Partnership in Weather Observation using the Crowdsourcing Method

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Abstract. Proper weather observation is definitely required to obtain the right and accurate weather information. Currently the weather observation in Indonesia is managed by various parties and coordinated by the Meteorology, Climatology and Geophysics Agency (BMKG). BMKG manage weather observation networks that distributed nationwide. Unfortunately, in terms of quantity and distribution, the current weather observation network is not ideal yet. Increasing the density of the weather observation network is undoubtedly needed, therefore BMKG needs to develop a partnership with all parties including general public. This study attempts to identify level of participation of general public and find the ideal partnership model for weather observation in Indonesia. Three partnership variables, namely motivation, consistency and sustainability, examined in this study. As a result of the data analysis it was found that the level of participation of general public is very high especially in the participant group that threat with guidance. And it was also found that the crowdsourcing method can be implemented as an ideal partnership model between BMKG and general public in the field of weather observation.

Keywords: weather, partnership, crowdsourcing

1. Introduction

1.1. Background
Weather and climate are natural phenomena that have an enormous influence on human life in various sectors, such as health, agriculture, infrastructure, recreation, transportation, water management, energy, and others. Weather information, both in the form of analysis and forecast, has a very important role to support daily activities for people from various backgrounds, from households to industries.

Currently weather and climate information services in Indonesia are managed by the Agency for Meteorological, Climatological and Geophysics (BMKG) which is a government agency that has the task of carrying out tasks in the fields of meteorology, climatology, air quality, and geophysics. One of the tasks is to observe weather and climate in all regions of Indonesia. Appropriate observation data and density of observation points will produce good weather information products as well. However, currently the weather observation points owned by BMKG have not been spread evenly and densely.

Almost in all regions of Indonesia BMKG weather observation points are not even and dense. In the territory of Indonesia with an area of 1.905 million km\textsuperscript{2}, there are 179 BMKG offices, 193 Automatic Weather Stations (AWS), 576 Automatic Raingauge (ARG) and approximately 4000 rain
posts. To improve the quality and quantity of weather observation data, it is absolutely necessary to increase the weather observation network. However, considering that BMKG's resources to continue to increase the weather observation network are also limited, efforts are needed to increase the density of the observation network, one of which is to build partnerships with the general public through voluntary weather observation programs using crowdsourcing methods.

The voluntary weather observation program with the crowdsourcing method is a new concept of weather observation with a focus on voluntary community involvement or empowerment. This program has been implemented in several countries where the role of government in this program is also quite diverse, ranging from as a facilitator, regulator to only play a role in the consultancy function.

Some voluntary weather observation programs have been implemented, for example in Netherlands with Personal Weather Stations (PWSs) and using smartphones. The PWS network in the Netherlands is much denser than the KNMI automatic weather station network and continues to grow. Rainfall data at the resolution generated by the PWS network can be especially useful for urban hydrological applications. Then the use of smartphones to estimate the daily average air temperature.

In Indonesia, voluntary weather observation programs have not been done much. This research tries to reveal how much the community participate in voluntary weather observation and how the ideal partnership model that can be built in voluntary weather observation.

1.2. Partnership Theory

The term partnership has a very broad scope both in terms of concept and application. First, opportunities for synergy in various forms, resulting in an understanding that the results of joining will be greater than separated. Second, partnerships involve elements including the development and implementation of strategies or a set of projects / operations, although each party may not have the same level of involvement at each stage. Third, in public and private partnerships, the public sector is not only pursuing commercial goals. Therefore, the criteria of the partnership can also be interpreted as the existence of social partnerships [3].

In the perspective of economic, partnership is a scheme with involvement or funding from more than one institution [7]. The existence of shared objectives of several institutions and defining partnerships as cooperation agreements between several actors to work together to achieve the economic goals that have been determined together [1]. Other definition of partnership is collaboration between business people, non-profit organizations and governments where all risks, resources and capabilities are shared in a project which can ultimately bring benefits to the parties involved and also to the community [8].

In the perspective of national development in Indonesia, partnerships basically contain the essence of justice in the acquisition of benefits, the imposition of costs and the handling of risks that arise in such business activities [2]. Thus, the partnership developed is an equal partnership between actors in accordance with their contribution capabilities.

1.3. Partnership Models

In building partnerships there are 5 (five) main dimensions that need to be considered, namely: a). What you want to achieve from the partnership, b). Who is involved, c). When is the implementation, including phasing, d). Where the partnership will be carried out, and e). How the partnership will be carried out [4]. Based on these five dimensions, we can identify early partnership models.

