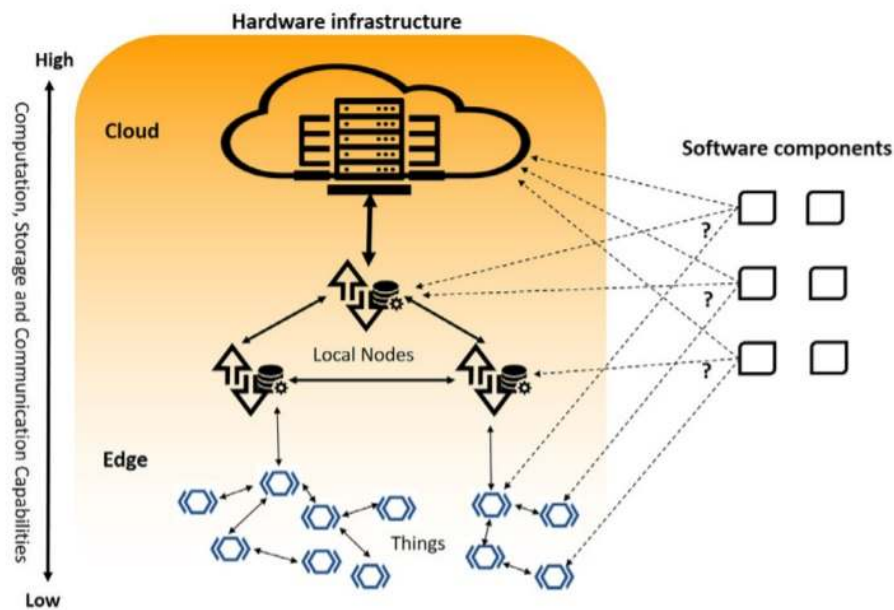# Quality attributes in edge computing for the Internet of Things: A systematic mapping study

ویژگی های کیفیت در محاسبات لبه ای برای اینترنت اشیا: یک مطالعه نقشه برداری منظم

Hybrid Edge-Cloud reference systemبرای سیستم های اینترنت اشیا .گزینه های زیادی برای محل استقرار مولفه های نرم افزار در سمت راست وجود دارد.
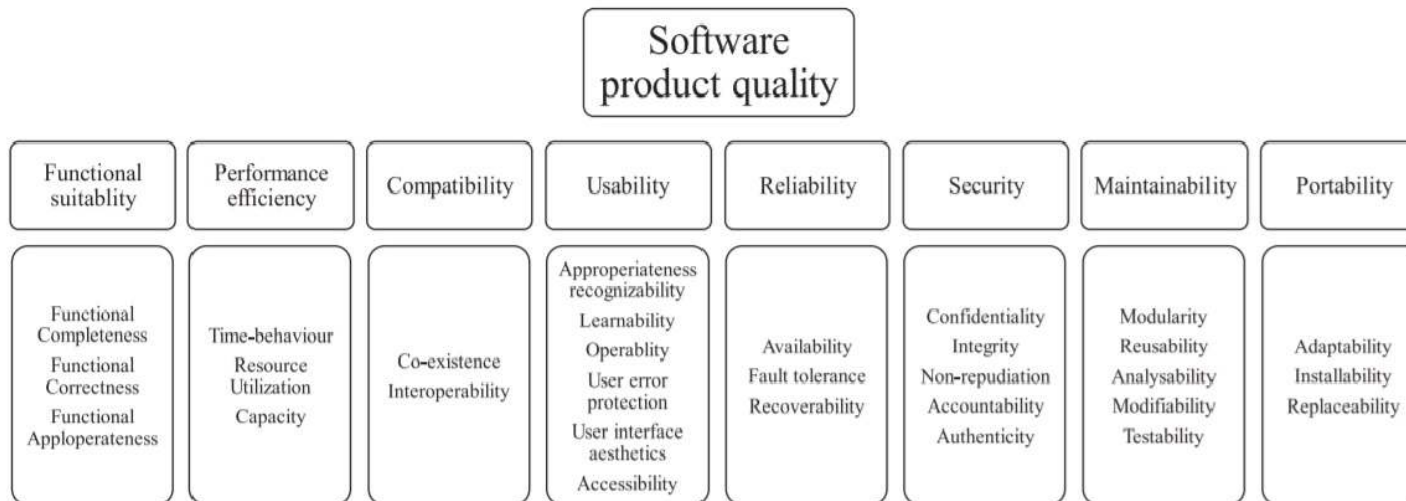
مقایسه مطالعات مروری ادبیات

