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UNIVERSITY OF TARTU FACULTY OF MATHEMATICS AND COMPUTER SCIENCE Institute of Computer Science Software Engineering Curriculum

Israel Cuautle Muñoz

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

Master's Thesis (30 ECTS)

Tartu 2016

Tartu 2016

Supervisor(s): Raimundas Matulevičius, PhD

Understanding the Quality of e-Services: Accessibility, Usability, Efficiency, and Security. Abstract: With the fast evolution of technology during last decade today it 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 not only on business drive us to think about it in two points (A) what exactly 'e-service' is? and (B) 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? This thesis presents a conceptual model in order to understand e-services key components (qualitative characteristics) regarding Accessibility, Usability, Efficiency, and Security (AUES), for this goal a systematic literature review on 'e-service' conceptual definition with emphasis on AUES was performed. Presented conceptual model allows to understanding the quality of e-services based on AUES and their dependability, it also contributes as base reference to cover gaps for understanding both 'e-service' concept and quality perception. We conducted a series of tests to see how conceptual model performs with selected Estonian e-services. Results show e-services key components relevance in terms of AUES to identify conceptual model applicability, scope and limitations.

Introduction The fast growth of Internet has created great opportunities for business regarding electronic services offered via Internet (e-services), E-services are becoming increasingly important not only for determining either success or failure of electronic commerce (Yang et al., 2001), but also 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 units. Nowadays users have better access to information they need in a different-easy manner, users don't have to wait too much or to be physically at specific venue to get results about specific services they need, indeed 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 on valid and different ways this concept according to their interests and convenience, therefore perception about provided quality is also different, this means entities interests have priority instead of users satisfaction when they use and consume e-services. In his thesis a conceptual model is presented in order to understand e-service key components of qualitative

characteristics regarding Accessibility, Usability, Efficiency, and Security, referencing to them along this thesis work as AUES; we will also understand concept of e-service, and specifically how it could be efficiently used, accessed and utilized, it is necessary to have reference point to understand how quality depends of AUES and how is the dependability among those dimensions. "How to assess the dependability among AUES in order to understand the quality of e-services?" is our research question. To determine a set of key e-service components regarding its UAES is our research objective. This work contributes to the State-of-the-Art with a reference point on defining e-service concept and mainly providing a conceptual model to understand quality on four dimensions: Accessibility, Usability, Efficiency and Security (AUES). Understanding e-service concept in standard way and its quality in terms of its AUES dimensions and their dependability through a model, gives the opportunity to combine different e-services to produce for example, new business artifacts, increase users satisfaction, and give the chance to notice improvement areas on e-services. Organization of thesis This thesis work is organized in the following 7 chapters: Chapter 1 gives an introduction and shows organization of this thesis work. Chapter 2 gives the State-of-the-Art regarding e-services related areas such as IT-Services, E-Services current definitions, Quality related to e-services, E-Government, E-Infrastructure, and E-Services Providers. Chapter 3 is focused on understanding concept of e-Service on four dimensions: (1) Accessibility, (2) Usability, (3) Efficiency and (4) Security (AUES) to understand its quality through dependability among them. Chapter 4 is the part where conceptual model is presented explaining how it works and ideas behind which contributed to its design. Chapter 5 is about applying proposed conceptual model to selected Estonian e-services and getting results on how model performs on them. Chapter 6 is a discussion about results from experiencing with conceptual model on selected Estonian e-services. Chapter 7 it is not only results summary and its interpretations but also we set what we learned from the model and its limitations when it is applied it to real Estonian e-services, future work and remaining questions are also presented here. The State-of-the-art The way how immaterial goods are delivered to users is giving remarkable opportunities to business over the Internet. The State-of-the-Art used in the thesis does mention about what has been understood as e-services during recent years and what is done related to them, for this, we consider IT-Services, e-services, quality related to e-services, e-government, e-infrastructure, and e-services providers. A Service is an intangible activity, which

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is not stored and does not result in ownership. A service is consumed at the point of sale (

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A Service is a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs or risks (ITIL V3, Service design).

