension in e-services positively influences customer satisfaction.

### Usability dimension

According to Yoo and Douth, ease of the site usage is one of the most significant elements that have influenced online satisfactions and behaviours on online users [[38](#BYo01)]. The complexity to use or consume an e-service might emerge dissatisfaction and respectively decrease the trust of users leading them to search for alternatives.

H.U.: Usability dimension in e-services positively influences customer satisfaction.

### Efficiency dimension

Two of the most important reasons for users to do their online transactions are convenience and time saving [[37](#MKi061)]. The efficiency dimension will play a substantial role in achieving the goal of providing fast and convenient access to information and services [[6](#Moh)].

H.E.: Efficiency dimension in e-services positively influences customer satisfaction.

### Security dimension

Security encompasses low risk associated with online transactions, safeguarding personal information, and safety in completing online transactions [[7](#Had14)].

Security is the degree to which the customer believes the sie is safe from intrusion and personal information is protected [[39](#APa05)].

H.S.: Security dimension in e-services positively influences customer satisfaction.

/\* how is e-service concept defined in terms of AUES? \*/

## Chapter Summary

# Conceptual model for understanding e-services qualitative characteristics

The literature indicates a lack of global set of dimensions for measuring e-SQ [[13](#NSe06)]. Researchers used various dimensions and proposed different quality measurement instruments for e-SQ based on the field of their study (Section 2.6, Table 1). Moreover, the dimensions of the common measures are subject to change based on researches study [[40](#Iha14)]. Yang et al. (2003) indicated that e-SQ dimensions tend to be dependent on various industries and different service types even within same industry [[19](#ZYa03)].

On this chapter, a quality in use and a product quality model are defined,

Note: A way of thinking on the user quality perspective and expectations (Quality in use model components) was strongly considered for creation of conceptual model for understanding e-services qualitative characteristics.

## Quality in use model for e-services

Quality in use model characterizes the impact e-services have on users to meet their needs to achieve specific goals with effectiveness, efficiency, freedom from risk and satisfaction in specific contexts of use [[5](#BSI11)].

In order to propose a set of attributes the question the question “What are the qualitative characteristics of an e-service from the user perspective?“ was considered.

Based on ... and from the perspective of e-service user, the attributes for quality in use considered on this thesis work are: Convenience, Performance, Trustworthiness, and Compatibility, depicted in Figure 2.



Figure 2. E-Service model for Quality in use

**Convenience** ...

**Performance** refers to how an e-service provides responce and processing times when by performing its functions, meet requirements.

**Trustworthiness** is the integrity of a system that errors or attacks will not lead to damage to the state of the system, including data, code, etc [[5](#BSI11)].

**Compatibility**, we define it as the degree to work or share information with other e-services of same type in which an e-service can be used in building new e-services regardless the hardware for software environment.

## Product quality model for e-services

Product quality model represents the characteristics expected by e-services users.

In order to propose a set of attributes the question the question “What are the qualitative characteristics of an e-service from the provider perspective?“ was considered.

Based on ... and from the perspective of e-service provider, the attributes for product quality considered on this thesis work are: Compatibility, Funcionality, and Reliability, depicted in Figure 3.



Figure 3. E-Service Product Quality Model

Hypothesis: Compatibility, Functionality, and Reliability contribute to the quality provided in e-services for users.

**Compatibility**, we define it as the degree to work or share information with other e-services of same type in which an e-service can be used in building new e-services regardless the hardware for software environment.

**Functionality** it refers to the service characteristics regarding the functions and availability of the e-service.

**Reliability** is defined as the ability to perform the promised service dependably and accurately [[7](#Had14)]. Comprises four items related to accurate online transactions, accurate records, correct performance and fulfillment, correct performance and fulfillment of promises [[41](#ZYa04)]. Reliability is a significant determinant of overall service quality, satisfaction, perceived value, intention to use and re-use intentions [[35](#RLa10)]. In online services, it is important to ensure trust that service provider keeps his promises. Reliability can make users realize the consistency of services providers and credibility as well [[15](#HLi091)].

## Quality in use model and AUES dimensions

// qualitative characteristics // E-service customer perceptions

Figure 5, shows both the quality in use model (Chapter4, Part 1) and the four proposed dimensions (Chapter 3, Part 1), where relationships between the e-service Quality in use model components and AUES dimensions are shown.