Table 1
The comparison of literature review studies.

	Target domain	Research Focus	Reference model
Shahzadi et al. [20]	Edge computing frameworks	Properties of edge computing frameworks	None – uses customized performance metric model
Orsini et al. [21]	Mobile Edge Computing (MEC)	Characteristics of MEC solutions	ISO/IEC 25010 quality characteristics
Odun-Ayo et al. [22]	IoT systems using edge and cloud computing	Research methods and architectures	Not studied
White et al. [23]	IoT systems	IoT systems layers and investigated qualities	ISO/IEC 25010 quality characteristics
Muccini et al. [24]	IoT systems	IoT architecture styles and related qualities	None – uses customized quality model
This study	IoT systems using edge computing	Qualities and metrics in IoT systems using edge computing	ISO/IEC 25010 quality characteristics ISO/IEC 25023 quality measures

مدل کیفیت ISO / IEC 25010، شامل هشت کیفیت ریشه و زیر کیفیت آنها

Software product quality

Functional suitablity	Performance efficiency	Compatibility	Usability	Reliability	Security	Maintainability	Portability
Functional Completeness Functional Correctness Functional Apploperateness	Time-behaviour Resource Utilization Capacity	Co-existence Interoperability	Approperiateness recognizability Learnability Operablity User error protection User interface aesthetics Accessibility	Availability Fault tolerance Recoverability	Confidentiality Integrity Non-repudiation Accountability Authenticity	Modularity Reusability Analysability Modifiability Testability	Adaptability Installability Replaceability

سوالات مطرح شده در مقاله:

▶ RQ1: چه ویژگی های کیفی برای سیستم های اینترنت اشیا با استفاده از محاسبات لبه ای در نظر گرفته شده است؟

