Crowdsensing for road sustainability

Validation of publicly sourced data for exploitation

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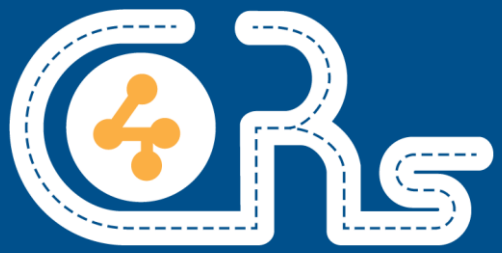


Collective intelligence

Collective intelligence refers to the capacity to mobilize and coordinate the expertise and creativity possessed by large groups of individuals in order to solve problems and create new knowledge. (Tjornbo, 2016)

Impact of ICT:

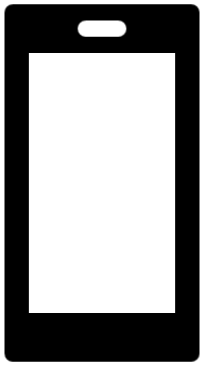
- No need for physical proximity,
- Asynchronous communication,
- Large-scale communication…

Crowdsensing

A new sensing paradigm that empowers ordinary citizens to contribute data sensed or generated from their mobile devices and aggregates and fuses the data in the cloud for crowd intelligence extraction and human-centric service delivery.

(Guo et al., 2015)

Mobile Crowdsensing (MCS)



- Devices are ubiquitous,
- Broad range of sensors,
- Connectivity,
- Computation,
- User interaction.

Road quality monitoring

Road quality indicators

- Traverse evenness
- Longitudinal evenness

  IRI (International Roughness Indicator)

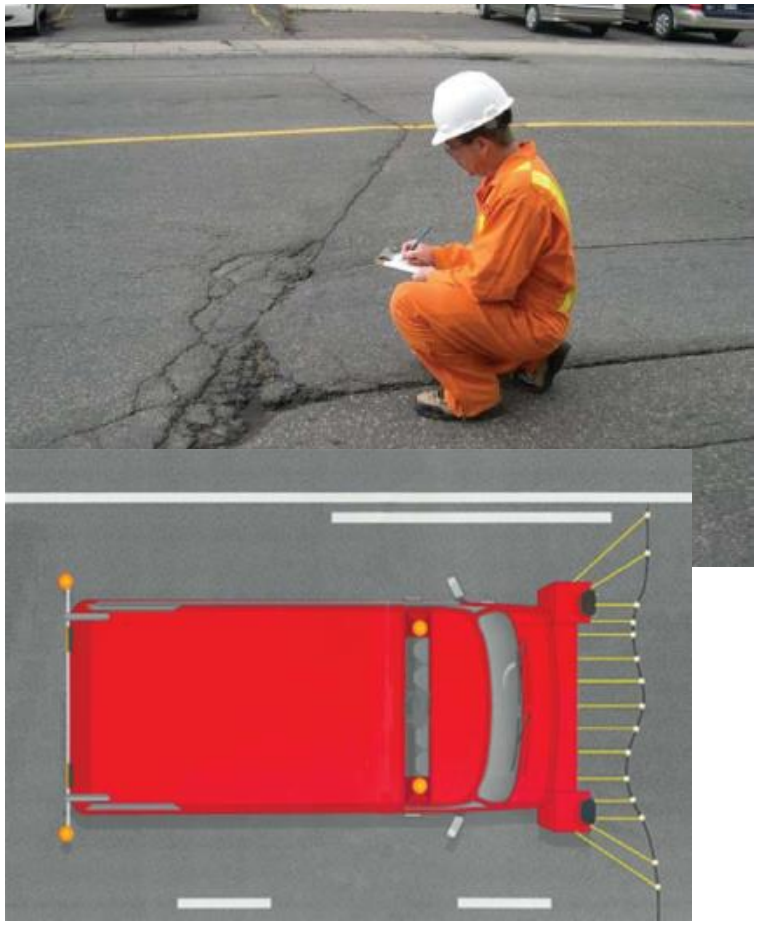
- Vehicle/road interaction

  Surface texture, skid resistance, noise, rolling resistance

- Surface defects

  Cracking, potholes, depressions, delamination, patching…

Monitoring methods



Laser profilometer
(Source: VTI, Sweden)