Partnership model can be identified by referring to the second dimension, namely who is involved or the actors in the partnership [6]. Based on actors involved, partnership models can be categorized into:

a. The Two-Parties Partnership Model

The form of a two-party partnership model includes Public Private Partnership, Public People Partnership, Public Professional Partnership, such as academics, researchers, engineers, and so on.

b. The Multi-Parties Partnership Model

The multi-party partnership model is carried out by more than 2 (two) parties. The form of the multi-stakeholder partnership model very varied, for example, Public Private Professional Partnerships, Public Private Professional and People Partnerships.
In weather observation, BMKG collaborates with BMKG partners to manage the observation network. Based on the role of BMKG partners in the management of observation networks, the partnership model is grouped into 6 (six) types of partnerships, namely: joint investment, joint operations, joint research, educational collaboration, data / information exchange, and land use.

1.3. National Policy in the Field of Meteorology, Climatology and Geophysics

a. Legal Standing of National Policy in Weather and Climate Information Services

The basis for national policy in the field of weather and climate information services is contained in Law No. 31 of 2009 concerning Meteorology, Climatology and Geophysics [9]. In this Law 31 it is stated that the government in this case the Agency for Meteorological, Climatological and Geophysical (BMKG) is required to provide meteorological, climatological and geophysical services, which includes weather and climate information services. And the Law also regulates that the services provided must meet national and international standards.

As a derivative of this law, a regulation has been produced under it regulating weather and climate information services, both government regulations, in this case Government Regulation No. 11 of 2016 concerning Climatology and Geophysics Meteorological Services [5] and regulations below, namely the Head of the Agency for Meteorological, Climatological and Geophysics.

b. Main Components of Weather and Climate Information Services in Indonesia

In carrying out its duties and functions, BMKG as the provider of weather and climate information services has 3 (three) components, namely:

i. Technical infrastructure components, which include Observation Networks, Equipment, Calibration, IT Systems, Software, Office Buildings, System Integration, Communication Networks and Maintenance.

ii. Production Components, including observing, processing and analyzing data, forecasts, supervision.

iii. Service Components that handle weather services in various fields, both scheduled (routine) and early warning information.

From the components above, it can be said that the Technical Infrastructure Components and Production Components belong to the Back Office component group and the Service Components are Front Office component groups.

1.4. Global Observing Networks

Management of global observation networks is currently regulated by the World Meteorological Organization (WMO) in a program called the Global Observing System (GOS). The aim of GOS is to provide quality weather observations both from land, sea level and from space, which will then be used for making weather analysis and forecasting and other related applications [10].

In general, GOS consists of 2 (two) sub-systems of observation, namely surface-based observation and space-based observation. Earth-surface based observations can consist of synoptic observation stations both land, sea, and upper air, climate observation stations, agricultural meteorological stations, aviation meteorological stations and special meteorological stations. Ground weather observation stations (land synoptic station) can be either manned station or unmanned station.

In making observations, all observation stations must be equipped with standardized observation equipment and are routinely calibrated, so that the resulting data is suitable for further use.

1.5. Research Questions

- How is the participation level of community on voluntary weather observation?
- What is the ideal weather observation partnership model on voluntary weather observation?

1.6. Research Objectives

- Identify the level of community participation in voluntary weather observations.
- Find the ideal partnership model between BMKG and the community in voluntary weather observation.
1.7. Research Benefits
- Increase the density of the weather observation network.
- Improving the quality of weather and climate information services.
- Increasing community participation in weather observation.

2. Research Methods
2.1. Research Type
This type of research is qualitative research where in addition to the description process of the theory and data, there is also an analysis of the data obtained. Qualitative analysis is mainly carried out at the operational level of theory, which is analyzing survey data about partnership models and variables.

2.2. Research Variables
- Partnership Variables:
  a. Partnership Motivation
  b. Partnership Consistency
  c. Partnership Sustainability
- Determinant Variables:
  a. Coaching
  b. Incentive

2.3. Operational Definition
- Partnerships in the development of weather and climate observation networks are partnerships between BMKG and other government agencies, private, public, professional and media.
- Partner Group is a group of parties who have or have the opportunity to make a partnership with BMKG. The partners are divided into four (4) groups, namely:
  a. Government Partner Group (Public/ P1), is a group of BMKG partners from other government agencies, such as Ministries/Institutions, Regional Governments, TNI and Polri.
  b. Private Partner Group (Private/P2), is a group of BMKG partners who come from private companies both pure private and BUMN.
  c. Professional Partner Group (Professional/P3), is a group of BMKG partners who come from professional institutions, such as Universities, Research Institutions and Professional Organizations.
  d. The General Community Partners Group (People / P4), is a group of BMKG partners who come from the general public group.
- Determinants include supporting and inhibiting factors in implementing partnerships.
- An ideal partnership model is a partnership model in the field of weather and climate observation network management which is considered the most suitable to be applied in Indonesia. The partnership model that will be tested in this study is specifically the Multi-Party Partnership model with the Crowdsourcing method.
- Weather and climate observation network is a network of weather and climate observation posts located on the surface of the earth (surface based observation) outside the BMKG office.
- Observation post consists of Rain Posts, Special Observation Meteorological Station, Automatic Weather Station (AWS), Agriculture Automatic Weather Station (AAWS) and Automatic Rain Gauge (ARG).
2.4. Research Design