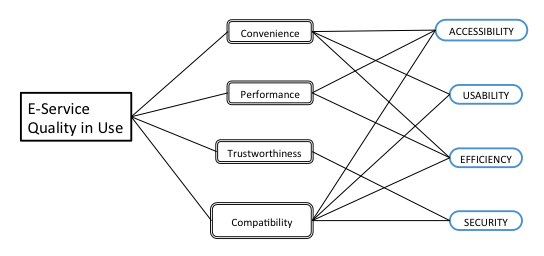


Figure 5. Relationships between quality in use model and AUES dimensions

## Quality product model and AUES

// E-service provider perceptions

Figure 6, shows the quality product model (Chapter , Part ) and and the four proposed dimensions (Chapter 3, Part 1), where relationships between the e-service Product Quality Model components and AUES dimensions are shown.

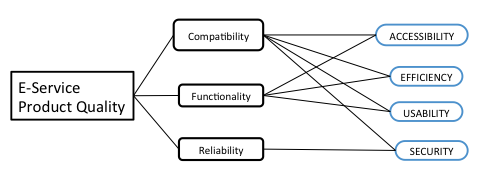


Figure 6. Relationships between product quality modela dn AUES dimensions

## Quality in use, Product quality models and AUES dimensions

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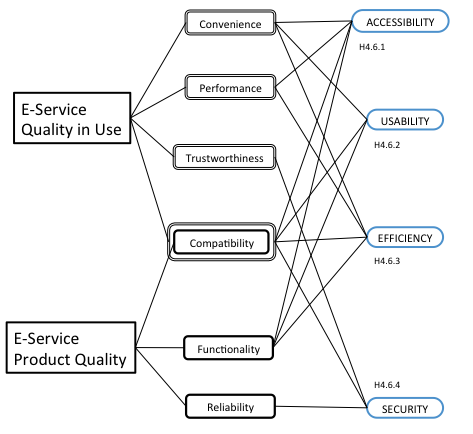


Figure 7. Quality in use, Product quality and AUES dimensions

Table 2 helps to understand relationships between e-service qualitative characteristics (quality in use, product quality models) and AUES quality dimensions.

Table 2. Relationships between e-service qualitative characteristics and AUES quality dimensions



## Hypothesis on e-services AUES dimensions and Qualitative characteristics

**H4.6.1**: Degree of Accessibility quality dimension contributes directly but independently to Convenience, Performance, Compatiblity, and Functionality qualitative characteristics.

**H4.6.2**: Degree of Usability quality dimension contributes directly but independently to Convenience, Compatibility, and Functionality qualitative characteristics.

**H4.6.3**: Degree of Efficiency quality dimension contributes directly but independently to Convenience, Performance, Compatibility, and Functionality qualitative characteristics.

**H4.6.4**: Degree of Security quality dimension contributes directly but independently to Trustworthiness, Compatibility, and Reliability qualitative characteristics.

Previous hypothesis are depicted on Figure 7.

## AUES and key e-service dimensional components

Based on ...

Figure 7 shows four proposed dimensions (Chapter 3, Part 1) with a set of components for each one of AUES dimensions.

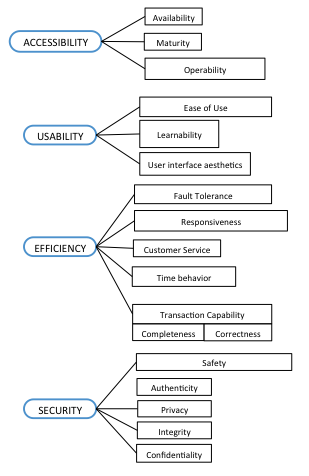


Figure 7. AUES dimensions and their key components.

Following subsections contain definitions for each dimentional key component.

### Accessibility key components

* **Availability** enables continuous access to online service and enhances loyalty on users [[42](#KWa02)]. If users cannot use the online system on their need to get online service, they will leave the site [[15](#HLi091)]. The system availability is a significant element to ensure the technical function, which may increase user satisfaction [[37](#MKi061)].
* **Maturity** is the degree to which a system, product or component meets needs for reliability under normal operation[[5]](#footnote-5).
* **Operability** is the degree to which a product or system has attributes that make it easy to operate and control5.

