

# Quality of experience metrics for cloud services: A systematic mapping

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## APPENDIX 1. CLASSIFICATION OF OoE 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		
			Req.	Acq.	Dev.	Int.	Ope.	Ret.	Spe.	Arc.	Ser.	SaaS	PaaS	IaaS	CSP	CSB	CSC	CSD	USE	Theoretical Validation		Empirical Validation				No Validation	
																				A.A.	A.T.M.	C.E.	C.S.	SU.		N.V.	P.C.
EFFE		Access update ratio (AUR)			X		X			X	X		X	X		X	X									S23	
EFFE		QoE				X		X			X	X		X		X										S04	
EFFE		QoE RAS System (Ins Upd Del)		X			X			X	X		X		X		X	X								S23	
EFFE		QoE RAS System (Sel)		X			X			X	X		X		X		X	X								S23	
EFFE		QoE RAS User (Ins Upd Del)		X			X			X	X		X		X		X	X								S23	

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																				A.A.	A.T.M.	C.E.	C.S.	SU.		N.V.	P.C.	
EFFE		QoE RAS User (Sel)	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											S23
EFFE		QoE System Total (Ins Upd Del Sel)	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		Successful service outcomes					X			X	X		X	X		X	X								X			S23
EFFE		User Experience Level	X	X			X			X	X	X	X	X	X	X	X								X			S03
EFFE		User Experience Level					X			X	X			X		X									X			S13
EFFE		Video Quality Score Squality					X			X	X			X		X									X			S04
EFFI		Cost					X			X			X	X											X			S15
EFFI		Cost	X	X			X		X	X	X			X	X	X									X			S08
EFFI		Delay Score					X			X	X			X		X									X			S04
EFFI		Game delay (GD)					X			X	X									X					X			S06
EFFI		Network delay (ND)					X			X	X									X					X			S06
EFFI		Playout delay (OD)					X			X	X									X					X			S06
EFFI		Price	X	X			X		X					X		X										X		S19
EFFI		Pricing	X	X			X		X	X	X	X	X	X	X	X	X									X		S03
EFFI		Processing delay (PD)					X			X	X									X						X		S06
EFFI		Response Delay(RD)					X			X	X									X						X		S06

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																				A.A.	A.T.M.	C.E.	C.S.	SU.		N.V.	P.C.
EFFI		Service cost	X	X			X			X			X	X	X	X										X	S14
EFFI		StateCost					X			X			X	X												X	S15
EFFI		TransCost					X			X			X	X												X	S15
EFFI		Workload delay					X			X			X	X						X						X	S24
SATI	Pleasure	Degrees of formalization of the employee's language and attitude (DoF-ATT)	X						X			X	X	X					X						X		S33
SATI	Pleasure	Game Experience Questionnaire (GEQ) or in-game version (iGEQ)					X				X	X			X		X		X						X		S18
SATI	Pleasure	Igroup Presence Questionnaire (IPQ)					X				X	X			X		X		X							X	S18
SATI	Pleasure	Player Experience of Need Satisfaction (PENS)					X				X	X			X		X		X							X	S18
SATI	Pleasure	Presence Questionnaire (PQ)					X				X	X			X		X		X					X			S18
SATI	Pleasure	Self-Assessment Manikin (SAM)					X				X	X			X		X		X							X	S18
SATI	Pleasure	Use Intention		X			X				X			X	X	X	X									X	S10
SATI	Pleasure	User patient					X				X			X	X					X						X	S07
SATI	Trust	Cloud Customer Confidence Level					X				X	X			X											X	S21
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

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																				A.A.	A.T.M.	C.E.	C.S.	SU.		N.V.	P.C.
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	Responsiveness (RESP)					X				X	X	X						X				X				S32
SATI	Trust	Responsiveness (RESP-CQ)					X				X	X	X	X					X							X	S31
SATI	Trust	Responsiveness(R )		X	X						X			X					X	X						X	S05
SATI	Trust	Satisfaccion degree		X			X				X	X	X	X	X		X								X		S16
SATI	Trust	satisfaction rate					X				X				X		X								X		S14
SATI	Trust	Security(Sec)					X				X			X	X		X									X	S28
SATI	Trust	Service Visibility					X				X	X			X				X							X	S21
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	User Experience	X	X							X			X		X	X		X					X			S02
SATI	Trust	User rating					X				X	X	X	X					X					X			S25
SATI	Trust	User rating					X				X	X	X	X					X						X		S25
SATI	Trust	Utility of trust for request(Ti)					X				X			X	X		X									X	S28

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																				A.A.	A.T.M.	C.E.	C.S.	SU.		N.V.	P.C.
SATI	Utility	Flow-Short-Scale (FSS) [17] or the Flow State Scale					X			X	X			X		X		X							X		S18
SATI	Utility	"Game Engagement Questionnaire (GEngQ) or																							X		S18
		Immersive Experience Questionnaire (IEQ)			X			X	X			X		X		X										X	S26
SATI	Utility	Game Mean Opinion Score (GMOS)					X			X	X								X						X		S27
SATI	Utility	Mean opinion score (MOS)					X			X	X							X							X		S27
SATI	Utility	Mean opinion score (MOS)					X			X	X							X							X		S27
SATI	Utility	Mean opinion score (MOS)					X			X	X							X							X		S10
SATI	Utility	Mean opinion score (MOS)		X			X			X			X	X	X	X									X		S20
SATI	Utility	Mean opinion score (MOS)					X			X	X							X							X		S03
FREE	Economic risk	Reputation	X	X			X			X	X	X	X	X	X	X									X		S29
FREE	Economic risk	Reputation					X			X			X	X				X								X	S02
FREE	Economic risk	Reputation of service provider	X	X						X			X			X	X		X							X	S09
FREE	Economic risk	Reputation(Repws)					X			X	X									X						X	S12
FREE	Environmental risk	Carbon Cost(CFP)		X						X	X			X		X										X	S11
FREE	Environmental risk	Data Center Infrastructure Efficiency (DCIE)		X						X			X			X					X						S11

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																				A.A.	A.T.M.	C.E.	C.S.	SU.		N.V.	P.C.	
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
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		S12
FREE	Environmental risk	Service Sustainability(E)		X						X	X			X			X									X		S03
COCO	Flexibility	API	X	X		X	X		X		X	X	X	X	X	X	X									X		S02
COCO	Flexibility	API	X	X						X			X			X	X		X							X		S03
COCO	Flexibility	Client interface	X	X		X	X		X		X	X	X	X	X	X	X									X		S03
COCO	Flexibility	Customer support	X	X	X	X	X		X		X	X	X	X	X	X	X									X		S21
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		S03

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			Req.	Acq.	Dev.	Int.	Ope.	Ret.	Spe.	Arc.	Ser.	SaaS	PaaS	IaaS	CSP	CSB	CSC	CSD	USE	Theoretical Validation		Empirical Validation				No Validation	
																				A.A.	A.T.M.	C.E.	C.S.	SU.		N.V.	P.C.
COCO	Flexibility	Free trial		X		X	X			X	X	X	X	X	X	X									X		S03
COCO	Flexibility	Monitoring	X	X			X		X		X	X	X	X	X	X									X		S25
COCO	Flexibility	Payment flexibility					X				X	X	X	X					X							X	S23