(Sou

Tyre microphone
(Source: Müller-BBM)

(See PIARC 2016R17EN)


SmartRoadSense

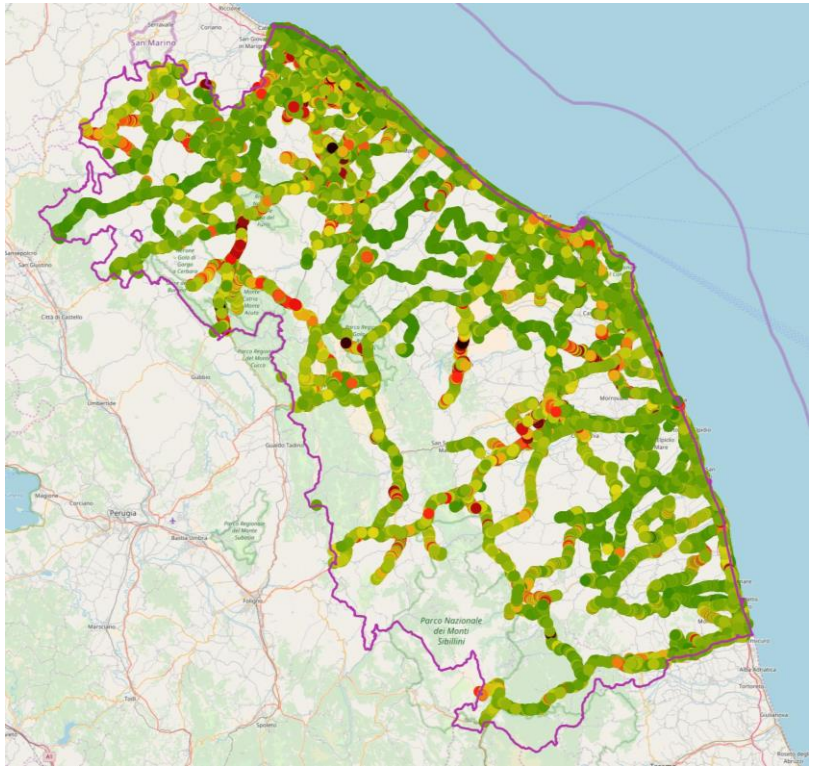
CROWD4ROADS pilots

National pilot: Italy

Approx. 650 000 kms

Mapped 47 497,44 kms (7%)

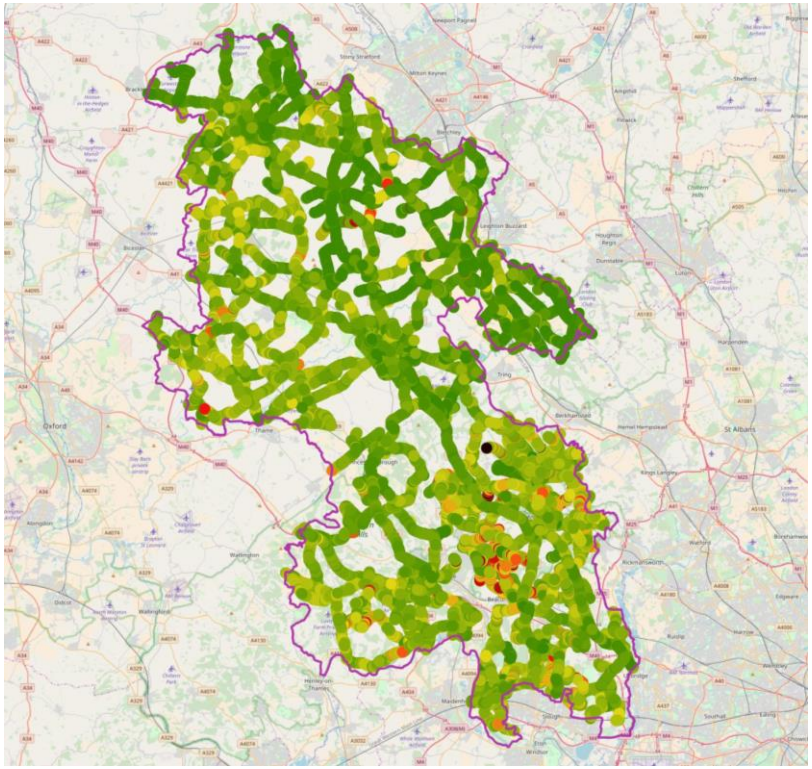
CROWD4ROADS regional pilots



Marche (Italy)