### Usability key components

* **Ease of use** refers to moderate efforts required to navigate a website, well organized/structured and easy-to-follow catalogs, and ease of completing an online transaction [[41](#ZYa04)]. Internet-based transactions might seem complex and intimidating to many customers, it is reasonable to expect the ease of use to be determinant of perceived e-service quality [[39](#APa05)]. Yoo and Douthu (2001) indicated that ease of use is a significant element that affect the satisfaction of the online user [[38](#BYo01)].
* **Learnability** is the degree to wich a product or system can be used by specified users to achieve specified goals of learning oto use the product or system with effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use6.
* **User interface aesthetics** is the degree to which a user interface enables pleasing ans satisfying interaction for the user6.

### Efficiency key components

* **Fault tolerance** is the degree to which a system, product or component operates as intended despite the presence of hardware or software limits[[6]](#footnote-6).
* **Responsiveness** is the handling of problems effectively and responding to users in online environment, wich can increase the satisfaction of users [[15](#HLi091)]. Online users expect the organization to punctually respond to their inquiries [[43](#Yan02)]. Lee and Lin stated that many studies showed a remarkable correlation between responsiveness and satisfactions on users [[12](#GGL05)].
* **Customer Service** consumers expect to be able to complete transactions correctly, to receive personalized attention, to have the product delivered on time, to have thier emails answered quickly and to have access to information. Website management should ensure these expectations are met in the best way possible. [[33](#ECr07)]
* **Time behavior** is the degree to which the response and processing times and throughput rates of a product or system, when performing its functions, meet requirements[[7]](#footnote-7). Obi claimed in [[44](#MCO09)] that lengthy process times may affect user satisfaction, user trust, and productivity negatively.
* **Transaction Capability**, this term refers to a set of communication capabilities that provide and interface between applications and a network layer service. is the degree to provide the means for the transfer of information between nodes, and to provide generic services to applications, while being independent of any of these [[45](#Int98)]. This particular component is composed of the following subcomponents to work with other e-services or applications:
  + **Completeness** is the degree to which the set of functions covers all the specified tasks and user objectives[[8]](#footnote-8).
  + **Correctness** is the degree to which a product or system provides the correct results with the needed degree of precision6.

### Security key components

* **Safety** is the attribute of a system that it will not incur any catastrophic failures in the interval of time when it is in use. [[5](#BSI11)]
* **Authenticity** is the degree to which the identity of a subject or resource can be proved to be the one claimed[[9]](#footnote-9).
* **Privacy** is the degree to which the e-service is safe and protects customer information [[39](#APa05)] and refers to companies not sharing information with third parties unless the customer gives permission [[7](#Had14)]. In addition, this includes providing visual symbols so customers know a secure connection is being achieved [[9](#JEC06)].
* **Integrity** is the degree to which a system, product or component prevents unauthorized access to, or modification of, computers programs or data9.
* **Confidentiality** is the degree of which a product or system ensure that data are accessible only to those suthorized to have access9.

## Hypothesis on AUES Key dimensional components

For this thesis work were considered a series of seven hypothesis based on connnections among the AUES key dimensional components, figure 9 depicts those connections which are meant for supporting the qualitative characteristics of e-services (Quality in use model, Chapter 4, part 1) throughout AUES quality dimensions.

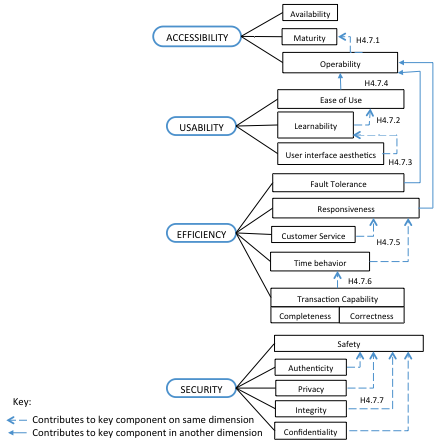


Figure 9. Connections among AUES key dimensioinal components

### Hypothesis series

**H4.7.1**: Operability component contributes to degree of maturity.

**H4.7.2**: Learnability component contributes to degree of Ease of use.

**H4.7.3**: User interface aesthetics contributes to degree of Learnability.

**H4.7.4**: Fault Tolerance, Responsiveness, and Ease of Use contribute directly but independently to degree of Operability.

**H4.7.5**: Customer Service and Time behavior components contribute directly but independently to degree of Responsiveness.

**H4.7.6**: Composed component Transaction Capability contributes directly to the degree of Time Behaviour component.

**H4.7.7**: Authenticity, Privacy, Integrity, and Confidentiality contribute the degree of Safety component.

Previous set of hypothesis would help on applying the conceptual model to selected Estonian e-sevices on chapter 5 which will support their dependability.

