Quality of experience metrics for cloud services: A systematic mapping

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APPENDIX 1. CLASSIFICATION OF QOE METRICS FOUND IN THE SYSTEMATIC MAPPING

Legend	
Data Extraction criteria	Possible Answer of each data extraction criteria
QoE characteristic	EFFE=Effectiveness, EFFI=Efficiency, SATI=Satisfaction, FREE=Freedom from risk, COCO=Context coverage
Metric	Name of the metric
Lifecycle phase	Req. = Requirements, Acq. =Acquisition, Dev. = Development, Int = Integration, Ope. = Operation, Ret = Retirement
Artifact evaluated	Spe. = Specification of cloud service, Arc. = Architecture of cloud service, Ser. = Cloud Service
Type of service	SaaS= Software as a service, PaaS = Platform as a service, IaaS= Infrastructure as a service
Stakeholder viewpoint	CSP = Cloud Service Provider, CSC = Cloud Service Consumer, CSB = Cloud Service Broker, CSD = Cloud Service Developer, USE= End-user
Validation procedure	A.A. = Axiomatic approach, A.T.M = Approach based on the Theory of Measurement, C.S. = Case study, SU. = Survey, C.E = Controlled Experiment, N.V.= Not validate, P.C. = Proof of concept

QoE characteristic	Sub-characteristic	Metric	Lifecycle phase						Artifact evaluated			Type of service			Stakeholder viewpoint					Validation procedure							Ref. Paper
																				Theoretical Validation		Empirical Validation			No Validation		
			Req.	Acq.	Dev.	Int.	Ope.	Ret.	Spe.	Arc.	Ser.	SaaS	PaaS	IaaS	CSP	CSB	CSC	CSD	USE	A.A.	A.T.M.	C.E.	C.S.	SU.	N.V.	P.C.	
EFFE	Productivity	Service cost	X	X			X				X				X	X	X	X				X					S14
EFFE		Access update ratio (AUR)			X		X			X	X				X	X		X	X							X		S23
EFFE		Cost					X				X				X	X											X	S15
EFFE		Cost	X	X			X		X		X	X			X	X	X										X	S08
EFFE		Price	X	X			X		X							X		X								X		S19
EFFE		Pricing	X	X			X		X		X	X	X	X	X	X	X	X								X		S03
EFFE		QoE		X			X			X	X				X		X										X	S04
EFFE		QoE RAS System (Ins|Upd|Del)	X				X			X	X				X	X		X	X							X		S23

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			Req.	Acq.	Dev.	Int.	Ope.	Ret.	Spe.	Arc.	Ser.	SaaS	PaaS	IaaS	CSP	CSB	CSC	CSD	USE	A.A.	A.T.M.	C.E.	C.S.	SU.	N.V.	P.C.	
EFFE		QoE RAS System (Sel)	X				X				X	X		X	X		X	X							X		S23
EFFE		QoE RAS User (Ins|Upd|Del)	X				X				X	X		X	X		X	X							X		S23
EFFE		QoE RAS User (Sel)	X				X				X	X		X	X		X	X							X		S23
EFFE		QoE System R&Q (Ins|Upd|Del|Sel)	X				X				X	X		X	X		X	X							X		S23
EFFE		QoE System Total (Ins|Upd|Del|Sel)	X				X				X	X		X	X		X	X							X		S23
EFFE		QoE User R&Q (Ins|Upd|Del|Sel)	X				X				X	X		X	X		X	X							X		S23
EFFE		QoE User Total (Ins|Upd|Del|Sel)	X				X				X	X		X	X		X	X							X		S23
EFFE		StateCost					X				X	X			X	X											X	S15
EFFE		Successful service outcomes					X				X	X		X	X		X	X							X		S23
EFFE		TransCost					X				X	X			X	X											X	S15
EFFI		Worrkload delay					X				X	X			X	X				X							X	S24
SATI	Acceptability	Flow-Short-Scale (FSS) [17] or the Flow State Scale					X				X	X			X		X		X						X		S18
SATI	Acceptability	Game Engagement Questionnaire (GEngQ) or Immersive Experience Questionnaire (IEQ)					X				X	X			X		X		X						X		S18

