

Table .9: Health Metrics of the Evaluation Approaches

<b>Id</b>	<b>Metric</b>	<b>Description</b>	<b>Studies</b>
1	Active Contributors	(definition not provided).	[S20]
2	Active Developers in the Past	The total number of active developers developing on top of a PaaS provides a direct measure of developer interest in the past year.	[S3]
3	Active Developers of Unique Repositories in the Past Year	The total number of active developers developing on top of a PaaS in the past year working on non-fork repositories, i.e. unique projects that were started from scratch instead of based on another project.	[S3]
4	Active Developers Per Segment of Time	The total number of active developers in time between releases or cycle time.	[S3]
5	Activity	The percentage of users with at least one antivirus product actively running with up to date signatures.	[S8]
6	Added Knowledge about Ecosystem	Aggregated information, blog posts, and manuals about ecosystem.	[S20]
7	Alliances with Other Manufactures	The measurements can be done using company specific data sources and calculating the multi market contact together with performance.	[S15]
8	Amount of Inquires or Feature Requests	Number of inquire or feedbacks received for the OSS community. Contributions could be corrective, adaptive, perfective or preventive.	[S12]
9	Artifact Quality	(definition not provided).	[S20]
10	Asset Buildup	Productivity will cause growth of the company and buildup of assets over time, e.g., growing value of technologies, patents, brands, increasing amounts of cash and securities.	[S15]
11	Average Files Changed per Commit	Average files changed per commit.	[S6]
12	Average Lines Added per Commit	Average lines added per commit.	[S6]
13	Average Lines Removed per Commit	Average lines removed per commit.	[S6]
14	Average Number of Supported Languages	(definition not provided).	[S13]
15	Betweenness Centrality	Reflects the number of shortest paths that pass through a specific node.	[S12]
16	Bug Delay	The service delays on open issues by subtracting the closing dates of issues in the bug report from the opening date of the issues.	[S19]
17	Bug Fix Time	How quickly problems are reported and resolved in the ecosystem.	[S20]
18	Bug Tracking Activity	Number of comments created in project bug tracker and total number of actions in the bug tracker.	[S12]
19	Buildup of Assets	Total factor productivity over time. Can be measured using individual company data.	[S12]
20	Capital Contributors and Donations	(definition not provided).	[S20]
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<b>Id</b>	<b>Metric</b>	<b>Description</b>	<b>Studies</b>
21	Centrality	Number of relations clique memberships. Number of individual network relations of a partner. The more central partner is the most persistent. When the partners are in clique or cluster, its persistence is considered high. Because is regarded as a secure environment.	[S12]
22	Centrality of the Company	The more central a company is in the business ecosystem, the more persistent it is.	[S15]
23	Centrality of the Platform	(definition not provided).	[S9]
24	Cluster of Collaborating Developers	The nodes are developers and the edges between them represent projects on which they collaborated. They both make modifications to the project for at least a certain number of times.	[S12]
25	Code Complexity	(definition not provided).	[S11]
26	Code Vocabulary Map	Summary of terms used in the source code of the project. The vocabulary map is a tool for the developer who wants to obtain a general overview of the domain language of a project.	[S12]
27	Code Growth	(definition not provided).	[S11]
28	Commercial Patronage	(definition not provided).	[S20]
29	Communication and Use Intensity	If a project has a healthy community, there is indication of strong relationship between some measures such as the number of download compared to mailing list postings and the active developer interaction in (different) mailing lists.	[S21]
30	Connectedness	Connectedness of the business ecosystem of the individual agent, i.e., number of relations the partner has.	[S15]
31	Connectedness of Company	Connectedness for the entire business ecosystem.	[S15]
32	Continuity of Use Experience and Use Cases	The experience of consumers of an ecosystem's products will gradually evolve in response to the introduction of new technologies rather than being radically transformed. Existing capabilities and tools will be leveraged to perform new operations enabled by new technologies.	[S20] [S22]
33	Contributor Activity Graph	The contributor distribution at ecosystem level.	[S12]
34	Contributor Commit Rate	Average between first and last commit.	[S12]
35	Contributor Connectedness	(definition not provided).	[S20]
36	Contributor Ratings and Reputation	Describe how well the developer is contributing and performing within the ecosystem.	[S20]
37	Contributor Satisfaction	(definition not provided).	[S20]
38	Core Network Consistence	(definition not provided).	[S20]
39	Cost of Changing and Upgrade	Costs of change and upgrade to be able to keep up with new technologies over multiple consecutive years.	[S15]

