
# Innovation
## in Public and Private Weather Services

Photo: Xinhua/Alamy Live News

Anhui Province, China—A student at the 32nd Hefei teenager science & technology innovation competition shows a smart weather condition reporting window she invented.


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*Technical Note from the series focusing on specific aspects of Public and Private Engagement in Hydromet Services*


## Abstract

The weather enterprise must continue to innovate and expand to keep people safe from disruptive weather, and to keep up with the demand for weather intelligence for economic development. Despite considerable scientific and technical advances, underinvestment in services, coupled with poor regulation and business practices, prevents the enterprise from fully protecting developing economies. New approaches are needed. The lean startup focuses on development with a minimum level of investment. While the build–measure–learn approach is used extensively in the private sector, we consider its application to NMHSs and how this might be used to prototype new capabilities quickly with modest investment in different components of the meteorological value chain. The process introduces new ways to manage projects under extreme uncertainty and benefits traditional institutions to strengthen the way they operate.


## Introduction

Present and growing weather extremes and the increasing dependence of economic performance on weather intelligence are challenging societies everywhere. Keeping people safe from disruptive weather, while enabling economic development, depend on inventive products and services that meet the needs of people and markets. Innovation impinges on the public, private, and academic sectors to embrace new technologies in the weather enterprise,[1] exploit the benefits of open data policies, enhance the capacity of the public and private sectors, expand the capacity of users to utilize weather-related intelligence for decision making, and operate within the framework of increasing constraints on government financing of public services.

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Organization and innovation form essential components throughout the weather enterprise to ensure that it is well suited and equipped for its roles. Despite its fundamental importance to society, the weather enterprise has not yet achieved its full potential (Thorpe and Rogers 2018). Underinvestment, coupled with poor regulation and business practices, has limited the ability of the enterprise to "weather proof" developing economies (Rogers and Tsirkunov 2021). Rivalry between public and private actors—rather than competitive innovation as well as limited interactions with the academic sector—has stymied the development of the weather enterprise in many countries (Rogers et al. 2021). Open data policies, which are proven to increase economic benefit, are not routinely applied to meteorological data (Rogers and Tsirkunov 2021). Ensuring the whole of society has access to the best available products and services is a challenge. Modern meteorological services must be in the vanguard of innovation—exploiting non-traditional observations and using data analytics to create impact-based forecasting and warning services or enabling business data integration of weather intelligence, are two examples. They require new tools to prototype rapidly and operationalize novel services and business practices that apply equally to the private and public sectors to enhance and expand the enterprise.

Large public sector investments in National Meteorological and Hydrological Services (NMHSs) and disaster management agencies tend to apply proven but often outmoded solutions based on the experience of past projects. In general, these are scoped well in the overall results expected, but do not account for the rapid development of technology and knowhow. The most advanced NMHSs and private companies include research and development (R&D) branches, and increasingly these include units that focus on rapid prototyping of new solutions. One approach is the application of the concept of the lean startup (Reis 2011), which has been proposed as a means to create nascent private weather services (World Bank 2019) but may be equally applicable to innovate products and services in the public sector. The lean startup focuses on the development of new services with a minimum level of investment and with users of the potential services engaged from the outset to ensure the products are tailored appropriately. In the public sector, this approach applies equally to products and services for any government, including disaster management, water resources, and agriculture, and can be used to create new integrated products and services. In civil society, this could focus on development of tools specifically to help disadvantaged or citizens with special needs.

In this technical note, we examine the application of the lean startup in the NMHSs, and consider how this might work within the context of international investment in developing countries. A potential benefit of the approach is the ability to test and evaluate the coproduction of services with the private sector or other government departments and agencies or jointly with both.

## The Changing Landscape

As countries embrace open data policies, they can expect that many data-focused public sector agencies will need to adjust their products and services (World Bank 2017). In particular, they may be forced to retreat from various forms of commercial enterprise—especially data sales—and comply with competition laws. In many developing countries, where the NMHSs exercise a monopoly over data and may have legislated in the past against private commercial services, this will require rethinking the role of the NMHSs in

the national economy. The prevalent understanding suggests that the weather-dependent economy will develop faster and more sustainability by encouraging: (i) the development of private commercial services that will innovate and improve economic efficiency through competition, and (ii) a public sector which focuses on delivery of public goods contributing to the economy and safeguarding people (World Bank 2019). Regulations would foster rebalancing the roles of the public and private sector and would define the respective responsibilities of the protagonists in the weather enterprise replacing often adversarial positions with cooperation, coproduction and an open market (Rogers et al. 2021, Rogers and Tsirkunov 2021).