▶ RQ2: از چه معیارهایی برای اندازه گیری کیفیت استفاده شده است؟

▶ RQ3: چه معامله ای بین کیفیت ها بررسی شده است؟

▶ RQ4: چه نوع تحقیقاتی در این زمینه انجام شده است؟

▶ RQ5: از چه روشی برای اعتبار سنجی استفاده شده است؟

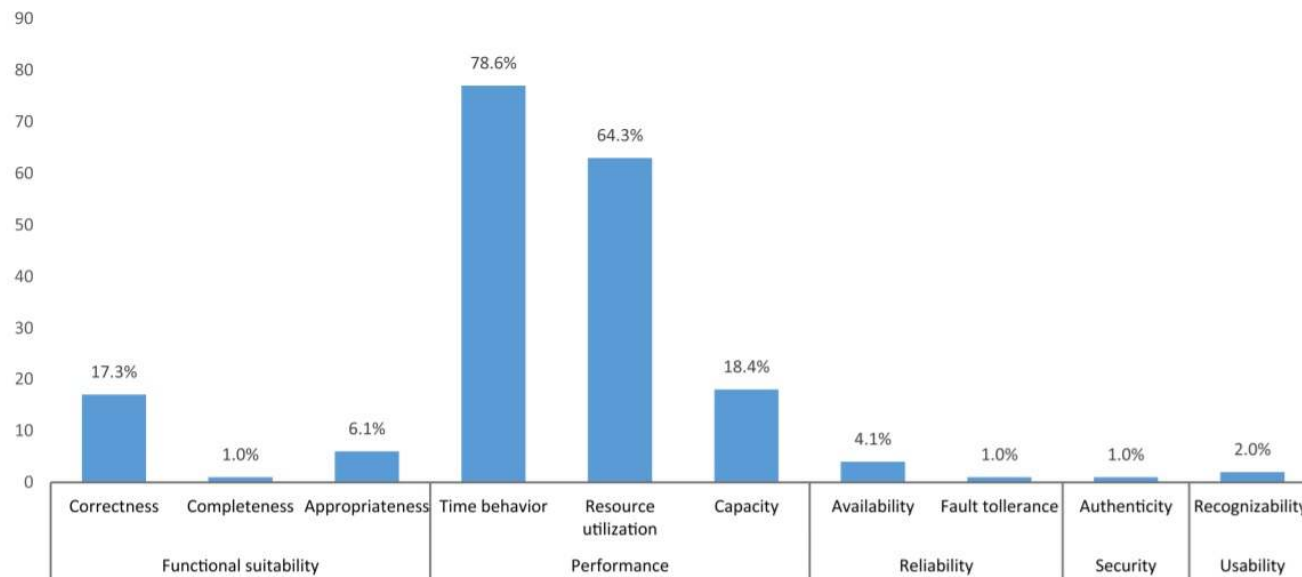کیفیت ISO / IEC 25010مورد استفاده ادبیات و تعداد دفعات استفاده از آنها

Fig. 4. The ISO/IEC 25010 qualities used by the literature and how often they are used.

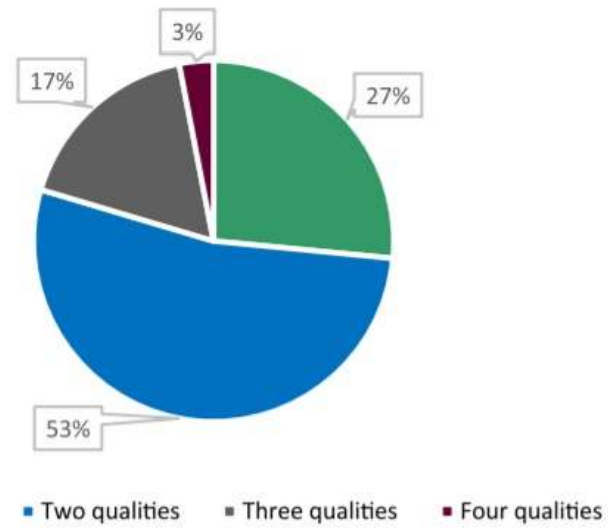درصد تعداد کیفیت مورد استفاده در ادبیات برای ارزیابی یک سیستم اینترنت اشیا

Fig. 5. The percentage of the number of qualities used in the literature to evaluate an IoT system.
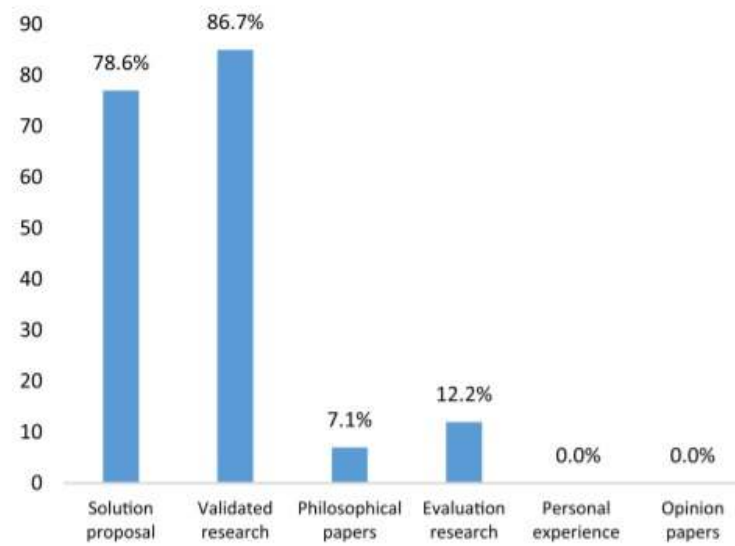
تعداد مقالات برای هر نوع تحقیق.

