

## Research Article

# Strengthening Metis Around Routine Health Information Systems in Developing Countries

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### Abstract

*James Scott argues that, in state interventions, there are significant attempts to simplify, standardize, and make legible processes which, by definition, are too complex to realize such changes. Scott also argues that, as a result, many state interventions have led to large-scale tragedies. The alternative provided by Scott is to focus on metis—a form of local and practical knowledge which is aimed at local problem solving. In this paper, Scott's notion of metis is applied to public health information systems in developing countries to examine how the trend of traditional non-use of systems can be corrected. Two sets of implications are developed with respect to metis: the first at the level of system design, and the second relating to institutional agency in creating an environment in which metis can flourish.*

## 1. Introduction

James C. Scott (1998), in a telling account of the use of state power in initiatives aimed at social transformation, argues that these efforts have led to large scale tragedies. Examples used by Scott to demonstrate these failures include the creation of permanent last names, the standardization of weights and measures, the establishment of cadastral surveys and population registers, the design of cities, and the organization of language. The common theme running through all these failures is the attempt by the state to make society legible by trying to transpose complex, illegible, and local social practices onto a standard grid, a place where, in their simplified form, the practices could be centrally recorded and monitored.

Scott's account of the nature of state power resonates with the concept of governmentality proposed by Michel Foucault as the art of government in a wider sense. Government exercises power not only through the instrument of state politics using hierarchical and top-down means, but also through including forms of social control in disciplinary institutions, such as schools and hospitals. Foucault defines governmentality as the following:

The ensemble formed by the institutions, procedures, analyses and reflections, the calculations and tactics that allow the exercise of this very specific albeit complex form of power, which has as its target population, as its principal form of knowledge political economy, and as its essential technical means apparatuses of security. (1991)

Apparatuses of security include means of surveillance and control, as well as particular practices that should lead to these ends. Gyan Prakash argues in his book *Another Reason* that, in governmentality, the chief

concern is the population, “which becomes available as a category through census classifications, epidemiological surveys and regulations and statistics” (2000, p. 10). Similarly, Scott argues that the state uses mechanisms such as censuses, cadastral maps, and identity cards, as well as statistical bureau and internal security apparatuses to simplify society and make it legible. Scott argues that these attempts are doomed to fail for two main reasons: “The proponents of these plans regard themselves far smarter and farseeing than they really were and, at the same time, regard their subjects as far more stupid and incompetent than they really were” (1998, p. 343).

The above statement reflects the power–knowledge relationship, where those exercising these plans see themselves as possessing the power of science and technology, while the recipients of the plans are seen to be ignorant, or worse still, as possessing irrational knowledge which would prove to be counterproductive to the implementation of the plans (Puri, 2006). In the field of public health, the use of statistics and epidemiological analysis represents this form of knowledge, based on which, only the government can apply public health interventions. This represents a form of governmentality aimed at exercising simplification and legibility on a population and their relation to diseases. Hacking (1990) describes how statistics were used in Europe in the mid-19th century for the “taming of chance,” and for making the world more apprehensible. Statistical data and laws help to make the world more controllable by discerning order and regularities in indiscriminate events, such as epidemics, so as to control natural and social processes. Prakash argues that, in colonial India, statistics were thus used by the British in a relentless fashion to create order and form the basis for public health reform. For example, he writes the following:

The desire to bring diseases and deaths under the statistical gaze represented an effort to relocate the indigenous population, to bring it under the colonial complex of men and things, where its irregularities in relation to climate, topography, habits and habitation could be observed and acted upon. Government officials searched for agencies that reached down to the village in order to collect vital information on births and deaths, and complained that inaccurate diagnoses and medical treatments provided by indigenous practi-

tioners enabled sickness and mortality to escape the net of statistics. (2000, p. 135)