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Examples of services include the transfer of goods, such as the postal service delivering mail, and the use of expertise or experience, when a person

is visiting a doctor. Figure 1. UML representation of the State-of-the-Art regarding e-services. IT-Services An IT

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service is a ready-to-use deliverable that is of value to the customer, allowing to do business without worrying about underlying technology or IT infrastructure (
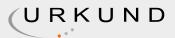
University of California Santa Cruz, 2015).

An IT Service exhibits the following characteristics: • Fulfils one or more needs of the customer. • Supports the customer's business objectives. • Is perceived by the customer as a coherent whole or consumable product.

Services need to be described and understood both in terms of functional capabilities and service quality properties (Kritikos, K., et al, 2013). Service quality combines several properties of a service, for instance, 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 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 considers subjectivity to do measurements, for example usability or reputation, both QoE and QoS give a perception to users. According to (Kritikos et al., 2009), 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, those 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 specifies the service characteristics, components and observable parameters. 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 understanding the interrelated work among a system elements is important to aware how other elements are affected (Lepmets, M., et al. 2013). 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 context: simple, complicated and complex. 5 Important facts about IT-Services: 1. Quality on IT Service is highly dependent on the customers' expectations. 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's 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-Service, current definitions 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. Hewlett Packard Company

> defines e-services as "modular, nimble, electronic services that perform work, achieve tasks, or complete transactions".

An e-service is any asset that is made available via the internet to drive new revenue streams or create new efficiencies. 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. E-commerce As definition of e-commerce we have it is

> 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 (

InvestorWords, 2015). In the online environment the power if fast shifting to consumers who can switch to a new provider with a click of a mouse. Online customers expect fast, friendly and high quality service. They want choice, convenience, and a responsive service with special touch (Zhao and Gutierrez, 2001). It is clear enterprises 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, enterprises need to be customer-centric. Success of a company is measured by how effectively it interacts with its customers. Important points about e-commerce: 1. 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, wins customers. 4. E-Services quality can be increased by applying new tools and techniques. 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. Quality related to e-services Quality on web portals is worth observing and should be evaluated taking in consideration different perspectives of quality, here quality is the perception of users and the results using a web portal. Some characteristics of quality have been studied but, there is no model aligned with the ISO/IEC 25010 standard, which is an evolution of ISO/IEC 9126, and defines three main characteristics about quality: Usability, Safety and Flexibility. 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 (Herrera, M., et all, ?). 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 safe 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. 11. Perception of quality in use must be measured in terms of results on using a software, not properties of the software itself. E-government Since the beginning of human civilization provision of services has been important, especially on how those are delivered. When user gets a product he/she does evaluation 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 his/her 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 the conceptual model with 10 dimensions (where Accessibility and Security were considered) were reduced to 7 (where none of the 4 considered elements are not considered as part of). Conceptual Model for e-government services does not consider any of the 4-dimensions (usability, security, efficiency, and accessibility) though 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 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. Standard frameworks for electronic governments service portals are still in early age (Sarantis, D., et al. 2009), 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 function 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. 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 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 eGovernment. 7. eGovernment services are not either well designed or not suitable promoted. E-infrastructure

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Interoperability in e-government has been recognized as key factor in the quest

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administrations at national, local and international level to achieve the provision of one-

topp Panetto, Loukis, & Mertins, 2008).

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Deployment of information systems over the last 30 years or more has resulted in the need for opening up closed application and connectin them. Such an interoperable, networked and heterogeneous structure is called information infrastructure (

Eriksson, O., & Goldkuhl, G. 2013).

E-infrastructures usually from only when various applications mege allowing dissimilar application s to be linked into networks,

design of e-infraestructure 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,

how to accomplish this is still limited.

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 designed and the e-infraestructre emerges from e-infraestructure growth. 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-infrastructures. 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 to work together across traditional boundaries to improve services significantly and to reduce operating costs. 5.
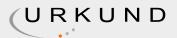
Central problem is how to integrate existing applications, which are locally controlled by different organizations into an interoperable distributed e-infrastructure of IT

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 of 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 regarding security). Relevant point about those identified elements is a developed tool for the quantitative assessment of trustworthiness, it has two parts one for evaluating the e-service provider and other part to assess the e-service provider from the user's perspective (Ostasius, E., & Petraviciute, Z. 2010).

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Different maturity, complexity and rapid growth of new e-services promote assessment and comparison with each other.

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

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for

e-government implementation, they bear basic features in common and are based on the stage models of sophistication.

