

Open Source Software Resilience Framework

Apostolos Kritikos / Ioannis Stamelos
PhD Candidate / Professor

Informatics School., Aristotle University of Thessaloniki

akritiko@csd.auth.gr

in /apostoloskritikos **🐦** /akritiko



Affiliation

RESEARCH GROUP

*Software Engineering Group
(SWENG)*

LAB

*Software engineering, Web & Intelligent Systems
(SOFTWARE)*

SCHOOL

Informatics

UNIVERSITY

Aristotle University of Thessaloniki



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Motivation

- An Open Source Software (OSS) project can be utilized either as is, to serve specific needs on an application level, or on the source code level, as a part of another software system serving as a component, a library, or even an autonomous third party dependency.
- There are several OSS quality models that provide metrics to measure specific aspects of the project, like its structural quality. Although other dimensions, like community, health and activity, software governance principles or license permissiveness, are taken into account, there is no universally accepted OSS assessment model.
- In this work we are proposing an evaluation approach based on the adaptation of the City Resilience Framework to OSS with the aim of providing a strong theoretical basis for evaluating OSS projects.

Motivation

In literature we find several works that suggest a holistic approach in evaluating an Open Source Software project, extending beyond structural quality. For example:

- Permissiveness of the license, number of active developers & end users, language translations. (*Midha & Palvia, [6]**)
- Open Source Governance Model. (*Vision Mobile, [7]**)
- Maturity, stability, documentation, community aspects. (*Wasserman et al., [9]**)
- Competition & Collaboration in large OSS systems. (*Teixeira et al., [10]**)
- Maturity of an OSS project's community. (*Andrade et al. [11]**)

* Note: The extensive references list can be found to our publication.

We propose that...

1. To approach an OSS project as an evolving system in order to be able to study it in a holistic way.
2. For an OSS project to be able to succeed and achieve longevity, it is crucial to be resilient in order to survive potential stresses and crises that might occur.

Stressors & Crises Examples in OSS

- Forks of the project that might drive the attention of the original project's community away.
- Migration of lead developers or even part of the development community to other forks or projects.
- An unsuccessful major release that might hurt the reputation of the project, changes to the license.
- Migration to another forge.

Example

The case of Libre Office, an OSS project that started as a fork of Open Office, but managed to retain the development community and evolve, as of the time of writing, to a successful OSS project. (*Gamalielsson et al.*, [12])

Resilience

Indicative definitions of the term resilience from different disciplines:

“the ability [of a system] to cope with change”

Logistics, (*Wieland et al.*, [13]).

“a resilient system can take a hit to a critical component and recover and come back for more in a known, bounded and generally acceptable period of times”

Software, (*Axelrod*, [14]).

Resilience (2)

Indicative definitions of the term resilience from different disciplines:

“city resilience describes the capacity of cities to function, so that the people living and working in cities particularly the poor and vulnerable survive and thrive no matter what stresses or shocks they encounter”.

Urban Planning, (*Da Silva, et al. [15]*).

City Resilience Framework (CRF)

- Is the result of research undertaken with the aim of establishing an accessible, evidence-based definition of Urban Resilience by Arup and the Rockefeller Foundation.
- The CRF is used by the 100 Resilient Cities a non profit organization to primarily evaluate the Urban Resilience of more than 90 cities around the world and, additionally, to assist the cities on crises with tailored made resilience strategies.

City Resilience Index (CRI)

- It is a set of indicators, variables and metrics that allow cities to understand, baseline and subsequently measure local resilience over time.

“The CRI will measure relative performance over time rather than comparison between cities. It will not deliver an overall single score for comparing performance between cities, neither will it provide a world ranking of the most resilient cities.”

City Resilience Index (CRI)

4 Dimensions



12 Goals



Indicators (KPIs)

CRI: Dimensions & Goals (1)

I. Health & well-being:

Related to people, working and living in the city.

Goals:

1. Minimal human vulnerability
2. Diverse livelihoods & employment
3. Effective safeguards to human health & life.

CRI: Dimensions & Goals (2)

II. Economy & society:

Related to the organization of cities on a social and economical level.

Goals:

1. Sustainable economy
2. Comprehensive security & rule of law
3. Collective identity & community support.

CRI: Dimensions & Goals (3)

III. Infrastructure & environment:

Related to place, the quality of infrastructure and ecosystems.

Goals:

1. Reliable mobility & communications
2. Effective provision of critical services
3. Reduced exposure & fragility

CRI: Dimensions & Goals (4)

IV. Leadership & strategy:

Related to knowledge of the past and adapting appropriately for the future.

Goals:

1. Effective leadership & management
2. Empowered stakeholders
3. Integrated development planning

NOTE: The aforementioned goals are further decomposed to indicators. Due to time constraints we didn't include them in this presentation.