5 835 kms

Mapped 4 754,74 kms (81,4%)

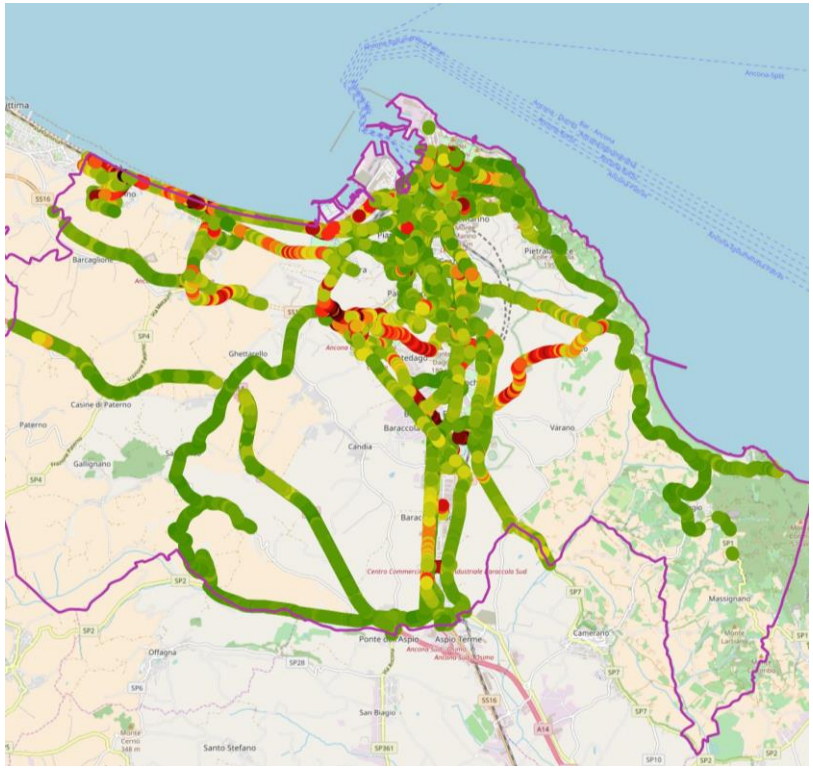


Buckinghamshire (UK)

Approx. 3 500 kms

Mapped 1 693,32 kms (51,5%)