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E-services on demand with higher service level means the more complex system providing the e-service. And contrary, the higher sophistication level means the simpler e-service from the user point of view (

Al-Dabbous, N., et al. 2011) Important points about e-services providers: 1. Assessment and comparison on new e-services takes place as the number of new e-services grows. 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.

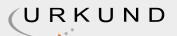| 0: http://dl.ifip.org/db/conf/ifip5-5/prove2010/OstasiusP10.pdf	97%

The higher sophistication level means the higher maturity of the e-service, the higher sophistication causes the higher service level. 6.

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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 is a service that preserves and enforces the confidentiality, integrity and availability of information while in storage, or being processed or transmitted. Understanding e-service concept The following table represents dimensions of interest on each instrument. No. INSTRUMENT DIMENSIONS 1 E-S-QUAL Efficiency, Privacy 2 WebQual Design, Intuitiveness, Visual appeal 3 WebQual 4 Usability 4 e-TailQ Security/Privacy 5 SITEQUAL Ease of use, Security 6 NetQual Ease of use, and Security/privacy

Accessibility as Instrument, has no dimensions. Four dimensions for e-services (SAUE) 3.1.1 Understanding Security 3.1.2 Understanding Accessibility 3.1.3 Understanding Usability 3.1.4 Understanding Efficiency Key e-service components for Quality Conceptual model for understanding e-services quality Applying conceptual model on selected Estonian e-services Results Conclusions References x [1] Kritikos, K., Pernici, B., Plebani, P., Capipiello, C., ... Carro, Manuel. (2013). A Survey on service Quality Description. ACM Computer Surverys, Vol. 46, No. 1, Article 1. [2] Lepmets, M., Lluís, A., Cater-Steel, A., Mas, A., & Ras, E. (2013). The Evaluation of the IT Service Quality Management Framework in Industry. Global Institute of Flexible Systems Management. [3] Sá, F., Rocha, Á. & Pérez, M. (2014). Quality Models of e-Government Online Services Towards a Local Focus. IEEE. [4] Sarantis, D., Tsiakaliaris, C., Lampathaki, F., & Charalabidis, Y. (2009). A Standardization Framework for Electronic Government Service Portals. Springer Science + Business Media. [5] Eriksson, O., & Goldkuhl, G. (2013). Preconditions for public sector e-infrastructure development. Elsevier Ltd. [6] Ostasius, E., & Petraviciute, Z. (2010).

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should enable efficient information exchange between applications from different agencies with help of IT-Services. 2. Interoperability is accomplished by e-infrastructures. Knowledge of how to develop e-infrastructures in the public sector is still limited. 3.	should enable efficient information exchange between applications from different agencies with the help of IT-services. Interoperability in networked IT-service delivery is accomplished by e-infrastructures. However, knowledge of how to develop e-infrastructures in the public sector is still limited.

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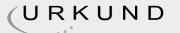
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Success in e-government requires to work together across traditional boundaries to improve services significantly and to reduce operating costs. 5.

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Success in e-government requires agencies to work together across traditional boundaries to improve services significantly and to reduce operating costs.

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Different maturity, complexity and rapid growth of new e-services promote assessment and comparison with each other.	different maturity and rapid growth of the number of new e-services promote the assessment and their comparison with each other.
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for e-government implementation, they bear basic features in common and are based on the stage models of sophistication.	for e- services: they bear the basic features in common and are based on the stage models of sophistication.
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The higher sophistication level means the higher maturity of the e-service, the higher sophistication causes the higher service level. 6.

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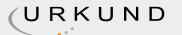24: http://dl.ifip.org/db/conf/ifip5-5/prove2010/OstasiusP10.pdf   100%

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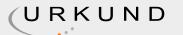| 10: http://isiarticles.com/bundles/Article/pre/pdf/9197.pdf 70%	10: http://isiarticles.com/bundles/Article/pre/pdf/9197.pdf 70%
Deployment of information systems over the last 30 years or more has resulted in the need for opening up closed application and connectin them. Such an interoperable, networked and heterogeneous structure is called information infrastructure (Eriksson, O., & Goldkuhl, G. 2013). E-infrastructures usually from only when various applications mege allowing dissimilar application s to be linked into networks,	deployment of information systems over the last 30 years or more has resulted in the need for opening up closed applications and connecting them. Such an interoperable, networked and heterogeneous structure is called an information infrastructure (Hanseth & Lyytinen, 2004, 2010), or e-infrastructure (Edwards, Bowker, Jackson, & Williams, 2009). E-infrastructures typically form only when various applications merge allowing dissimilar applications to be linked into networks.