Fig. 6. Number of papers for each research type.

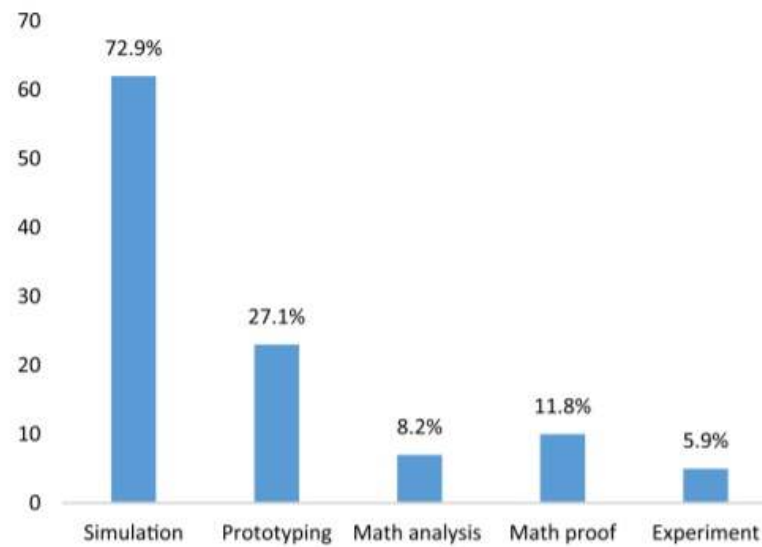روش های اعتبار سنجی که در مقاله هایی شامل تحقیقات معتبر استفاده می شود.

Fig. 7. The validation methods used in the papers that included validated research.

لیست مقالات برای هر کیفیت بر اساس روش های ارزیابی.

Table B1
List of papers for each quality based on the evaluation methods.

ISO/IEC 25010 root category	Qualities	Papers
Functional suitability	Correctness	P1, P9, P48, P53, P80, P82, P87, P89, P91, P96, P100, P115, P120, P121, P122, P132, P139
	Completeness	P74
Performance	Time-behavior	P1, P2, P8, P10, P11, P12, P16, P19, P29, P23, P27, P29, P31, P37, P39, P40, P42, P43, P45, P46, P48, P49, P50, P52, P53, P60, P62, P63, P65, P68, P75, P80, P81, P83, P84, P85, P86, P88, P90, P91, P92, P94, P97, P98, P99, P103, P104, P105, P106, P107, P108, P109, P110, P113, P114, P115, P116, P117, P118, P119, P120, P121, P122, P123, P124, P125, P126, P127, P128, P129, P130, P131, P134, P135, P136, P137, P138, P139
	Resource utilization	P2, P4, P8, P10, P11, P12, P16, P19, P23, P37, P39, P42, P43, P45, P46, P48, P49, P50, P57, P62, P63, P64, P65, P68, P75, P81, P82, P83, P84, P86, P89, P90, P91, P92, P93, P95, P96, P98, P104, P106, P107, P108, P110, P112, P113, P115, P116, P117, P118, P119, P123, P124, P125, P126, P127, P128, P131, P132, P133, P135, P136, P139
	Capacity	P9, P12, P16, P37, P48, P49, P53, P57, P60, P64, P66, P68, P75, P88, P98, P107, P134, P138
Reliability	Availability	P10, P68, P125, P132
	Fault tolerance	P53
Security	Authenticity	P4
Usability	Appropriateness recognizability	P9, P111

معیار های استخراج شده ، طبقه بندی شده توسط ISO IEC 25023

Table B2

Extracted metrics, categorized by ISO/IEC 25023 (The metrics marked * are not included in ISO/IEC 25023.).