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Id	Metric	Description	Studies
40	Created at Date Smaller Than Push Date/Created at Date $\geq$ Than Push Date	The proportion of repositories forked or created and subsequently never updated in relation to repositories that are updated.	[S3]
41	Date of Last Commit	Date of last commit of a project/community.	[S12]
42	Delivery of Innovation	Does the ecosystem effectively deliver new technologies, processes, or ideas to its members? Does it lower the costs of employing these novelties, as compared with adopting them directly, and propagate access to them widely throughout the ecosystem in ways that improve the classical productivity of ecosystem members?	[S20] [S22]
43	Developer Activity Diagrams	Give an overview of the contributors daily activity within an ecosystem.	[S12]
44	Distribution of Last Updates Over the Last Years	(definition not provided).	[S13]
45	Distribution over the Species	Variety measure for niche creation factor. The equality of the division of partners over the species. E.g., the distribution between numbers of resellers, number of system integrators, numbers of OEMs.	[S12]
46	Diversity	The diversity of the antivirus ecosystem was characterized based on its richness, degree of concentration, and dominance. The richness can be defined as the total number of antivirus vendors within the ecosystem.	[S8]
47	Download of New Projects	(definition not provided).	[S20]
48	Ecosystem Cohesion	Number of relations present in a sub-group/maximum possible of relation among all the nodes in the sub-group.	[S12]
49	Ecosystem Connectedness	Number of relations as a proportion of the theoretically maximum number of relations in all ecosystem. Is a metric of connectedness. Is a property that keeps communities structure safe from risks, guaranteeing their well-being and health.	[S12]
50	Ecosystem Entropy	The second law of thermodynamics, in principle, states that a closed systems disorder cannot be reduced, it can only remain unchanged or increase. A measure of this disorder is entropy. This law also seems plausible for software systems; as a system is modified, its disorder, or entropy, always increases. Can be viewed as being similar to the measurement of the existence of order or disorder among the participating software components, software products, or software organizations.	[S12]
51	Events	Looks at organized events where stakeholders are brought together that share an interest in the total ecosystem, instead of only including specific project events.	[S20]

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<b>Id</b>	<b>Metric</b>	<b>Description</b>	<b>Studies</b>
52	Expertise View Contributor	Visualization about a contributor expertise based on file extensions (number and type of files changed within a month).	[S12]
53	Extensions developers by Partners	(definition not provided).	[S13]
54	Frequency of Contributors	Frequency of contributors to the bug report system.	[S17]
55	Findability of the Ecosystem	(definition not provided).	[S9]
56	Files Changed	Number of files that has been changed.	[S12]
57	Files Changed per Day	Number of files that has been changed per day.	[S6]
58	Files per Version	Number of files per version.	[S12]
59	Forks	Number of forks made regardless of GitHub restrictions.	[S3]
60	Geographical Distribution	Geographical distribution of community members.	[S12]
61	Group Stability	Group stability can be measured. Three different concepts are available: perfect stability, time to stability and endurance.	[S15]
62	Growth of the Platform	(definition not provided).	[S9]
63	Heterogeneity	Number of different affiliations of the contributors.	[S17]
64	Identification of the Contributors	(definition not provided).	[S9]
65	Interest: Page Views, Search Statistics	(definition not provided).	[S20]
66	Job Advertisements	Number of job advertisements on the project/community.	[S12]
67	KLOC/time Period Added	(definition not provided).	[S20]
68	Knowledge and Artifact Creation	Manuals, translations, marketing materials, etc.	[S20]
69	Labor Stability	According to one of the interviewed experts, labor stability within the business ecosystem is a used measure for the continuity. The measurement of unemployment per industry and stability of labor productivity are possibly useful. Longitudinal measures are needed to create the benchmark.	[S15]
70	Leavers per Month	(definition not provided).	[S13]
71	Level of Contribution per Community User	(definition not provided).	[S9]
72	Level of Transparency in the Governance	(definition not provided).	[S11]
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Id	Metric		Description	Studies
73	Limited Obsolescence		There is no dramatic abandonment of “obsolete” capacity in response to a perturbation. Most of the installed base or investment in technology or components finds continued use after dramatic changes in the ecosystems environment.	[S20] [S22]
74	Lines Added		Lines added.	[S12]
75	Lines Added per Day		Lines added per day.	[S6]
76	Lines Changed		Lines changed.	[S12]
77	Lines Removed		Lines removed.	[S12]
78	Lines Removed per Day		Lines removed per day.	[S6]