An underlying assumption of a policy to make public data free to use and re-use without restriction is that it will fuel more economic activity. While sufficient evidence supports this notion (World Bank 2019), resetting the relationship between the NMHSs and the private sector has a number of consequences that may adversely affect the public institutions' ability to fulfil their responsibilities, unless anticipated and mitigated. These include replacing any lost income from the NMHSs' data sales and non-competitive commercial activities or repurposing or downsizing (World Bank 2019). In countries where the private sector has been absent, the NMHS is a monopsony, which means the government may set the price for wages and goods artificially low. As the economy opens, the market price for wages and goods is likely to be much higher and the government may no longer be an attractive employer or consumer of goods. Such a likelihood can result in a transfer of human capital from the public to the nascent private sector, and put additional pressure on the NMHSs' ability to provide services.

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## Transformation of Meteorological and Hydrological Services

Modernization or upgrades to the NMHSs funded by development banks and other international development agencies have had mixed results. While the aim is to help the government and its agencies develop public services that meet the growing needs of society, the investments often fall short of this ambition. The issues have been elaborated at length (Rogers et al. 2019, Rogers and Tsirkunov 2013, World Bank 2019) but transformation remains a stubbornly difficult problem to solve. Rather than reiterate the problems and attempted solutions, we draw on a different line of thinking about business practices and innovation.

We can address an aspect of the root cause of some of the problems facing development partners investing in the NMHS using five "why" questions:

### Why do large investments in the NMHS regularly fail to achieve the expected improvements in public services?

- After the project ends, no funds are allocated to cover the additional costs of operations and maintenance of the new systems. Therefore, modernization is not sustainable.

### Why is the modernization not sustainable?

- A lack of understanding exists about how much resources and effort are needed to support the national weather enterprise, particularly its public part. This leads to government policies that stimulate the use of fee-based services, neglect education

and R&D, and that introduce regulations supporting the NMHS's monopolistic role instead of incentivizing market development, and give insufficient support for basic infrastructure.

### Why is the government not committed?

- Neither revenue nor public response demonstrates additional social and economic benefits by the end of the project.

### Why are the benefits not clear?

- The project financed the development of new services; however, the producers (NMHSs) believed that infrastructure would somehow resolve the issues, and did not consider what users and customers wanted, or the need for education and training, and raising public awareness of users.

### Why did the NMHS not engage with users more effectively?

- It is not in the culture of the NMHS to engage with its users in a way that they help define the products and services that they want. Historically, the NMHS's main task was to produce high quality data and conduct research.

We can surmise that user engagement is critical in any modernization project. However, it is a skillset that is often missing from the NMHSs' engagement strategy. Consequently, it is often heavily discounted, or considered an add-on rather than the first step in developing services for users and limited to a few stakeholder encounters concluding with the request for more timely and accurate weather forecasts and warnings; a statement that is axiomatic and not particularly helpful in designing specific products and services.

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Meteorological and hydrological services are going through a major transformation about the way products are made, how services are delivered (Rogers et al. 2021) and who provides those services (Thorpe and Rogers 2018, World Bank 2019). A pivotal change occurred in 1994 with the creation of the public weather services program within World Meteorological Organization (WMO) (WMO 1996, 2000) when the focus shifted from the NMHSs providing products and services which they considered useful to engaging with customers to determine what services were required for these customers. The WMO (1996) states, "Public weather services should only be undertaken in response to actual and real needs and requirements expressed by the user community and not as an end in itself." This assertion is prescient of modern business practices that emphasize engagement with customers to determine what they want, and therefore, the right thing to build. It may seem alien to many NMHSs which have mandates to provide weather forecasts and warnings, but in the end, it is actions of the users of these services that determine their utility.

*The Power of Partnership: Public and Private Engagement in Hydromet Services* (World Bank 2019) poses two questions: (i) what are the characteristics, advantages, challenges and potential risks of the various public-private engagement models in the hydromet sector?; and (ii) what are the available options for developing countries that wish to streamline and augment public and private engagement to strengthen the provision of hydromet services, and, accordingly, the conditions necessary to succeed? Among many important conclusions, the study (World Bank 2019) highlights the need for development projects to **focus on improving the entire hydromet value chain**, rather than only on the NMHS infrastructure and capacity that has hitherto been the main motivation for investment.