ISO/IEC 25010 Qualities	ISO/IEC 25023 Metrics	Metrics
Functional Correctness	Functional correctness	Accuracy (P53, P89, P100), Square error (P80, P100), Number of raw data messages discarded (P1), Normalized mutual information (P48), Number of accomplished tasks (P82), Relative percentage deviation (P87), Total tardiness (P87), Successful rate (P87), Fair load balancing (P91), Top 1 accuracy (P96), Detection rate (P100), False positive rate (P100), False negative rate (P100), Precision (P100), F1-measure (P100), Mathew correlation coefficient (P100), Cohen's Kappa K coefficient (P100), Fairness index (P115), Bonus score (P120), Service time error (P121), Recognition accuracy (P122), Packet reception rate (P132), Executed and failed tasks (P139)
Functional Completeness	Functional coverage	Requirements fulfillment index (P74)
Functional appropriateness	Functional appropriateness of usage objective	Number of task migrations (P101), Task disutility (P101), Compression rate (P102), Number of required runtimes (P103), Percentage of QoS satisfied applications (P106), Offloading overhead (P117), Preference level (P125)

(continued on next page)

Table B3
List of the papers for each research type.

Research type	Papers
Solution proposal	P1, P2, P4, P8, P9, P11, P12, P16, P19, P20, P23, P27, P29, P31, P35, P37, P39, P40, P42, P43, P45, P46, P48, P49, P50, P52, P53, P57, P60, P62, P63, P64, P65, P66, P68, P74, P75, P80, P81, P82, P83, P84, P86, P87, P88, P89, P91, P92, P94, P95, P96, P97, P98, P99, P100, P101, P102, P103, P104, P105, P106, P107, P109, P111, P112, P113, P115, P116, P117, P120, P121, P122, P123, P125, P126, P128, P129, P131, P132, P133, P134, P135, P136, P137, P139
Validated research	P1, P2,4, P8, P9, P11, P12, P16, P19, P20, P23, P27, P29, P31, P35, P37, P39, P40, P42, P43, P45, P46, P48, P49, P50, P52, P53, P57, P60, P62, P63, P64, P65, P66, P68, P74, P75, P80, P81, P82, P83, P84, P86, P87, P88, P89, P91, P92, P94, P95, P96, P97, P98, P99, P100, P101, P102, P103, P104, P105, P106, P107, P109, P111, P112, P113, P115, P116, P117, P120, P121, P122, P125, P126, P128, P129, P131, P132, P133, P134, P135, P136, P137, P138, P139
Philosophical papers	P11, P45, P110, P118, P119, P124, P125
Evaluation research	P10, P85, P90, P93, P108, P114, P118, P119, P124, P127, P130, P138,
Personal experience papers	–
Opinion papers	–

Table B4
List of the papers for the validation types.

Validation type	Papers
Simulation	P2, P4, P8, P9, P11, P12, P16, P19, P20, P29, P31, P35, P37, P39, P40, P43, P45, P48, P50, P53, P57, P62, P64, P66, P68, P74, P75, P80, P82, P83, P84, P87, P89, P91, P92, P95, P97, P98, P99, P100, P101, P103, P106, P107, P109, P112, P113, P115, P116, P117, P120, P121, P128, P129, P131, P132, P134, P135, P136, P137, P138, P139
Prototyping	P1, P8, P9, P27, P42, P46, P49, P52, P60, P65, P81, P86, P88, P94, P102, P105, P106, P111, P122, P125, P126, P133, P137
Mathematical analysis	P20, P39, P48, P50, P65, P94, P138
Mathematical proof	P19, P39, P48, P53, P64, P65, P101, P102, P115, P121
Experiment	P23, P63, P96, P100, P104