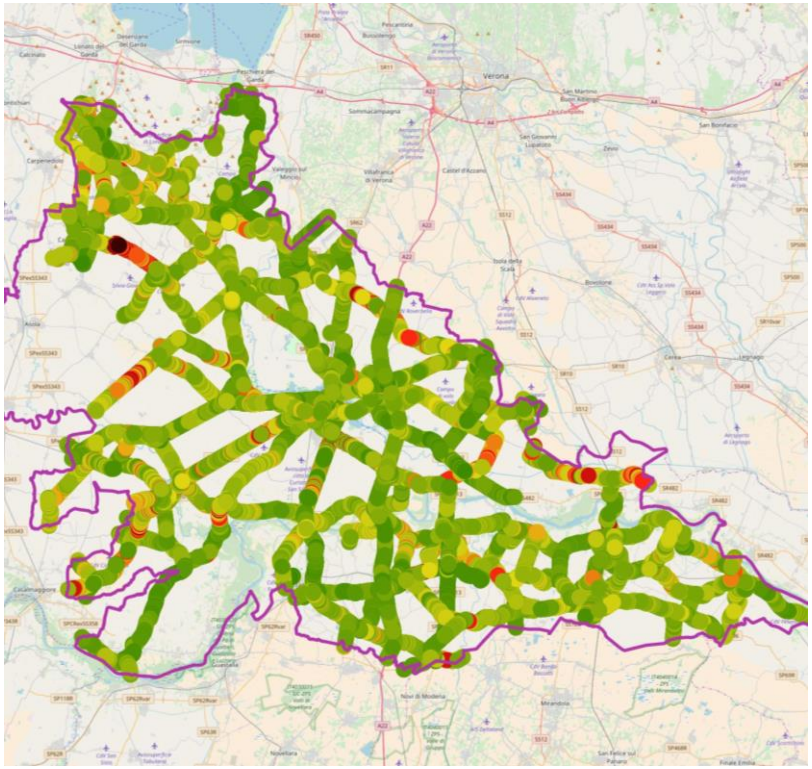
CROWD4ROADS city-level pilots



Ancona city (Italy)

350 kms

Mapped 252,44 kms (72,1%)



Mantova municipality (Italy)

Approx. 1 124 kms

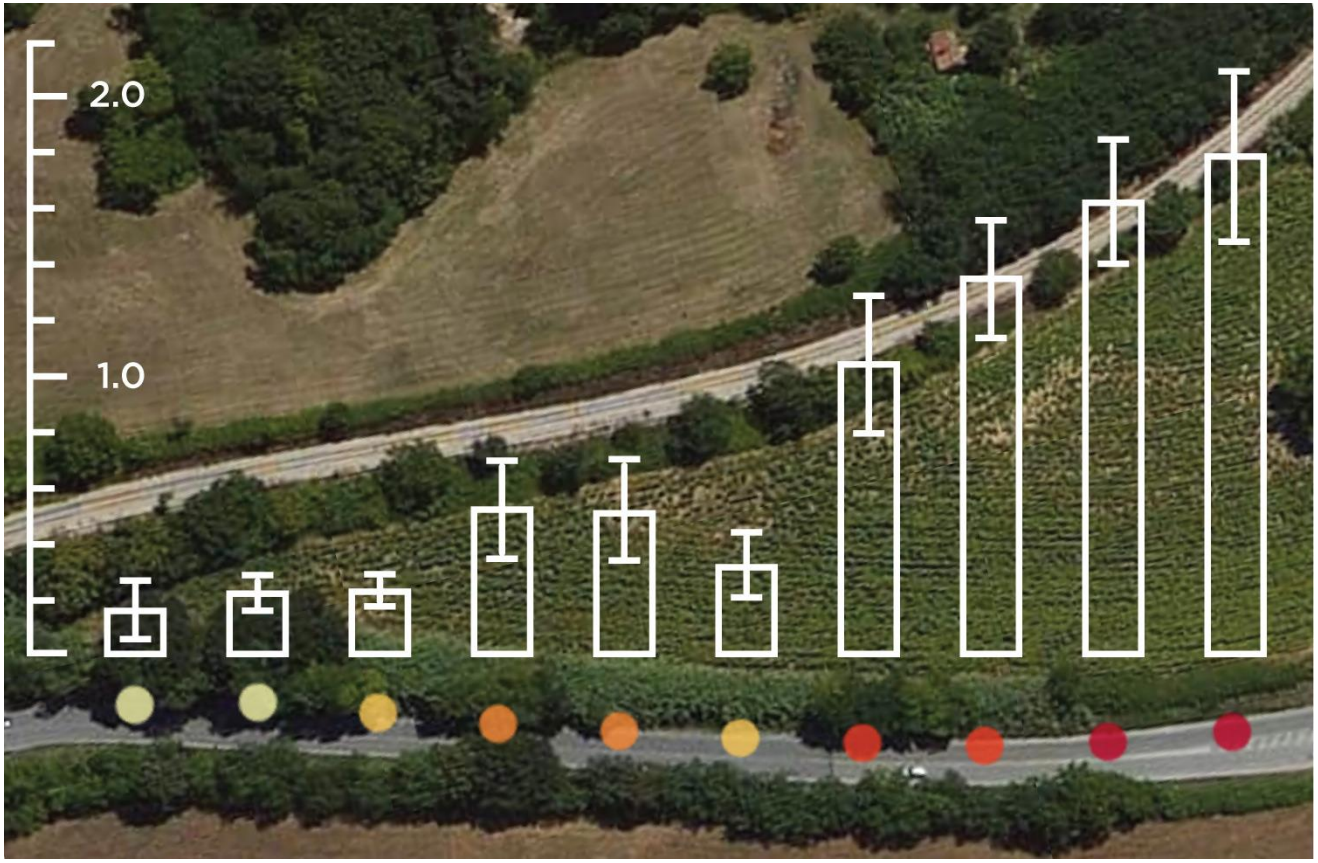
Mapped 248,38 kms (22,1%)