2.4.1. Framework and Conceptual Framework

![Figure 1: Framework](image1)

![Figure 2: Conceptual Frame](image2)

2.4.2. Research Period

a. Pre Observation Period
   Conducted for 1 (one) month, namely in January 2019. The activities include:
   i. Making a crowdsourcing application for data transmission
   ii. Disseminating website information to the public
   iii. Preparing survey questions

b. Observation Period
   Held for 3 (three) months, starting from 1 February to 30 April 2019. The activities include:
   i. Inputting the data observation by the public through crowdsourcing application
   ii. Giving guidance in the form of notification to 20 respondents were selected randomly after the first week observation period

c. Post Observation Period
   Carried out for 1 (one) month which includes:
   i. Recap observation data
      The observed data that has been entered will be recapitulated to know the data consistency.
   ii. Survey continuity of observation
      Do the observers to find out whether they are willing to continue observations for a longer period
   iii. Analysis of observational data
      Conducted to determine the frequency consistency of observation. The consistency analysis are expected to be concluded what kind of partnerships model that have a high level of consistency.

2.4.3. Goals and Research Respondents

The objectives research are the general public as a data source crowd. The respondents of this study is the general public who regularly report weather observations through crowdsourcing application.

2.4.4. Data collection technique

1. Online observation
   From the online observation obtained data of coaching and consistency variable. Observations made with the crowdsourcing online app which have been disseminated to the general public. By using the application, respondents can report weather observations anywhere and anytime. It will record observational data reported by the respondent along with the location and time of reporting.

2. Online survey
   Data obtained from an online survey include motivation partnership, continuity and consistency variables. An online survey conducted by distributing links online survey distributed to the general public who have participated observed during the period of observation.
2.4.5 Data analysis technique

1. Motivation Partnership and Sustainability Partnership Variables
   The data used is the online survey data. The questions asked about motivation becomes a weather observer, respondent’s opinions of the weather observing, whether respondents utilize weather data, and also the willingness of respondents to be a weather observer independently and voluntarily.

2. Consistency Partnership Variable
   The data used in this analysis is the observed data to note the consistency of observations and data transmission. Index consistent implementation of the partnership:

| No. | Percentage of Data Delivery               | Consistency index |
|-----|------------------------------------------|-------------------|
| 1   | 0-25% of the data sent on time           | 1 (inconsistent)  |
| 2   | 26% - 50% of the data sent on time       | 2 (less consistent)|
| 3   | 51% - 75% of the data sent on time       | 3 (consistent)    |
| 4   | 76% - 100% of the data sent on time      | 4 (very consistent)|

Table 1 The determination value of the consistency index.

3. Results and Discussion

3.1. Partnership Variables Data Analysis
   Partnership variables data consist of three aspects, such as motivation, sustainability, and consistency.

3.1.1. Motivation aspect
   The analysis results of the motivation aspect obtained from some questions in an online survey conducted in July 2019 which was attended by 20 respondents. According to the survey, 50% of respondents stated that their motivation to participate in the program PAMANCARA is because they want to participate as weather observer. As many as 35% because they feel the program support the task / work, while the remaining states interested about the weather or just want to spend leisure time.

   Other factors associated motivation aspect is whether there is a reward or incentive routine to report weather conditions. Based on the survey results, either with or without a routine incentive, as much as 85% of the respondents are willing to be a participant in weather reporting. Therefore, can be concluded that motivation aspect is satisfactorily because the majority of respondents expressed interest in becoming a weather observer with or without incentives.

3.1.2. Sustainability aspect
   The analysis of this aspect is also obtained from online survey. The results showed 90% of respondents are willing to become a volunteer weather observer if PAMANCARA program resumes. Meanwhile, when the PAMANCARA program made into a paid platform, as much as 45% of the respondents are willing to buy and become a volunteer weather observer using these applications, 35% stated not willing, and the rest did not know. The conclusion of this aspect analysis showed satisfactory results when the program continued to include the general public as a volunteer weather observer.

3.1.3. Consistency aspect
   Consistency aspect data is obtained from weather data report through PAMANCARA program of 40 participants as a randomly selected. Where 40 participants were then divided into 2 groups: group of participants who were given weekly routine notifications and group of participants who did not.
Based on the analysis of these two groups during the period of implementation of the PAMANCARA program, from February to April 2019, showed that the group of participants who received the notification routinely showed values higher consistency, both in terms of percentage of the weather report and in terms of number participants reported than the group that did not receive the notification.