Instances from: http://www.wseas.us/e-library/conferences/2010/Harvard/CEA/CEA-04.pdf

23: http://www.wseas.us/e-library/conferences/2010/Harvard/CEA/CEA-04.pdf 93%	23: http://www.wseas.us/e-library/conferences/2010/Harvard/CEA/CEA-04.pdf 93%
Measures of performance, productivity and success have to be related to the degreee of service users' trust and satisfaction with the provided services. 12.	measures of performance, productivity and success have to be related to the degree of service users' trust and satisfaction with the provided services.

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8: http://link.springer.com/content/ pdf/10.1007/978-3-642-16985-4_9.pdf 96%	8: http://link.springer.com/content/ pdf/10.1007/978-3-642-16985-4_9.pdf 96%
According to ISO, there are various perspectives of quality: internal, external and in use. 3.	According to the ISO, there are various perspectives of quality: internal, external, and in use.

Instances from: http://th4.ilovetranslation.com/F19KQ6b-bHS=d/

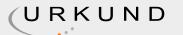| 22: http://th4.ilovetranslation.com/F19KQ6b-bHS=d/ 94%	22: http://th4.ilovetranslation.com/F19KQ6b-bHS=d/ 94%
eight fundamental elements affecting the level of trustworthiness of e-service: service personnel, information and communication, technology, policies and plans, service level agreements, privacy, accountability and third party. 10.	eight fundamental elements affecting the level of trustworthiness of e-service organizations, namely, the service personnel, information and communication, technology, policies and plans, service level agreements, privacy, accountability and third party.

Instances from: http://searchcio.techtarget.com/definition/e-services

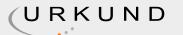| 5: http://searchcio.techtarget.com/definition/e-services 100%	5: http://searchcio.techtarget.com/definition/e-services 100%
defines e-services as "modular, nimble, electronic services that perform work, achieve tasks, or complete transactions".	defines e-services as "modular, nimble, electronic services that perform work, achieve tasks, or complete transactions."

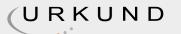Instances from: http://www.investorwords.com/6664/service.html

0: http://www.investorwords.com/6664/service.html	100%

is not stored and does not result in ownership. A service is consumed at the point of sale (

0: http://www.investorwords.com/6664/service.html	100%

is not stored and does not result in ownership. A service is consumed at the point of sale.

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Examples of services include the transfer of goods, such as the postal service delivering mail, and the use of expertise or experience, when a person

2: http://www.investorwords.com/6664/service.html	92%

Examples of services include the transfer of goods, such as the postal service delivering mail, and the use of expertise or experience, such as a person

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A Service is a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs or risks (ITIL V3, Service design).

1: http://its.ucsc.edu/itsm/service.html	100%

A service is a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs or risks. ITIL v3, Service Design

3: http://its.ucsc.edu/itsm/service.html	88%

service is a ready-to-use deliverable that is of value to the customer, allowing to do business without worrying about underlying technology or IT infrastructure (

3: http://its.ucsc.edu/itsm/service.html	88%

service is a coherent, ready-to-use deliverable that is of value to the customer. Services allow customers to do business without worrying about underlying technology or IT infrastructure.

4: http://its.ucsc.edu/itsm/service.html	95%

An IT Service exhibits the following characteristics: • Fulfils one or more needs of the customer. • Supports the customer's business objectives. • Is perceived by the customer as a coherent whole or consumable product.

4: http://its.ucsc.edu/itsm/service.html	95%

An IT Service exhibits the following characteristics: • Fulfills one or more needs of the customer • Supports the customer's business objectives • Is perceived by the customer as a coherent whole or consumable product

Instances from: http://www.investorwords.com/1637/e_commerce.html

7: http://www.investorwords.com/1637/e_commerce.html 95%	7: http://www.investorwords.com/1637/e_commerce.html 95%
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 (	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 the buying and selling of products over the internet,