79	Liquidity		Provide an indication whether a partner is able to meet its short-term obligations. Can be measured with: financial status of a partner; counting the number of new members in a business ecosystem.	[S12] [S15]
80	Mailing List		Number of messages posted to project mailing lists and the number of responses obtained from those messages.	[S12] [S17]
81	Mailing List Responsiveness		(definition not provided).	[S20]
82	Maintenance Cost		Maintenance (education and upgrading) costs per product or technology per individual supplier over multiple consecutive years.	[S15]
83	Market Share		(definition not provided).	[S13] [S20]
84	Market Share Analysis		(definition not provided).	[S9]
85	Maturity rate for Apps		It is based on the content of the apps and shows if the platform is mostly used for apps with a low or high minimum age for use.	[S1]
86	Maximum Number of Commits of a Developer		The size and density of a contributor in a project.	[S12]
87	Member Activity Rate		Activity rate 1 means that a single person carries out all the work.	[S12]
88	Member Effort		The effort of member m in community c.	[S12]
89	Multiply Markets		(definition not provided).	[S20]
90	Multi-homers		(definition not provided).	[S20]
91	Network Effectiveness		Amount and availability of the three factors: effective resource usage, application of norms to guarantee accountability, and significant rules that influence effectiveness.	[S15]
92	Network Resources		Measure for delivery innovations factor of productivity. They can be measured directly, e.g., using balance of partners, but also indirectly, through the network relations.	[S12]
93	Network Resources		Calculation can be performed by rating the strength of the relation according to the governance structure.	[S15]
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Id	Metric	Description	Studies
94	Networks Node Connection	Connections between central and non-central species or partners.	[S12]
95	New Customers per Month	(definition not provided).	[S13]
96	New Developers per Month	(definition not provided).	[S13]
97	New Downloads	(definition not provided).	[S20]
98	New Members	Counting the number of new members at any point in time.	[S12]
99	New Partnerships	(definition not provided).	[S20]
100	New Patents	(definition not provided).	[S20]
101	New Releases per Month	(definition not provided).	[S13]
102	New Related Projects	They are projects that are part of the ecosystem.	[S20]
103	New Tickets	(definition not provided).	[S20]
104	Niche Variety of Partners	Two possibilities of calculating the variety are present, based upon the number of different species in the ecosystem and based on the role a species fulfills in the business ecosystem.	[S15]
105	Number of Active Projects	Number of active projects.	[S12]
106	Number of Authors	Number of authors for projects. Author can change files in a project.	[S12]
107	Number of Bug Fixers	Number bug fixers in the community.	[S12]
108	Number Committers	Number of committers per project.	[S12]
109	Number of Activity Communities	The number of activity communities in which member m is involved.	[S12]
110	Number of Certified Extensions	(definition not provided).	[S13]
111	Number of Commits	Total number of commits containing source code, documentation, and translation. Average number of commits per week (project/community).	[S12]
112	Number of Commits per Day	Total number of commits per day.	[S6]
113	Number of Commits per Month	Total number of commits per month.	[S10]
114	Number of Commits for Top Committers	Total number of commits for top committers.	[S10]
115	Number of Community Project	Number of projects built on top of the platform of a community.	[S12]
116	Number of Contributors	Total of contributors per project.	[S12] [S14] [S17]
117	Number of Core Developers	Core developer contribute most of the code and oversee the design and evolution of the project.	[S12]
118	Number of Developer Releases	Number of releases that a developer has been active on a project.	[S12]
119	Number of Developer Projects	Number of projects of a developer.	[S12]

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<b>Id</b>	<b>Metric</b>	<b>Description</b>	<b>Studies</b>
120	Number of Downloads	Number of downloads from the official community portal or mirrors.	[S12]
121	Number of Event People	The number of people participating in project events and meetings gives direct information on the activity in the community.	[S12]
122	Number of Files	Files during projects life.	[S12]
123	Number of Mailing List Users	Number of users subscribed to the project mailing list.	[S12]
124	Number of Markets	Company level measurements on numbers of markets the company is active in, together with market domain overlap and the performance of the companies.	[S15]
125	Number of Members	The number of activity members involved in community c.	[S12]
126	Number of Messages in Developer- and User Mailing Lists	The number of messages in developer-and user mailing lists.	[S10] [S16]
127	Number of Multiplatform Repositories the PaaS is a Part of	Counting all repository name + owner combinations which also occur for other PaaS providers measures the interest of high profile development projects.	[S3]