The new approach means supporting activities that will enable both the public and private sectors weather services as well as the academic sector develop cooperative and competitive relationships that sustain the entire weather enterprise. This includes early adoption of advances in science, and using business practices that support consumer-focused development and implementation of innovative solutions across the enterprise.

## The Lean Startup

Rogers et al. (2019, 2021) highlight different business models that can be applied to the NMHSs ranging from outsourcing activities to the private sector to the coproduction of services with the private sector. However, in many developing countries, the private sector is nascent, and its growth depends on developing a commercial market for services. This stage of development aligns with a public–private engagement scenario, which emphasises strengthening and focusing on the NMHSs providing public services, and lays the foundation for the private sector to provide non-public services (World Bank 2019).[2] The lean startup concept is proposed as a means of rapidly developing and bringing to market new products and services in the private meteorological services sector (World Bank 2019), but is equally applicable to the production of government services (Ries 2011). In the private sector, an example of the application of the lean startup methodology, relevant to meteorology, is the company Symphony Creative Solutions Private Limited[3] founded by Nippon Yusen Kabushiki Kaisha Group (NYK), Weathernews (WNI) and Kozo Keikaku. The company fuses NYK's shipping and logistics knowledge with WNI's innovative infrastructure network and weather forecasting technology and Kozo Keikaku Engineering's advanced operations research techniques and data–analysis technology. The lean startup methodology is used in product development that employs an entrepreneurial business work style to create next generation shipping and logistics solutions.

*We pose the question: can the lean startup methodology be used to develop tailored products and services within the NMHSs that would otherwise have limited or no access to R&D?*

While the most advanced NMHSs can rely on their own internal R&D departments and on academic research, many developing NMHSs do not have this capacity (Rogers et al. 2019). Instead, they tend to depend on products created through external R&D and technology transfer from more advanced NMHSs, the private sector or both. Infusion of new technologies is often sporadic and not necessarily fully fit for purpose. Consequently, we pose the question: can the lean startup methodology be used to develop tailored products and services within the NMHSs that would otherwise have limited or no access to R&D?

Ries (2011) defines a startup as "a human institution designed to create a new product or service under conditions of extreme uncertainty." This would apply equally to a new multi-hazard, impact-based warning service for a biological threat created by an NMHS, health service and disaster management agency (Rogers et al. 2020a), and a weather service to optimize train operations developed by a private firm, for example.[4] The definition highlights several important points: (i) the activity is essentially a human enterprise involving creativity, coordination and a culture to deliver results; (ii) it aims to create something that is a source of value for the people who become its customers or users and how they interact with the company or agency; and (iii) it is undertaken in an environment with a lot of unknowns that will influence the viability of the product or service. Innovation is at the heart of success in this enterprise. It can take many different

forms from the application of a new scientific discovery or technique to simply bringing a product or service to a new location or to a previously underserved set of users.

An important tenet of a lean startup is experimentation to test its strategy to build a sustainable business around a vision. The aim is to trial many different assumptions by initially building a simple product that enables the agency or firm to observe the real behavior of customers and users. Let us consider, for example, a service for government-issued, impact-based warnings that aims to provide people at risk with information about what to do in response to a severe weather hazard. The service would then consist of creating warning messages that people understand and are willing to act on. The meteorological agency and the disaster management agency need to interact with users to understand how they want to receive information, and how they will use the information received. Is a short messaging service (SMS) sufficient? How should the message take action to be reinforced? Do people respond on their own, or only when the information is validated by other sources? How long will people mill around before making a decision? How long does it take to reunite a family with children at school and family members at work before collective action is possible? These and many other aspects can only be informed through direct contact with the potential users of these services. So, even if no intention exists to build a business, the approach helps agencies engage with their users.

Interacting with potential users and customers of the service helps build a minimum viable product that allows the team building the product to collect the maximum amount of validated learning to test various assumptions with the least effort. In many countries, it is common to find that, while relatively good meteorological forecasts and warnings are issued, it is just as likely to find that these warnings are not heeded (WMO 2015). Many reasons support why this may be the case, but often these are not well known to the service providers because they have minimal or sometimes no interaction with the users of their services, contrary to the WMO guidelines for public weather services (WMO 1996, 2000). Professional standards often lead the NMHSs to strive to create a quality product, but without knowledge of their specific clientele behaviors and needs, it is not possible to know what quality is, and therefore, risk overengineering a solution. Adherence to International Standards Organization (ISO) standards that focus on meeting customer demands and needs would help address this challenge. The NMHSs often claim that their observations are of a higher quality than those made by the private sector, but this does not mean that the products produced by the public sector are superior to those produced at probably lower cost by a private firm; moreover, the private sector will produce what is needed and paid for. Quality is directly linked to what the customer or user cares about. Discovering that a product or service does not meet expectations drains resources in money and effort, and ultimately is a risk to reputation and belies the authoritative voice to which most NMHSs aspire.