Data validation approaches

Crowdsensing is inherently susceptible to the collection of low quality data.

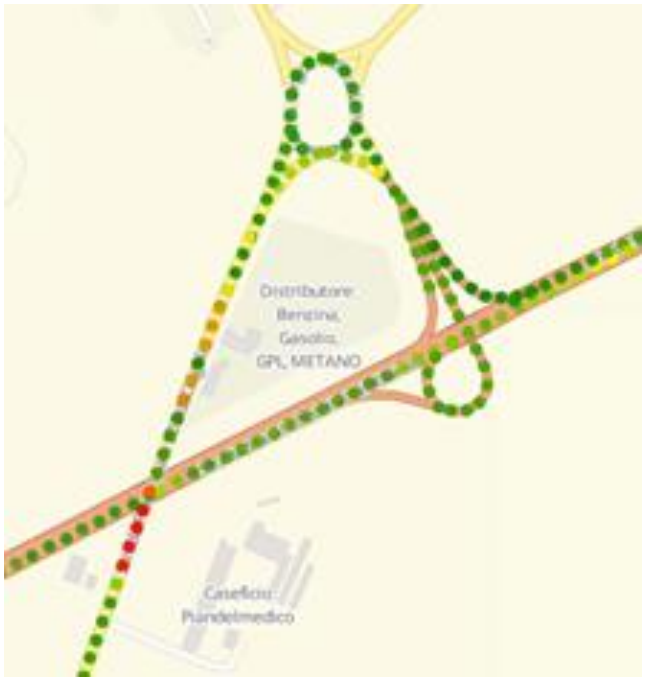
1. Statistical significance assessment
2. Visual road inspection
3. Systematic comparison with authoritative road quality data

Statistical significance assessment



(See Freschi et al., 2017)

Visual road inspection



SP502: km 02+150–02+400 (Marche)

Consistent. Slight deformation on the road (before the overpass) and noticeable longitudinal damage to the road surface (after the overpass). SRS data: orange (before the overpass, north) and red (after the overpass, south).

Visual road inspection

A4157 Douglas Road, Aylesbury (Buckinghamshire)

Not consistent. Inspection indicates the highway surface is in poor condition and impacted by heavy (including freight) traffic. Inspection shows cracking in the transverse highway surface, wearing coarse deterioration and surface deterioration. SmartRoadSense data shows dark green with very minor variations (PPE readings between 0.074 and 0.464).

Comparison with authoritative data

Tag			Indirizzo	Comune	Provincia	Regione
2	Start	Inizio ammal.	«Address»	«City»	«DISTRICT»	«State»