While Prakash’s account is from colonial Indian times in the mid- to late 19th century, we find in contemporary times, too, that many developing countries, including India, continue to harness and use statistics to simplify complex phenomena, such as maternal deaths, into mortality indicators which can be measured and controlled. Complex social and health-related processes, such as underage marriage of women, the prevalence of diseases like HIV and malaria, existing conditions of anemia, and the absence of effective access to basic emergency obstetric services—all important determinants of maternal deaths—are converted into output indicators of “maternal mortality rate,” which the state will then seek to control and manage. This issue is of contemporary and urgent importance, as most developing nations are pursuing their Millennium Development Goals (MDG) for addressing problems such as maternal and child health. While the state needs to monitor macro indicators at the national level (such as of maternal mortality and infant mortality rates), these macro figures represent aggregates from sub-districts, states and districts. Unless the local level is empowered with systems and capacities to monitor these indicators at the field level, the national level will never be able to generate reliable indicators at the macro level.

Scott would warn us from taking a centralized approach based primarily on statistics, as such attempts to simplify and make the world legible are doomed to fail. The substantial legacies of health information systems which have failed to provide significant improvements in public health delivery (Braa et al., 2004) are arguably examples of the outcomes achieved from attempts to use statistics to control the world and make it legible. What, then, is the alternative that Scott provides to deal with complex social phenomena, such as public health? While not directly touching upon the domain of public health, Scott argues for the development of “metis”—a form of practical skills that underwrite any complex activity. Scott writes, “Metis represents a useful array of practical skills and acquired intelligence in responding to a constantly changing natural and human environment” (1998, p. 313).

The questions that become relevant for us to explore in the context of this paper are the following:

- a) What is the relevance of the concept of metis to the context of health information systems to support public health management?
- b) How can health information system be appropriately designed and used to support the effective use of metis for public health management?

The paper aims to address these two central research questions, answers to which we believe could help increase the relevance and utility of health information systems in the developing world—especially in such critical areas as the monitoring of MDG progress. This issue is of urgent importance to both the research and practice of public health. There is an increasing acknowledgment of the important role that information should play in strengthening management, and yet simultaneously, there is also the stark realization that, practically, computer-based health information systems have failed to deliver their promised benefits. Huge investments of money and resources, which developing countries can ill afford, have literally gone to naught over the past two to three decades, with more than 90% of such efforts having been termed complete or partial failures (Heeks, 2002).

The empirical basis for this investigation is more than a decade of engagement on the part of the authors in the design, development, and implementation of health information systems in various countries in the Global South. In particular, for this paper, the empirical focus is on action research efforts in a large Asian country (which is kept anonymous) that has been conducted since 1999. The rest of the paper is organized as follows: In section 2, the theoretical ideas surrounding metis are elaborated upon, including how it has been used to inform this analysis. Section 3 elaborates on the empirical approach, while section 4 describes the case study, which is presented in the form of examples of data analysis from the contrasting perspectives of state control and bottom-up, user-driven efforts. Section 5 contains the discussion, which develops the ideas of metis to consider the research questions being pursued. Finally, some conclusions are presented in section 6.

## 2. Theoretical Idea: Metis

The section on theory is divided into three parts. First, we discuss the challenges of statecraft while trying to render complex social phenomena legible

and in a simplified form. Second, we discuss the phenomenon of public health management and its supporting information systems, and we examine some of the reasons for their lack of success in the developing world. Finally, the concept of Metis, as articulated by James Scott, is discussed. We examine the ways in which it can help to inform our analysis of health information systems to support public health management.

### **2.1 Statecraft: Can Complex Phenomena Be Made Fully Legible?**

Scott, in his analysis of the workings of the state, identifies legibility as a central problem and comes to the conclusion that the state “always seemed to be the enemy of people who move around” (1998, p. 2). A central effort of the modern state is to make a society legible, which is in contrast with the pre-modern state, which knew little about the subject. Making society legible requires the state to rationalize and standardize, which makes administration more convenient, and also enables the making of more fine-grained interventions in areas such as taxation, public health measures, political surveillance, and relief for the poor. However, in this process of simplification, the realities of the complex underlying social processes are abridged. Scott provides an interesting example in discussing cadastral mapping:

These state simplifications, the basic givens of modern statecraft were, I began to realize, rather like abridged maps. They did not successfully represent the actual activity of the society they depicted, nor were they intended to; they represented only that slice of it that interested the official observer. They were, moreover, not just maps. Rather, they were maps that, when allied with state power, which would enable much of the reality they depicted to be remade. Thus a state cadastral map created to designate taxable property-holders does not merely describe a system of land tenure; it creates such a system through its ability to give its categories a force of law. (ibid., p. 3)

Taking from various diverse examples, Scott identifies four elements that contribute to making various attempts of the state into large-scale failures. The first concerns an attempt at conducting social engineering through administrative ordering and simplification. The second concerns an adherence to a highly modernized ideology, one which

emphasizes the value of using technical and scientific progress to master nature and create natural laws to apply to social processes. The third element concerns an authoritarian state using its coercive powers to bring a high-modernist design into being. For this to happen, there is the fourth condition of an incapable civil society which is passive in resisting the design of the state. Taken together, these four conditions, Scott argues, help to create the "imperialism of high-modernist, planned social order."

In the area of information systems, there are various examples of such high-modernist attempts to create social order. Raghvendra and Sahay (2006) report the efforts of one state government in India to generate a unique, multi-purpose household number to help trace by homes the demographic details of its citizens, including their caste, income levels, and various disease-related health profiles. A centralized software system was an essential component of this high-modernist design, as the state instructed health programs to collect their health services data using these ID numbers. This involved a radical shift of collecting data not as aggregate statistics, but by individual names. The state tried to enforce these directives by stating that reports not based on these ID numbers would not be accepted.

This attempt by the state to reduce the individual households and the complex social processes intrinsic to them to a 17-digit number so that they could be better managed represents a classic attempt by the state to make social behavior legible using a process of rationalization and standardization. Raghvendra and Sahay (2006) elaborate on many social-technical-cultural conditions that contributed to this effort becoming a large-scale failure. These were problems in the concept of the ID number itself, which was based on the household, rather than on the individual. This static number was insufficient to capture the dynamism of the real, on-the-ground family, where in the joint-family structure there were constant movements due to births, deaths, marriages, etc. Since no support system had been designed to deal with the complex process of updating the database, the rhythms of change in the reality (of the household) were incompatible with those in its representation (the 17-digit number). Further, since this 17-digit number created through household surveys was based on revenue boundaries which did not directly apply to health

boundaries, its relevance for public health was limited. The centralized software designed to support this system of data collection and reporting was extremely rigid, and it could not respond to the various change requests made by the users. For example, the introduction of a new health program required new data elements and reports to be included in the software. The rigid design of the software and the contractual limitations with the vendor, who needed to be paid for services outside the scope of the original contract, further made continued use of the system untenable.

At the heart of Scott's argument is that efforts of the state to make a complex social world legible require a tunneling of knowledge involving standardization, careful measurement, and calculation. This abridges reality to the extent that state plans for social change end up as tragedies. The use of statistics is an important form of knowledge that is used by states in this process of simplification.

While Scott does not provide similar examples from the field of public health, we can see the relevance of his arguments, as the public health world is complex and dynamic, while the use of statistics to control it tends to be rather abstract and far-removed from reality. In the next section, we discuss how health information systems in the developing world have failed to deliver practical benefits, as well as some of the underlying reasons for that outcome.

### **2.2 Public Health Information Systems: Designed for Disagreements**

In the field of public health, Bowker and Star's classic 1999 study on the issue of representations is based on an empirical study of ICD 10 (International Classification of Diseases and Related Health Problems, Version 10). Classification systems are assumed to be consistent, unique, and complete, and the categories are assumed to be mutually exclusive. However, in practice, no system is ever "complete," and different groups continue to be in disagreement. The important point made by the authors is that any kind of classification system tends to keep some aspect of the human interaction invisible. Each category thus valorizes a certain point of view and keeps the other silent, and as such, it gives advantage or suffering to different groups of people. They argue further that the choices of who are valorized and who are silenced are not neutral

ones, and that intrinsic to such choices are moral and ethical decisions. If classification systems are always a site for disagreement and lack of consensus, the information systems that are used to represent them also suffer the same fate, which is the reason why many of them are doomed to failure.