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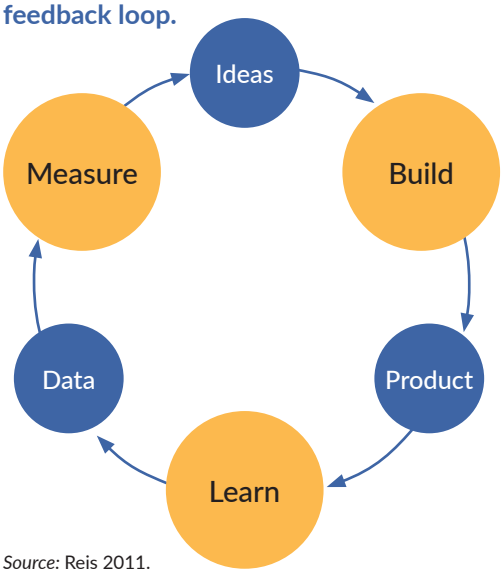
In both private and public sectors, we need to address two hypotheses—**value creation and growth**. It is fundamental to determine if the product or service is value creating or value destroying, and whether this leads to growth or not. An increasing number of people who use a public warning service or more clients who buy a weather product from a private weather firm, would be measures of growth. The value creation of a product or service should be a primary driver of any public sector entity, or else its sustainability will depend on continuous infusion of funds from development partners. In practice, this is a common scenario where huge capital investments are made, the systems they support work for a while and then fail, and the process cycle begins again. It is highly

likely that the supposed users of these services hardly noticed the period when services functioned as expected. While not a guarantee of sustainability, services are more likely to be publicly financed and supportable if they create value for a significant number of customers or users. Ideally users would provide continuous feedback that enables quantitative measurement of the value and helps minimize a waste of resources.

A core component of the lean startup methodology is the build–measure–learn feedback loop (Reis 2011). A goal of the process is to minimize the amount of total time through the feedback loop (**Figure 1**). In the process, the focus should be on what needs to be learned, what needs to be measured to gain validated learning, and then to figure out products to be built that run the experiment to get that measurement. The initial loop leads to the minimum viable product, and thereafter the validated learning based on customer or user experience for further iterations and product or service improvements. Maximum speed in its implementation is critically important to minimize wasting time, effort and money developing something that nobody wants, and to minimize the time reaching the decision point to persevere with the product or to pivot—that is, make a structured course correction to test a new fundamental hypothesis about the product, strategy and sustainability based on feedback. Returning to the example of an impact-based warning service, the team might learn that while users understand the product—a warning of the likelihood of flooding of their homes—they do not have sufficient lead time to evacuate. The startup needs to pivot to provide earlier warnings, possibly with a reduction in the accuracy of the warnings. The earlier alerting may be more useful to those at risk than the precise timing and intensity of the event.

**Figure 1. Build–measure–learn feedback loop.**




*Source:* Reis 2011.

## Prototyping in the NMHSs

Previously, we have argued that investments in the NMHSs should be transformative, and that small investments are insufficient to change a weak organization into a moderate or high performing service (Rogers and Tsirkunov 2013). While this argument remains true, the transformation structure needs further investigation.

Modernization efforts have and continue to focus on institutional strengthening, upgrades to infrastructure, and service delivery (Rogers et al. 2019). While the latter has become more prominent in recent years, most NMHSs want to focus on infrastructure—more observations, more computers, access to turn-key products, ability to run limited-area models, and development of applications. Any training emphasises the use of these tools. This consumes most of the project's money and time. As we noted in our preliminary five-question assessment, the most important element in the process—the customer, user, consumer—is not really part of the process despite results frameworks promising actionable weather warnings for an entire population.

Certainly, investment in infrastructure is important and should proceed, but it should not outpace the development of new products and services and the institutional changes needed to support these developments. Creating an environment where the lean startup methodology can be applied could address this problem; and would require restructuring the service delivery aspects of modernization projects as a collection of lean startups in parallel with some traditional business methods aimed at improving existing services. Such measures would increase opportunities to engage actively with different sets of users or customers as a part of the product or service development process.