To measure the consistency of these two groups, made four grade categories: inconsistent, less consistent, consistent, and very consistent (Table 1). The results of the analysis of the categorization of participants in both groups more shown in Table 2.

| Category      | Group with Notifications | Group without Notifications |
|---------------|--------------------------|-----------------------------|
|               | Number of Participants   | Percentage (%)              | Number of Participants | Percentage (%) |
| Inconsistent  | 7                        | 35                          | 16                      | 80             |
| Less Consistent | 2                      | 10                          | 3                       | 15             |
| Consistent    | 4                        | 20                          | 0                       | 0              |
| Very Consistent | 7                      | 35                          | 1                       | 5              |

Table 2: The determination value of the consistency index.

Table 2 above shows that the group of participants who regularly receive notifications have the higher number of participants by consistent and very consistent category. While the group who did not receive regular notifications only as much as 5% or 1 out of a total of 20 participants were in the category consistent and very consistent. It can be concluded that consistency aspect shown satisfactory results for the group of participants who received the notification routine.

3.1.4. Determinants Variable Data Analysis

Determinant variables for PAMANCARA program are consist of two aspects: coaching and incentives. Coaching aspect obtained from analysis of the level of consistency in the two sample groups of participants each consisting of 20 people. Coaching is done by giving a weekly routine notification to one group of participants contain the report number of weather conditions that have been submitted, as well as thank them for their participation. While the second group did not receive a similar notification. The second aspect of the determinant variable is incentive aspect, where the analysis of this aspect obtained from an online survey of 20 respondents from both groups of participants (with and without notification). In the online survey, there are some points of questions related to incentive aspect.

The result for coaching aspect showed significant differences between the two groups of participants. Where the group who receive coaching or in this case be notified weekly showed a higher participation rate compared with the level of participation of the group that was not given notification. In the group who receive coaching, the highest quantity of weather report in the period PAMANCARA program is 388 reports during the 87 days of the total 89 days of this program, or about 98%. While in the group without notification highest number of incoming weather report amounted to only 228 reports, or about 78%. The notification group average percentage participation of 20 participants by 51%, while in the group without notification only a third of which is 17%. More is shown in Table 3 below.

| Parameter      | Group with Notifications | Group without Notifications |
|----------------|--------------------------|-----------------------------|
|                | Average                  | Max.                        | Average             | Max.                        |
| Total Reports  | 116                      | 388                         | 31                  | 228                         |
| Number of days | 45                       | 87                          | 15                  | 69                          |
| Percentage (%) | 51                       | 98                          | 17                  | 78                          |

Table 3: Coaching aspect parameters analysis.
As for the incentive aspect analyzed based on the results of the online survey of 20 respondents said that the incentive aspect not significantly affect the motivation of respondents. In an online survey conducted in July 2019, there are two points related to this aspect asked the respondent's willingness to participate as a volunteer weather observer well if given the incentive routine and without incentive. The results is equal to 85% of the respondents are willing to participate as a volunteer weather observer either incentives or no incentive is given. And only 15% remaining states were not willing.

The conclusion of the second aspect of this determinant variables satisfying, where participants receive coaching show that the participation rate is much higher than they who did not, as well as the incentive aspect that was not the main aspects that affect people's willingness to participate in the program.

4. Conclusion

- The level of community participation in voluntary weather observation can be summarized:
  a. Based on partnership variables data analysis showed that 50% of respondents do voluntary weather observation is that the motivation would like to become a weather observer, 90% of respondents are willing to continue be voluntary weather observer if the program continued. The average percentage of the consistency of the observations in the period February to April 2019 were 51% for the observation group who receive coaching.
  b. Based on determinant variables data analysis showed satisfactory results for incentive aspect, where 85% of the respondents with or without incentive routinely still willing to be a volunteer observer. As for the coaching aspect showed satisfactory results for the group who received coaching (51%), while for the group without coaching result is not satisfactory, or by 17%.
  c. The conclusion that can be taken as a whole that is a partnership in weather observations through crowdsourcing effectively implemented in Indonesia when seen from the high motivation of people to participate as a volunteer weather observer, with a note that coaching is still carried out to obtain a high level of participation and consistency of participants. As well as the incentive aspect of routine can be considered as a reward factor for this volunteer weather observers.

- Ideal partnership models in weather observations through crowdsourcing methods is many-parties partnership using crowdsourcing methods and enriched with coaching variable. It can be seen from the high level of participation of observers who receive treatment coaching.

Acknowledgments

This research can be done well by the help and participation of all parties. In this occasion the author would like to thank you profusely to the people who have participated actively submit reports weather conditions in PEMANCARA program implemented over a period of 3 months. As well as to the respondents who have participated in an online survey about the system's crowdsourcing-based weather observations.

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