Information systems in general are devices that are used to represent the reality of a situation. An indicator is an informational construct that might be used, for example, to represent the reality of HIV/AIDS prevalence. It could indicate the percentage of the population which carries the virus or exhibits the disease in a particular time period (Chilundo & Sahay, 2005). The information system then helps to create and circulate the representation by the functions it provides to record, process, analyze, and present the data. Chilundo and Sahay go on to argue that the field of public health, because of the dominance of medical doctors and epidemiologists, tends to work within a positivist framework, where the primary focus is on using advanced statistical techniques to model diseases. Such a statistical focus tends to take the attention away from the local and social processes that surround the construction of data and the indicator. Various authors have criticized the dominance of the positivist epistemology in health and public health, including the limits of computers to represent medical work (Berg, 1997) and how politics shape processes of representation, including implications on when computers make aspects visible (Suchman, 1995). Latour (1999), using the concept of circulating reference, draws our attention to how aspects are both lost and magnified in the process of constructing a representation—which then can never construct a mirror-image of “reality.”

Chilundo and Aanestad (2004) discuss the issue of integration of public health information systems in the context of Mozambique. They bring out the challenge arising from the multiple rationalities that are inscribed in different public health systems. Rationality refers to an underlying logic, and they discuss three kinds in the context of health information systems in developing countries. The first concerns the rationalities on the ground, which refer to the conditions at the point of service delivery, including high patient loads; the capacities of the field staff, who are the users of the systems; and the nature of their interaction with the different constituencies, including the community. In contrast to

this, there is the rationality at the “top,” which includes the agendas and interests of the donors who, for example, seek to support disease specific programs, or of the Ministry of Health officials who may need to appease the donors in order to ensure that the flow of funding does not dry up. Then, there is the rationality of the diseases themselves, which have their own specific implications on the supporting information systems. For example, the HIV information system would need to have specific functionalities for securing the names of patients, which is not an issue with malaria patients. When these different rationalities need to come together and be reconciled within particular empirical sites, disagreements and lack of consensus will abound, which of course will have implications on how the health information systems get designed and used.

Relations between the different actors in the health system are, by definition, asymmetrical (*ibid.*). So, the entities at the top (namely the donors and central ministry officials) have more power than users at the peripheral level, due to status and resources. Similarly, some disease programs (such as HIV/AIDS) are better funded than others (Malaria, for example, in Mozambique), which means they will have more resources for systems, training budgets, and other infrastructure required for the running of systems. With these inherent asymmetries, which are beyond the scope of an information systems designer to modify, the entities with power then have the capacity to direct the health information systems to suit their specific interests and agendas.

An example of the above is of routine health information systems in developing countries, which tend to be controlled and directed by statisticians at the national level. Under the statistical paradigm, where more data is preferred as compared to less, data is collected typically for hundreds of data elements, which are then processed (normally aggregated), converted into reports, and successively transmitted to the level above, from the community to the central level of the national ministry. Historically, the focus of this reporting system has been to satisfy the various needs of the central bureaucracy. One is the extensive engagement of donors who drive various data-collection efforts, which is needed to ensure continued funding support (Haga, 2001). Within the framework of this top-down, centralized approach, the peripheral level is only seen as

a source of passive data provision, and not as active consumers of data for their everyday local action. Data collection instruments and reporting formats are usually designed by centrally located epidemiologists, statisticians, and administrators (Lippeveld, 2001), which again reinforces the bias of upward reporting. Various researchers (Kimaro & Nhampossa, 2005; Monterio, 2003; Chilundo & Aanestad, 2003; Braa et al., 2001) have criticized the donor-driven efforts aimed at creating parallel systems, as they contribute to overlaps and gaps in data collection, to a lack of standard definitions of data, and to a huge work burden on the peripheral worker, who ultimately becomes the target for most data collection.