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			Req.	Acq.	Dev.	Int.	Ope.	Ret.	Spe.	Arc.	Ser.	SaaS	PaaS	IaaS	CSP	CSB	CSC	CSD	USE	A.A.	A.T.M.	C.E.	C.S.	SU.	N.V.	P.C.	
SATI	Acceptability	Game Experience Questionnaire (GEQ) or in-game version (iGEQ)					X				X	X			X		X		X						X		S18
SATI	Acceptability	Igroup Presence Questionnaire (IPQ)					X				X	X			X		X		X						X		S18
SATI	Acceptability	Player Experience of Need Satisfaction (PENS)					X				X	X			X		X		X						X		S18
SATI	Acceptability	Presence Questionnaire (PQ)					X				X	X			X		X		X						X		S18
SATI	Acceptability	Self-Assessment Manikin (SAM)					X				X	X			X		X		X						X		S18
SATI	Courtesy	Degrees of formalization of the employee's language and attitude (DoF-ATT)	X						X			X	X	X					X							X	S33
SATI	Courtesy	Free trial		X		X	X					X	X	X	X	X	X								X		S03
SATI	Pleasure	API	X	X		X	X		X			X	X	X	X	X	X								X		S03
SATI	Pleasure	Client interface	X	X		X	X		X			X	X	X	X	X	X								X		S03
SATI	Pleasure	Use Intention		X			X					X			X	X	X	X					X				S10
SATI	Pleasure	User Experience Level	X	X			X					X	X	X	X	X	X								X		S03
SATI	Pleasure	User patient					X				X				X	X			X							X	S07
SATI	Responsiveness	Delay Score					X				X	X			X		X									X	S04
SATI	Responsiveness	Game delay (GD)					X				X	X							X							X	S06

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																				Lifecycle phase / Artifact evaluated / Type of service / Stakeholder viewpoint / Theoretical Validation / Empirical Validation / No Validation							
SATI	Responsiveness	Network delay (ND)					X				X	X							X							X	S06
SATI	Responsiveness	Playout delay (OD)					X				X	X							X							X	S06
SATI	Responsiveness	Processing delay (PD)					X				X	X							X							X	S06
SATI	Responsiveness	Response Delay (RD)					X				X	X							X							X	S06
SATI	Responsiveness	Responsiveness (RESP)					X				X	X	X						X							X	S32
SATI	Responsiveness	Responsiveness (RESP-CQ)					X				X	X	X	X					X							X	S31
SATI	Responsiveness	Responsiveness(R)		X	X						X			X				X	X							X	S05
SATI	Trust	Cloud Customer Confidence Level					X				X	X				X										X	S21
SATI	Trust	Monitoring	X	X			X		X		X	X	X	X	X	X	X								X		S03
SATI	Trust	Monitoring	X	X							X			X		X	X								X		S02
SATI	Trust	Number of Clients		X							X	X							X						X		S01
SATI	Trust	Perceived fluidity of gameplay (ACR scale)					X				X	X							X							X	S22
SATI	Trust	Perceived graphics quality (ACR scale)					X				X	X							X							X	S22
SATI	Trust	Reliability (Rel)					X				X			X	X		X								X		S28
SATI	Trust	Reputation	X	X			X				X	X	X	X	X	X	X								X		S03
SATI	Trust	Reputation					X				X			X	X				X						X		S29