Id immagine	Id immagine
Sp301v_00000_751_0.jpg	Sp301v_00000_751_1.jpg
	
Id immagine	Mappa

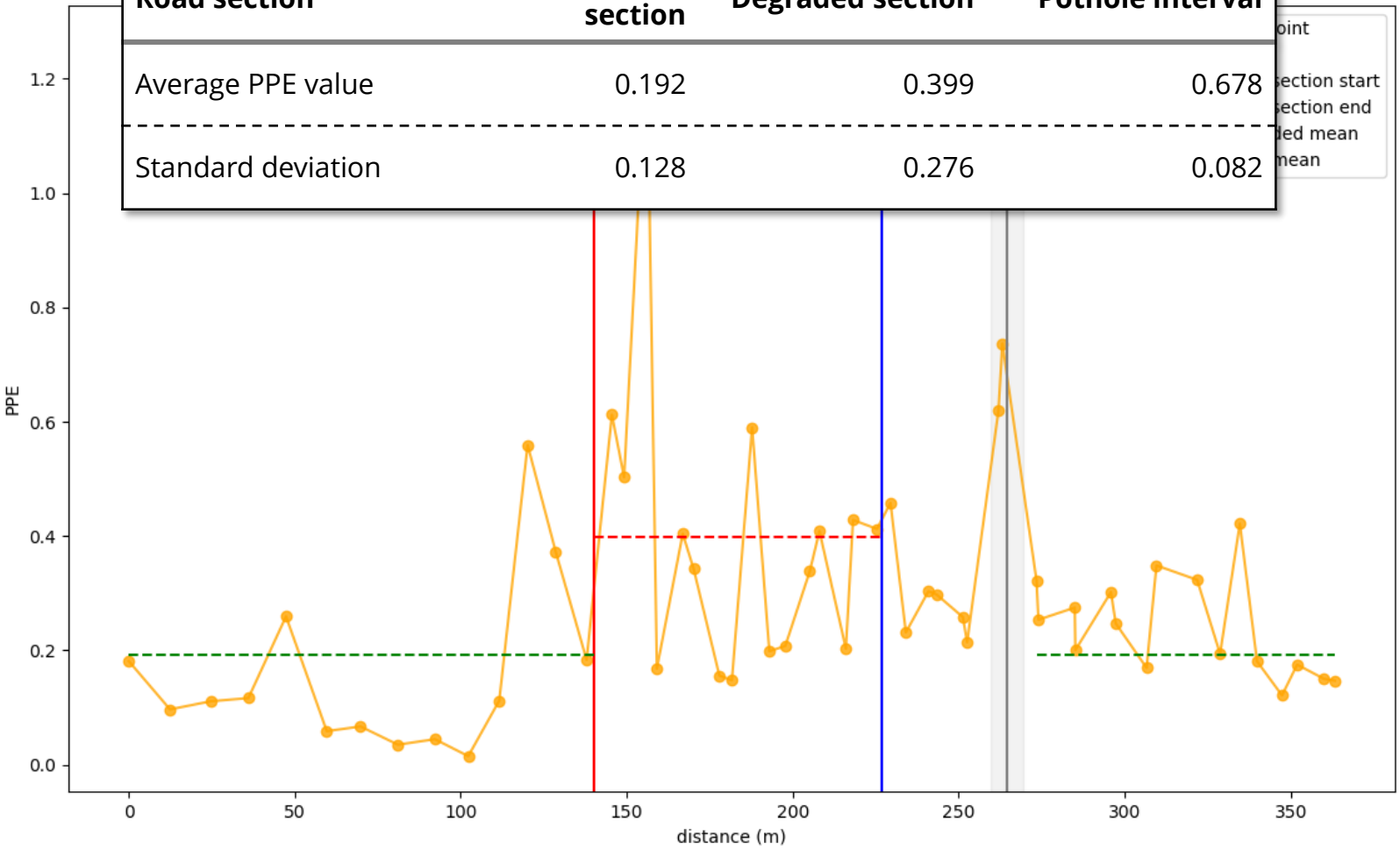
Note

Coordinate GPS (lat, lon, alt)	Data/ora	Operatore rilevazione	Operatore playback	Verificatore
45.148328;11.029818;00.000000;150.140000	2018/05/14 9:58:04.298	a	b	

Comparison with authoritative data

Comparison with authoritative data

Road section	Non-degraded section	Degraded section	Pothole interval
Average PPE value	0.192	0.399	0.678
Standard deviation	0.128	0.276	0.082



Conclusions

Crowd-based data collection allows **citizens to contribute with data** that can have **substantial value** and can be carefully exploited.

Comparison with ground truth data, quality estimation, tampering detection, the adoption of trust or reputation schemes offer a **wide range of research opportunities**.

Preliminary results show that the **data validation methods show promise** and that in-depth studies to reliably map crowd-collected data to useful metrics are needed.

Thank you.