The other pertinent characteristic of a routine health information system is that it needs to be flexible, as an extreme dynamism is inherent in the demands of the health system. For example, a new disease may become relevant. Such was the case with the recent swine flu epidemic, which required new data elements to be collected and fresh indicators and reports to be generated. Or, there could be a situation where there is a reorganization of political boundaries which requires a revision of the organization unit hierarchy. Such changes in requirements are the norm, rather than the exception. As such, we need health information systems to be customizable and adaptable; we cannot expect that requirements will be frozen and the health system will adapt to the rigidity of the information system. In addition to being dynamic, the changes are of an uncertain nature. We never know when a new disease may come, or when there could be a political decision to reorganize the health system in a particular way.

In summary, public health information systems, by the nature of the contexts within which they operate; the existing structures of power relations; and the technologies of knowledge production that are used, primarily related to statistics, are inherently problematic as regards creating simplifications and legibility. Due to the multiple stakeholders involved, these systems are, by design, about disagreements.

### **2.3 How Metis Can Help to Inform Public Health Information Systems**

Scott differentiates between *techne* and *metis*, saying that *techne* represents technical knowledge that can be expressed precisely and comprehensively as

“hard and fast rules (not rules of the thumb)” (1998, p. 319). Its rigor is informed by its process of logical deduction, based on self-evident first principles. For example, in Euclidean geometry, a right angle represents 90 degrees of a circle; or in physics, the freezing point of water is always zero degrees centigrade. *Techne* is universal, and “even chance itself, which *techne* was designed to master, was eventually, thanks to statistics and probability theory, transformed into a singular fact that might enter the formulas of *techne*” (ibid., p. 321).

In contrast, *metis* is always contextual and particular. Scott argues that high-modernist interventions, by ignoring *metis* in their plans, deprive themselves of the most valuable source of knowledge. The proponents of high-modernist attempts would argue that, since *metis* is local and varies from place to place, it is not relevant for their universalist efforts. In *metis*, the logic of classification used is one of practical value. For example, Scott writes the following:

The classification of flora . . . what matters is local use and value. Thus, the categories into which various plants are sorted follow a logic of practical use: good for making soup, good for making twine, helpful in healing cuts, effective for settling an upset stomach . . . and so on. (ibid., p. 323)

Given this purpose of *metis*, its test is practical success. For example, was the farmer’s harvest abundant? The aim is not to contribute to and make some form of universal knowledge to solve the concrete problems being experienced. This does not imply that people practicing *metis* do not produce innovations, for on the contrary, they surely do that—by combining and recombining different elements and approaches which they observe very closely and astutely in empirical settings. This approach of problem solving has also been acknowledged in the domain of policy, illustrated clearly by Charles Lindblom in his expression, “the science of muddling through” (1959). This approach is incremental in nature, often disjointed and comprised of a series of trials and errors, followed then by revised trials. So, *metis* is not only relevant in practical domains like farming and carpentry, but also in public policy formulation and implementation.

Often, in the context of ICT for development projects, officials from the World Bank and funding agencies assume local knowledge to be rigid and

monolithic. Scott argues that this is not so, as metis is extremely plastic, local, and divergent. Since metis is contextual, fragmented, and based on empirical observation, it tends to be extremely permeable and open to new ideas. Since there is no underlying doctrine of a monolithic centralized training, there is the potential of a thousand flowers blooming, and with them, new innovations emerging.

Given this brief overview of the underlying principles of metis, the aim of the article is to examine how metis becomes relevant to public health information systems, and if metis is a proposed way forward, then how we, as system developers, can design and implement information systems that can support the nurturing of metis. The practical purpose of this metis is toward supporting the use of information to make improvements in public health delivery systems.