128	Number of Nodes and Edge	Number of nodes and edges.	[S12]
129	Number of Open Problems	(definition not provided).	[S17]
130	Number of Passive User	Passive users in the community.	[S12]
131	Number of Patents	For product or technology innovation, the number of patents registered per industry segment over a period can be measured.	[S15]
132	Number of Readers	Number of readers in the community.	[S12]
133	Number of Relations	Number of relations and number of agents measured per year subject to structural changes. These changes can be measured over multiple years.	[S15]
134	Number of Repositories Updated at Least Once	Counting the number of repositories that are updated at least once after creation.	[S3]
135	Number of Scientific Publications	Number of scientific publications mentioning the community.	[S12]
136	Number of Startups and Bankrupt	Number of startups and bankrupt companies over multiple years.	[S15]
137	Number of Unique Programming Languages	The total number of unique languages used for each PaaS.	[S3]
138	Open Issues, Service Delays	Bugs and issues are listed in the bug-tracking system, but the fixes are not done in appropriate time.	[S21]
139	Organizational Maturity	(definition not provided).	[S20]
140	Outbound links to Other SECOS	Indicate how well the ecosystem is connected to other ecosystems, and how much those ecosystems depend on this ecosystem.	[S20] [S15]

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<b>Id</b>	<b>Metric</b>	<b>Description</b>	<b>Studies</b>
141	Outdegree of Key-stone Actors	Is defined as someone who has a lot of developers he works with and also plays a large role in the software ecosystem.	[S12]
142	Participation in Cliques and Clusters	A measure is the count of participation in clusters or the number of cliques for an individual company in a business ecosystem.	[S15]
143	Partnerships and Embeddedness	(definition not provided).	[S20]
144	Perceived Ecosystem Health	(definition not provided).	[S9]
145	Percentage of Messages Contributed by the Core Developers for the Developer- and User Mailing Lists	(definition not provided).	[S16]
146	Percentage of Messages Contributed by Providers for the Developer- and User Mailing Lists	(definition not provided).	[S16]
147	Persistence of Structure	Changes in the relationships among ecosystem members are contained; overall the structure of the ecosystem is unaffected by external shocks. Most connections between firms or between technologies remain.	[S20] [S22]
148	Platform Findability	(definition not provided).	[S13]
149	Predictability	Change in ecosystem structure is not only contained, it is predictably localized. The locus of change to ecosystem structure will differ for different shocks, but a predictable “core” will generally remain unaffected.	[S20][S22]
150	Principal Member Activity	The principal activity of a member m for a given time t. Community c for which m carried out the most effort.	[S12]
151	Product Market Share	Market shares of products or product groups marketed by individual companies, measured over multiple consecutive years.	[S15]
152	Productivity of the Actor	The productivity of the actor and their contributions can be characterized by the frequency of releases and the lines of code committed.	[S11]
153	Productivity Improvement Over Time	Do the members of the ecosystem and those who use its products show increases in productivity measures over time? Are they able to produce the same products or complete the same tasks at progressively lower cost?	[S20] [S22]
154	Project Activity Diagrams	Allow identify the project evolution comparing six metrics; calculating the contributors involvement distribution.	[S12]
155	Project Developer Experience	Total number of releases in which the developer was active.	[S12]
156	Project Code Size	(definition not provided).	[S17]
157	Projected Connectedness/Cohesion	(definition not provided).	[S20]
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<b>Id</b>	<b>Metric</b>	<b>Description</b>	<b>Studies</b>
158	Proportions	The proportions of activity in the community, e.g.: the volume of mailing list postings, bugs status changes per time slot, updates in the SVN.	[S21]
159	Proportion of Activities	The proportions by comparing the number of bug status changes per times slots and the volume of mailing list posts in the same time slots.	[S19]
160	Proportion of Commits per Affiliation Over Time	Proportion of commits per affiliation over time.	[S10]
161	Rated Extensions	(definition not provided).	[S13]
162	Reciprocity of the Ecosystem	(definition not provided).	[S12]
163	Relation between Categorical Event and Developer Participation	Relation between categorical event and developer participation.	[S12]
164	Regeneration	First and last contributions of each individual developer over the project's history.	[S17]
165	Satisfaction Rate for Apps	(definition not provided)	[S1]
166	Social Media Hits	Number of hits the project gets in the social media.	[S12]
167	Solvency	Value creation measure for niche creation. Can be measured by standard metrics such as revenue share or profit share of newly introduced products or technologies. An alternative is to look at the build-up of partner equity.	[S12]