The prototyping that is synonymous with lean startups would allow new products and services to be developed while also helping build new infrastructure. An element of a no-regrets strategy has to be applied to the latter, but the build–measure–learn model used to develop new services would incorporate assumptions about the existing and future capabilities of the infrastructure. It should be noted that the lean startup methodology could also be applied to internal products, such as using data analytics or ensemble predictions systems or both in the forecasting process, for example, where the customers are the forecasters in the NMHS, providing validated learning to the design team.

At this stage, we consider how we might develop an integrated new multi hazard impact-based early warning service and a decision support system. The first consideration is to create the team to undertake the venture. The team could be a small group from the existing public organizations—disaster managers, meteorologists, hydrologists, Information and Communication Technology (ICT) experts—or it could be a firm contracted for the purpose, or a combination of a firm and internal experts. A lean startup is a human institution; therefore, it requires management geared to its context of extreme uncertainty. It requires creating space for experimentation and allowing continuous innovation through testing and interaction with users, where the measure of success initially is in validated learning that is used to improve the service. While the basic building blocks of warning and decision support systems are well established, how to adapt them to the specific needs of individuals, communities and local authorities are at the outset unknown and untested. Traditional warnings focus on what the weather will be; in contrast, the impact-based system emphasises the impact of the weather on people, and therefore needs considerable data on the vulnerability and exposure of people. The initial minimum viable product will likely have very limited functionality and may only work for a small group of people, but will be able to iterate quickly. It might develop ways to acquire vulnerability and exposure data directly from users to improve the specificity of the warnings through mobile applications or SMS. The expectation is that by incorporating users in the process, warning messages will be relevant to their needs, the quality of the service will match users' expectations, and the service will be scalable migrating from a prototype to a mainstream operational product.

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## Conclusions

Our technical note has examined how innovative products and services can be developed in public and private weather services. The lean startup methodology described in detail by Reis (2011) is an essential tool that supports an entrepreneurial business, applicable to any sector—government, private, academic, non-profit. It can be used for internal development or external products. The approach can help the weather enterprise expand to meet the demands of users and customers, particularly where the national institutions need significant strengthening, and where the private sector weather services are nascent.

Incorporating the lean startup methodology into major development partners' investments in the NMHSs and disaster risk reduction may be a way to significantly enhance the delivery of services without requiring a complete overhaul of the investment process. How would this work within a development project cycle? To complement and improve the design of the development project with the help of innovations such as the lean startup would most likely require grant-funding instruments. Potential innovations

should start prior to final project design so that promising activities are included in it. The need for flexibility of procurement is another constraint.

A biproduct of the process is the introduction of a new approach to managing projects under conditions of extreme uncertainty that may have wider benefits to the overall functioning of traditional institutions that are trying to reinvigorate the way they operate and respond to societies' growing needs for weather, climate and hydrological information.

Sustainability of the NMHSs and disaster management agencies remains a critical issue, and the approach described is not a panacea; however, by putting users first, a greater chance emerges that the cost of services can be well justified to compete effectively with the many demands on public finances. Actively engaging with largest possible number of users and cohorts, and for those users to be able to demonstrate the value of the services to their lives and livelihoods will be the most effective way of defending increased public investment.

In the private sector, the lean startup approach is a way to bring new local actors to market. Their involvement is critical to provide weather-sensitive economic sectors the tools to manage their businesses' exposure to meteorological and hydrological risks.

## Notes

1. The Global Weather Enterprise is the value chain of activities of the public, private and academic sectors providing accurate, reliable, and timely weather and climate related information. It contributes to the safety of life and property, poverty reduction, and the promotion of economic development.
2. World Bank (2019) defined public services as "Services which are of public interest and which show public good characteristics or natural monopoly features."
3. https://www.nyk.com/english/news/2016/004280.html
4. Tuukka Järvenpää (2014) describes the lean startup methodology with numerous examples of its application. The Master's thesis case study focuses on a Finnish startup company working in the intelligent traffic systems domain by connecting and improving different areas related to total traffic including vehicles, roads and railways and weather information. He concludes that regardless of the industry, companies should aim to quickly build minimum viable products and test them in practice in the marketplace before committing to significant investments. https://www.theseus.fi/bitstream/handle/10024/80505/Jarvenpaa_Tuukka.pdf?sequence=1&isAllowed=y

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