### 3. Research Methods

The empirical material presented in this paper is drawn from longitudinal experiences gained during the design, development, and implementation of an ongoing action research project, in a large Asian country. For reasons of confidentiality, the name of the country is anonymized. However, it would be pertinent to add that the country under study here is extremely advanced in its adaptation of IT for various application areas, including public health. The country is characterized by an extremely large bureaucracy with a deep-rooted hierarchical structure and way of functioning. This, indeed, has implications on the design, development, and implementation of health information system within a centralized state control framework of bureaucracy.

This action research initiative aims to support the strengthening of health care systems in developing countries by enhancing the capacity of health systems to “use information for local action” and with it, to further the broader agenda of supporting evidence-based decision making. Two sets of software implementation have been ongoing in the country, one of which was designed and implemented by the state using a largely top-down model. The other initiative, which was begun through a nonprofit agency, in collaboration with a quasi-governmental technical support agency, was aimed at primarily strengthening systems at the district level and below. Experiences gained from both of these

implementations and their contrasts have provided the basis for the empirical data.

The NGO, of which both the authors are members, has worked in the country for over a decade at various levels, from the community to the outreach facilities, to the district, state, and national levels. This NGO is part of a global research and development program on health information systems, putting it in an advantageous position to leverage global learning using its network resources and incorporate that learning into the local systems. The decade-long experience of the authors in the design, development, and implementation of systems provided useful empirical learning that was also taken into the processes of the national system’s redesign. The research has broadly been conducted within an action research framework, popularized as a “network of action” (Braa et al., 2004) which focuses on creating enabling mechanisms by which ideas, software, experiences, training material, etc. can be shared freely between different members of the network. This approach is based on the principle that people learn more effectively in networks than they do compared in singular settings.

Data collection primarily consists of examples of preliminary analysis of routine data by the authors, followed by discussions of this analysis with the health staff. This occurred alongside the action research pursuits. For example, during the course of training programs carried out in the states, we would observe, investigate and analyze the routine data by districts or sub-districts and discuss our findings with the participants. The broader aim was to help develop in the users the capacities to actually carry out such analysis on their own. During this interaction, we would try to understand what the user needs for analysis were, and what kind of information support they would require to be able to carry out local analysis. We would further try to understand the level of general public health understanding users had, and what the gaps might have been that needed to be addressed with more effective technical support.

Another form of data collection, done through the study of national and state reports, was intended to help understand the nature of data analysis done at these higher levels and its relevance to district and sub-district levels. Participation in various meetings; conducting situation analysis, observation, and assessment during project management

## STRENGTHENING METIS AROUND ROUTINE HEALTH INFORMATION SYSTEMS

Table 1. Administrative Level and Its Key Services Provided.

Administrative level	Key services provided	Responsibility of
Outreach facility	Routine, preventive, promotive, few curative and referral services in addition to all the national health programs as applicable	Field nurse/para-medical staff
Primary health facility	Routine, preventive, promotive, curative and emergency care in addition to all the national health programs	Medical officer
Sub-district facility	Routine and emergency care in surgery, medicine, pediatrics, and obstetrics and gynecology, in addition to all the national health programs	Senior medical officer
District administrative office	Monitoring of all national health programs, maintains the logistics of drug and supplies, collects statistics	District medical officer
State administration	Strategies planning and monitoring	State health commissioner
National ministry	Policy and program level interventions	Central bureaucracy

activities; obtaining feedback from users during system prototyping; and various other sources provided very rich empirical qualitative data. All this helped to develop a rich account of the various practices that made use of information at different levels, to determine the structure of the flow of information, and to understand the capacities required for promoting information use.

Our data analysis was geared at understanding the issue of metis—reflecting the practical skills required to strengthen information utilization. The strategy used was to compare the two forms of implementation—one more national-driven, and the other with a greater bottom-up focus—and examine the kind of skills they were promoting or suppressing, as well as the natures of the identifications that users have with the systems. This helped to develop insights into the characteristics of systems and their implications on metis, along with the institutional conditions required for a form of metis to flourish.

## 4. Empirical Story

### 4.1 Case Background

The health system studied here has six levels of health administrative hierarchy, an arrangement which is depicted in Table 1, along with the services each level provides.