Open Source Software Resilience Framework

We argue that Open Source Software projects share a conceptual similarity with cities.

- They are dynamic and continuously evolving systems with their own structural properties
- They attract people that form communities around them which, on a second level, may utilize a governance model.
- Some OSS projects have commercial activity.
- As it is happening with cities, OSS projects can face stresses and crises (we saw some examples earlier).

Open Source Software Resilience Framework

4 Dimensions



12 Goals



Indicators (KPIs)

OSSRF: Dimensions & Goals (1)

I. Source Code:

- The first dimension of CRF is Health & Well-being and it is related with people.
- In Open Source Software we consider source code (i.e. classes) to be the structural unit of the project.

II. Business & Legal:

- The second dimension of CRF is Economy & Society and is related with organization.
- In Open Source Software the norm is voluntary work but, more mature projects are utilizing Open Source Business Models to offer commercial services (be it pro features or support). For those types of projects licensing plays a key role when it comes to commercialization.

OSSRF: Dimensions & Goals (2)

III. Integration & Reuse:

- The third dimension of CRF is related to place.
- Open Source Software projects usually reuse components of other OSS projects or are being reused themselves. In this spirit, in the third dimension of the Open Source Software Resilience Framework we will be dealing with the aspects of integration and reuse.

IV. Social (Community):

- The last dimension of CRF is about Leadership & Strategy and is related with utilizing knowledge from the past to become better and more resilient in the future.
- In Open Source Software both leadership and strategy related processes are usually connected with the community. Knowledge base is the codebase itself, the CVS system, issue trackers etc.

OSSRF: Dimensions & Goals (3)

I. Source Code

- Continuous Growth
- Holistic Documentation
- Systematic Testing & Violation Minimization

II. Business & Legal

- Economic Sustainability
- Flexible Licensing
- External Organization Support

OSSRF: Dimensions & Goals (4)

III. Integration & Reuse

- Low Dependability
- Low Complexity
- Ease of Integration

IV. Social (Community)

- Well defined Project Standards
- Well Defined Governance
- Developer Base Activity

OSSRF: Indicators

- The twelve (12) goals are further analyzed to indicators in order to provide a more specific description of the goals.
- For the purposes of this paper we will analyze the indicators related to the goals of the Business & Legal dimension.
- Due to space limitations, we provide the full analysis of the indicators to the following url: http://users.auth.gr/akritiko/ossrf_indicators.html for the intended audience.

OSSRF: Indicators - Business & Legal Dimension

1. Economic Sustainability

- a. **Donations:** 0 (no) or 1 (yes) based on whether the OSS project accepts donations. 0 is considered a non resilient value.
- b. **Commercial features:** 0 (no) or 1 (yes) based on whether the OSS project offers commercial features or a pro (paid) version. The indicator was based to the work of [18]. 0 is considered a non resilient value.
- c. **Paid support:** 0 (no) or 1 (yes) based on whether the OSS project offers a paid plan for support. [18]. 0 is considered a non resilient value.

OSSRF: Indicators - Business & Legal Dimension (2)

2. Flexible Licensing

- a. **Level or permissiveness:** 0 (all restrictive - i.e. commercial), 1 (persistent i.e. GPL), 2 (all permissive - i.e. BSD). We base the indicator to the of [19]. The indicator is considered non resilient when it is less than 1.
- b. **Level of persistence:** 0 (no) or 1 (yes) based on whether there are parts of the project's code or dependencies published under persistent licenses (i.e. GPL). We base the indicator to the of [19]. 1 is considered a non resilient value.

OSSRF: Indicators - Business & Legal Dimension (3)

3. External Organization Support: 0 (no) or 1 (yes) based on whether the OSS project is supported by an external organization (non profit, governmental or corporate). 0 is considered a non resilient value.

OSSRF: Resilience Determination Mechanism

- Starting to the indicators level we will consider an OSS project successful towards a resilience goal when it is considered resilient at least to 50% of the goals ingredients.
- Moving to the dimensions level, an OSS project will be considered successful towards a resilience dimension when it is considered resilient at least to 50% of the goals of the specific dimension.
- Likewise, on a project level, the OSS project is considered resilient when at least two (2) out of four (4) dimension (50%) are considered resilient.

OSSRF: Application - A non-resilient project

The first project, OKapi is a small framework for building web applications. It's built on PHP and is hosted in Github [20]. It started during 2008 and hasn't been updated since July 2011. We selected this case in order to test our framework to a project that intuitively seems non resilient.