168	Solvency	The growth of equity over debts. Equity represents the value the company creates over time.	[S15]
169	Spendings on Technology Education	Total amounts spent on technology-related education within a business ecosystem.	[S15]
170	Spin Offs and Forks	(definition not provided).	[S20]
171	Stability	The percentage of users by status that have a different antivirus status compared to the previous month.	[S8]
172	Supported Natural Language	(definition not provided).	[S20]
173	Survival Rates	Ecosystem participants enjoy high survival rates, either over time, or relative to other, comparable ecosystems.	[S20] [S22]
174	Switching Costs to Alternatives	(definition not provided).	[S20]
175	Switching Costs to other SECOs	(definition not provided).	[S20]
176	Technologies Introduced	Measurements of turnover or profit growth caused by newly introduced technologies for the whole business ecosystem.	[S15]
177	Technology Market Share	Market shares for each technology, measured over multiple consecutive years.	[S15]
178	Temporal Community Effort	The combined effort of all members belonging to community c during time period t.	[S12]
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<b>Id</b>	<b>Metric</b>	<b>Description</b>	<b>Studies</b>
179	TFP	TFP should be measured relating the added value created to the amount of labor and capital employed.	[S15]
180	TFP with ROI	Analyzing total factor productivity with return on investment (ROI). The TFP is calculated using sales, costs and investments over a given time period.	[S15]
181	TFP Over Time	The TFP over multiple consecutive years.	[S15]
182	TFP with ROI Over Time	Analyzing total factor productivity with return on investment (ROI) as described by Miller. For differences over time the data over multiple consecutive years needs to be measured.	[S15]
183	Total Effort of Members	Total effort done by a particular community member m in a set of communities C.	[S12]
184	Total Factor Productivity	Leveraging techniques used in traditional economic productivity analysis, ecosystems may be compared by the productivity of their participants in converting factors of production into useful work.	[S20] [S22]
185	Total Number of Activity Projects	(definition not provided).	[S20]
186	Total Number of Followers	Followers are GitHub members who have starred a repository, a mechanism that is used to be kept up-to-date with changes.	[S3]
187	Total Number of Commits and Contribution by Inter-project Committers	Total number of commits and contribution by inter-project committers.	[S10]
188	Total Repositories	The total number of repositories which contain the PaaS keyword is the most basic method to measure the contribution of spin offs to project success.	[S3]
189	Unique Developers	(definition not provided).	[S13]
190	Unique Developers by Partner Category	(definition not provided).	[S13]
191	Unique Repositories	The total number of original repositories.	[S3]
192	Up-to-dateness of Modules	(definition not provided).	[S9]
193	Usage	(definition not provided).	[S20]
194	User Loyalty and Usage	(definition not provided).	[S20]
195	User Satisfaction or Ratings	(definition not provided).	[S20]
196	Value Creation	The overall value of new options created.	[S20] [S22]
197	Value of New Technologies	Value of new technologies expressed in added value or company turnover, measured by specific product or service.	[S15]
198	Variation in Contributor Type	(definition not provided).	[S20]
199	Variation in Project Applications	(definition not provided).	[S20]

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<b>Id</b>	<b>Metric</b>	<b>Description</b>	<b>Studies</b>
200	Variety	The number of new options, technological building blocks, categories, products, and/or businesses being created within the ecosystem in a given period of time.	[S20] [S22]
201	Variety in Projects	Number of niches, platforms, domains, etc., in which a new player can become active.	[S20]
202	Variety in Products	Offered by the partner depends on alliances with other partners. Euclidean distances towards the overall mean of the business ecosystem can be used to measured most of these variety of scores. (definition not provided).	[S12]
203	Variety in Development Technologies	(definition not provided).	[S20]
204	Variety in Supported Technologies	(definition not provided).	[S20]
205	Variety of Categories	(definition not provided).	[S13]
206	Variety of Partners	Covariance with market indicates the variety of different partners a partner has.	[S12]
207	Variety within Ecosystems and Partners	Variety scores can be compared and optimized measuring Euclidean distances towards the overall mean of the business ecosystem.	[S15]
208	Visibility	Tell us something about the centrality of a partner in the market. Popularity of the partner.	[S12]
209	Web Page Requests	Total request to OSS community web page.	[S12]
210	Zeta Model	Bankruptcy classification score model.	[S12] [S15]
211	Z-score	Bankruptcy model to test the creditworthiness and solvency of partners.	[S12] [S15]