Two parallel implementations of health information systems have been engaged with during the

course of the empirical work. One was a national system implemented through the central ministry, and the other was supported collaboratively by a national technical support agency and a local NGO. With respect to the first system, the authors were more observers, although we did engage in some of their capacity-building exercises. In the second case, the authors were actively involved in the design, development, and implementation of this system. From the vantage point of having closely experienced the unfolding of both these systems, examples are drawn from both and compared and contrasted.

### 4.2 Case Examples

The empirical story is presented in the form of examples that the authors have been engaged with over the past two years across the two systems. The analysis is grouped into five thematic areas, with two examples given for each area, respectively representing the two systems. The five thematic areas covered are:

- a. Information flows
- b. Managing data quality
- c. Software characteristics
- d. Design for monitoring
- e. Knowledge spread

In each case, the example of the national system is given first, followed by the more local.

#### 4.2.1 Information Flows

##### a. *Cylindrical structure flow*

The National Ministry routinely collects data on different health programs relating to reproductive and child health, immunization, family planning, neonatal care, stocks, communicable and non-communicable diseases, laboratory services, and various other centralized schemes. In most of these programs, the forms tend to be centrally designed in accordance with the specification of the data elements that are to be collected. Most often, data elements are disaggregated across various dimensions of age, sex, and caste. Disaggregations multiply the number of data elements that need to be individually collected. In the case studied here, the number was about 3,000 per month per facility for the routine health system. The forms, by their very design, support centralized monitoring. The data is expected to flow upward, with little or no feedback system.

##### b. *Pyramid structure flow*

Another approach to designing health information systems is a pyramid-shaped flow based on the principle that not all information is needed or relevant at all levels of health administrative hierarchy, and that only data required for decision making should be reported. For example while data collected at the outreach center will include all services provided by the facility, not all details of that data (for example, the names of the pregnant women) need to be reported to the higher level of the district, and surely not to the state and national levels. Similar principles of flow need to be worked out for each data element and facility type—what should be reported and what retained by different facilities. As a facility needs more at their level than what they send above, a pyramid information flow of information is structured.

To try and design such a flow, an interdisciplinary team of experts from international, national, state, and district agencies was formed. A detailed situational analysis was conducted of the existing system. Also, extensive consultation with various program divisions of the national ministry and international donors was involved. Some guiding design principles were adopted:

- *Shifting the focus from data forms to data set*
- *Moving disaggregated data elements to surveys*
- *Reciprocity between the provider and recipient*
- *Shifting focus from data element to indicators*

#### 4.2.2 Managing Data Quality

In recent years, the issue of data quality has become significant with respect to health information systems, both to improve the quality of patient care, and to strengthen management processes, including budgeting and maintenance of health services (WHO, 2003). Through our examples, we describe two contrasting approaches by which data quality improvement as is being practiced.

##### a. *A centralized approach*

Routine health data aggregated at the district level is uploaded into a national database using centralized, Web-based software. A centralized group in the health ministry has adopted a statistical approach to identifying “statistical outliers” and informing the states about the “probable” problems they face and that they should make the required corrections. This communication between the center and state is through official letters or meetings in the capital, which the states were asked to attend. On the technical side, the approach adopted was of the boxplot statistical method, which computes first the median of a particular data element over the last 12 months, multiplies the median by a factor, and adds or subtracts to calculate the upper and lower quartiles and the inter quartile ranges, and classifies all data outside the range as outliers. Statistics assumes that data values are clustered around some central value, and that the data points that lie “too far” from the central values become “outliers.”

However, a public health perspective will always demand that we look at similar data elements in conjunction, so as to identify data abnormalities. Outliers are not necessarily only statistical artifacts, but could reflect abnormal program-related conditions. For example, we may have children coming from other districts to be weighed, or other child-health interventions. Thus, when compared to the number of children born in that facility, the figure may look abnormal, but nevertheless it might not be a data outlier, but an actual reflection of the situation on the ground. Without a public health interpretation of statistical outliers, we get a different picture than what exists on the ground. When the power of the ministry is behind a letter to the state to correct an error, even if it says “probable” outlier, they will tend to “normalize” the data, so that it does not show in color in an Excel sheet, rather than try to present a public health-inspired defense of their data in front of the senior officers, and thereby avoid the gaze of statistics and control.