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																				Theoretical Validation		Empirical Validation			No Validation		
SATI	Trust	Reputation of service provider	X	X							X			X			X	X	X						X		S02
SATI	Trust	Reputation (Repws)					X				X	X							X						X		S09
SATI	Trust	Security (Sec)					X				X			X	X		X								X		S28
SATI	Trust	Transparency		X							X			X			X		X						X		S11
SATI	Trust	Trust					X				X	X	X	X					X						X		S25
SATI	Trust	Trustworthiness of service		X							X	X							X							X	S17
SATI	Trust	Trustworthiness of virtual resources and services					X				X	X	X	X					X						X		S30
SATI	Trust	Utility of trust for request (Ti)					X				X			X	X		X								X		S28
SATI	Trust	Video Quality Score Squality					X				X	X				X		X								X	S04
SATI	Utility	API	X	X							X			X		X	X		X						X		S02
SATI	Utility	Customer support	X	X	X	X	X		X		X	X	X	X	X	X	X								X		S03
SATI		Game Mean Opinion Score (GMOS)					X				X	X							X							X	S26
SATI		Mean opinion score (MOS)					X				X	X						X								X	S27
SATI		Mean opinion score (MOS)					X				X	X						X								X	S27
SATI		Mean opinion score (MOS)					X				X	X						X								X	S27

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			Req.	Acq.	Dev.	Int.	Ope.	Ret.	Spe.	Arc.	Ser.	SaaS	PaaS	IaaS	CSP	CSB	CSC	CSD	USE	A.A.	A.T.M.	C.E.	C.S.	SU.	N.V.	P.C.	
SATI		Mean opinion score (MOS)		X			X				X			X	X	X	X						X				S10
SATI		Mean opinion score (MOS)					X				X	X							X						X		S20
SATI		Satisfaction degree		X			X				X	X	X	X	X		X							X				S16
SATI		satisfaction rate					X				X						X							X				S14
SATI		Service Visibility					X				X	X			X				X							X	S21
SATI		User Experience	X	X							X			X			X	X	X						X		S02
SATI		User rating					X				X	X	X	X					X						X		S25
SATI		User rating					X				X	X	X	X					X						X		S25
FREE	Environmental risk	Carbon Cost (CFP)		X							X	X			X		X								X		S12
FREE	Environmental risk	Data Center Infrastructure Efficiency (DCIE)		X							X			X			X								X		S11
FREE	Environmental risk	Data Center Performance per Energy (DPPE)		X							X			X			X								X		S11
FREE	Environmental risk	Efficiency of the physical infrastructure (PUE)		X							X			X			X								X		S11
FREE	Environmental risk	IT equipment energy efficiency (ITEE)		X							X			X			X								X		S11
FREE	Environmental risk	IT equipment utilization (ITEU)		X							X			X			X								X		S11

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			Req.	Acq.	Dev.	Int.	Ope.	Ret.	Spe.	Arc.	Ser.	SaaS	PaaS	IaaS	CSP	CSB	CSC	CSD	USE	A.A.	A.T.M.	C.E.	C.S.	SU.	N.V.	P.C.	
FREE	Environmental risk	Penetration of renewable (green) energy into the system (GEC)		X							X			X			X								X		S11
FREE	Environmental risk	Power Usage Efficiency (PUE)		X							X			X			X								X		S11
FREE	Environmental risk	Service Sustainability(E)		X							X	X			X		X								X		S12
COCO	Flexibility	Flexible Capacity (C)					X					X		X	X											X	S21
COCO	Flexibility	Flexible Degree					X					X		X	X											X	S21
COCO	Flexibility	Flexible Distance (Si)					X					X		X	X											X	S21
COCO	Flexibility	Flexible Force (Fi)					X					X		X	X											X	S21
COCO	Flexibility	Flexible Point (FXPi)					X					X		X	X											X	S21
COCO	Flexibility	Payment flexibility					X					X	X	X	X				X						X		S25
COCO		User Experience Level					X				X	X			X		X									X	S13

The studies of the population and the intervention is as follows:

Population: Research articles that present metrics for the evaluation of the quality in use of cloud services.

Intervention: Quality metrics used to evaluate the quality characteristics of cloud services.

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Results: Analysis of a set of metrics that serve as the basis for the development of a cloud services quality model aligned with the ISO / IEC 25010 and based on the literature.

Context: Quality assessment of cloud services that propose metrics to measure quality in use (QoE - Quality of Experience).

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