The versions of the releases of OKapi to which we will be applying the OS-SRF, with their corresponding dating (year / month) are shown to the following table: By applying the Business & Legal dimension's indicators to OKapi we are

Table 1. OKapi releases

Version	1.1.5	1.2.1	1.2.3
Date	2008/12	2009/12	2010/12

getting the results as shown in Table 1. In order to make the demonstration of

Table 2. OKapi - Business & Legal dimension. Goals & Indicators

Indicator	v1.1.5	v1.2.1	v1.2.3
Economic Sustainability			
Donations	0 (F)	0 (F)	0 (F)
Commercial features	0 (F)	0 (F)	0 (F)
Paid support	0 (F)	0 (F)	0 (F)
Flexible Licensing			
Level or permissiveness	0 (F)	0 (F)	0 (F)
Level of persistence	0 (S)	0 (S)	0 (S)
External Organization Support			
External Organization Support	0 (F)	0 (F)	0 (F)

OSSRF: Application - A resilient project

The second project is WooCommerce, an open source eCommerce plug-in for WordPress content management system, written also in PHP and hosted in Github [21]. It started as an OSS project in 2011 and as of the time of writing is active. We selected this case in order to test our framework to a project that intuitively seems resilient.

The versions of the releases of WooCommerce to which we will be applying the OSSRF, with their corresponding dating (year / month) are shown to Table 3. By applying the Business & Legal dimension's indicators to WooCommerce

Table 3. WooCommerce releases

Version	1.3.2	1.6.6	2.0.20	2.0.10	2.0.12	2.6.11	3.2.6
Date	2011/12	2012/12	2013/12	2014/12	2015/12	2016/12	2017/12

Table 4. WooCommerce - Business & Legal dimension. Goals & Indicators

Indicator	v1.3.2	v1.6.6	v2.0.20	v2.0.10	v2.0.12	v2.6.11	v3.2.6
Economic Sustainability							
Donations	0 (F)	0 (F)	0 (F)	0 (F)	0 (F)	0 (F)	0 (F)
Commercial features	1 (S)	1 (S)	1 (S)	1 (S)	1 (S)	1 (S)	1 (S)
Paid support	1 (S)	1 (S)	1 (S)	1 (S)	1 (S)	1 (S)	1 (S)
Flexible Licensing							
Level or permissiveness	1 (S)	1 (S)	1 (S)	1 (S)	1 (S)	1 (S)	1 (S)
Level of persistence	1 (F)	1 (F)	1 (F)	1 (F)	1 (F)	1 (F)	1 (F)
External Organization Support							
External Organization Support	1 (S)	1 (S)	1 (S)	1 (S)	1 (S)	1 (S)	1 (S)

Threats to validity

- We should note that OSSRF should be applied to project of a relative maturity in terms of community and age (we would intuitively suggest at least 10 contributors and a maturity of more than a year). Applying it in solo maintained OSS projects, or projects that not yet have reached the proposed maturity may lead to misleading results.
- OSSRF is an adaptation of the City Resilience framework to Open Source Software. Although the structure of the original framework was retained, despite the conceptual similarities that we have already mentioned earlier, the mapping of dimensions, goals and indicators is a product of the subjective lens of the authors.

Threats to validity (2)

- Regarding the goals and indicators, some of them are based on metrics available for object oriented source code. Additionally, as far as control version systems are concerned, for the needs of this publication we selected projects that are hosted in Github.
- As far as the scales and their aggregation is concerned, in this preliminary approach we considered each criterion equally important and the threshold for defining a project as resilient or non resilient is 50%.
- Finally, both of the projects analyzed in this paper, were developed in PHP and their domains are close (OKapi was a framework for web applications and WooCommerce is a plugin for a WordPress which is also considered by some a kind of web framework).

Future work

- For future work we intend to thoroughly fine-tune the rest of the indicators by testing it to a variety of OSS projects. This will also allow us to investigate how the OSSRF responds to projects of different age, community size or source code size and complexity.
- We also intend to investigate whether the software domain of an OSS project affects the results of the application of the OSSRF.
- Regarding the framework itself we will experiment with other approaches regarding the “Resilience determination mechanism” (i.e. weighted goals).
- In addition we will be extending the OSSRF to be able to work with a variety of control version systems (not only git-like but also Mercurial, SVN, CVS).

Future work (2)

- In a similar spirit will would like to experiment with projects of different programming languages (i.e. Java).
- Another challenging idea for future work would be to apply OSSRF to OSS projects that are known to have faced specific stresses or crises in order to identify how those crises relate with the resiliency levels of an OSS project.
- Finally we intend to attempt and request feedback, in the form of a survey, from key players of the Open Source Software international community (lead developers, stakeholders, academics and so forth) about OSSRF.



APOSTOLOS KRITIKOS

contact info

0030 6976 432 234
akritiko@csd.auth.com

social media

apostoloskritikos @ LinkedIn
akritiko @ Twitter

web

www.software resilience.com
apostolos.kritikos.me

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