## Dependability

## Conceptual Model

Based on Quality in Use model (Chapter 4, Part 1), Quality Product model (Chapter 4, Part 2), proposed AUES Quality dimensions (Chapter 3, Part 1) and their key components (Chapter 4, Part 6), and taking into account the ISO/IEC 25010 standard (Chapter 2, Part 5) the conceptual model on figure 10 proposes six qualitative characteristics for understanding the quality of e-services.

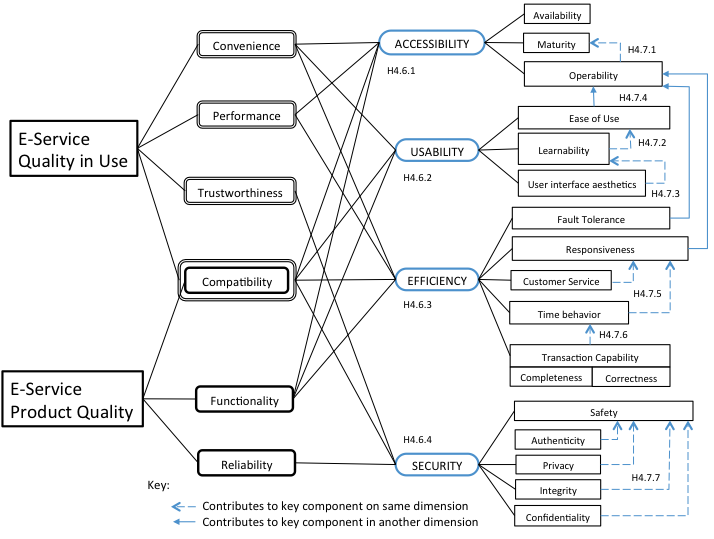


Figure 10. Conceptual model for understanding qualitative characteristics of e-services

Table 2 in section 4.5 can be used in order to have a clear understanding on how relationships between qualitative characteristics and AUES qualitative dimensions are.

On next chapter proposed conceptual model for understanding characteristics of e-services will be applied in order to test how effective it could be.

# Applying conceptual model on selected Estonian e-services

## Estonian e-service 1: Digital Prescription

## Estonian e-service 2: X-Road services for citizens via eesti.ee

## Methodology

## Scope

## Limitations

Some type of users in both provider (people who give support, content provider, system manager/administrator, security manager, maintainer, analyzer, porter, installer) and customer perspective (indirect people who receives output, but does not interact with an e-service) are not considered as part of this thesis work, those type of users accordig witn ISO/IEC 25010 are: Primary

# Results and discussion

## Results

## Discussion

# Conclusions and future work

## Conclusions

All the e-service quality evaluation methods should consider Accessibility, Usability, Efficiency and Security perspectives.

We agree with [[4](#ELo12)] on the fact that for each kind of e-service, it is still necessary to define the value dimensions and measures.

Most of current e-services are not matture in terms of quality.

Customers determine this qualitative characteristics in evaluating e-service quality regardless the type of service, other qualitative characteristics could be important in specific context and service objectives.

This thesis work has revealed that the AUES dimensions and its key components for each one ...

There are many other key components for AUES or another dimensions that are suitable for specific contexts, as part of future work they should be complemented to specific type of industry they are used in.

## Future work

To develop a mesarement instrument to evaluate the quality of e-services based on the conceptual model presented on this thesis work.

To see how the ISO/IEC 25012 standard (model for data quality) could be a complement to this work remains as future work as well.

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Appendix

1. Glossary

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| --- | --- |
| Attribute  Inherent property or characteristic of an entity that can be distinguished quantitatively or qualitatively by human or automated means [[5](#BSI11)]. | Sisestusmärk  Märk, mis märgib teksti sisestamise asukohta. |
| User  Individual or group that interacts with a system or benefits from a system during its utilization [[5](#BSI11)]. | Mall  Näidik, muster või valuvorm, mis esitab täitmisele võetava töö struktuuri. |
| Quality property  Measurable component of quality [[5](#BSI11)]. |  |
| Quality Model  Defined set of characteristics, and of relationships between them, which provides a framework for specifying quality requirements and evaluating quality [[5](#BSI11)]. |  |

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1. http://www.businessdictionary.com/definition/services.html [↑](#footnote-ref-1)
2. http://its.yale.edu/news/itil-foundations-what-service [↑](#footnote-ref-2)
3. http://its.ucsc.edu/itsm/servicemgmt.html [↑](#footnote-ref-3)
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