### **b. A decentralized approach**

The DHIS2 software, adopted by various states to meet their local data entry and analysis needs, provides an alternative, user-driven approach to data quality checks that contrasts with the centralized, statistically-driven one described above. The DHIS2 incorporates various data quality checks through the user interface, allowing users to view the quality of their own data. For example, there are min-max checks, and the user also has the ability to add a comment to justify a data value going out of the range. Further, there are validation rules that are developed by public health experts to help compare like data elements, so as to identify abnormalities and raise queries on data. We describe these options in the subsections which follow.

**Min/Max and comment option.** Before starting data entry, the supervisors can fill an acceptable range (min. and max. values) for particular data elements, based on their local knowledge and contextual understanding of the data element. After data is entered, the user can check if the entered data is within the range. If an entry is out of the range, the user has the option to add an explanation—for example, “This month the staff was on leave.” In this way, the user can incorporate a contextualized and local explanation for the eye catching data element. Data value aberrations are thus not always “data artifacts” reflecting a data error, but can be a “program artifact” which is a problem in the program and yet still reflects the situation on the ground. Such data does not have to be corrected, as the statistical outlier technique tends to assume.

**Run validation option.** Data elements in a data set are interrelated. These relations can be expressed in the form of rules—absolute or expert—that are defined by public health experts. For example, that total births should equal live births plus stillbirths is an absolute rule which should never be violated, and if it is, then it reflects a data quality error. In contrast, an expert rule—such as that BCG vaccinations given must be less than or equal to live births—may not always hold true. For example, if more children come for vaccines from surrounding catchment areas, more vaccines may be administered than the number of local births which were recorded. Here, when the system raises a query, it requires the user to investigate the reason for the possible incongruity, while not necessarily implying a

data-entry error. Once data entry is completed, the user can click on the “run validation” option provided on the data entry screen, and the system runs the data through defined validation rules, identifying validation queries which the user can then correct or explain with comments.

### **4.2.3 Software Characteristics:**

#### **a. Use of centralized, rigid, and proprietary software support systems**

The national level uses proprietary software developed by a commercial vendor. Two features of this software are pertinent to explain:

**1) Rigidity.** The centralized, Web-based software used by the national ministry is proprietary, designed, developed, and maintained by a private vendor. Further, the Excel sheets used by the software are encrypted, and data from external systems cannot be exported into the software. When, during a presentation, the vendor was asked to explain why they have adopted such an approach when the whole world is adopting an approach of integration and interoperability, the vendor explained that their aim was to develop “a single window of truth.” Further, as the national level wants to standardize the data being reported by all facilities in the country, standard data sets have been created for all facilities, with no option for the user to incorporate locally-required data. Often, the government mandates changes in the reporting units, such as the creation of new districts or sub-districts. The user is not allowed to make any changes, and requests have to be sent to the national ministry, who, in turn, will instruct the vendor to make the necessary changes. This process takes time to complete (if it ever does get completed).

**2) Limited data visualization.** The existing software allows for data entry and report generation in formats defined by the central level. Additional options are provided for the user to view individual or groups of data elements over periods and across districts. The software does not provide built-in capability for users to generate graphs and charts to visualize data, either across facilities or over time. Further, users did not have the option to generate their own locally-defined reports, and additional functionalities required need to go through central requests, who would then contract the vendor. The software does not differentiate between raw data

and indicators, and both are even called by the same title. The generation of indicators or creation of validation rules requires programming interventions, so they are not possible through the user interface.

#### **b. Free and open source software**

**Flexibility.** Some of the provinces (states) in the country decided to use the free and open source software program DHIS2 for their intra-district data entry and analysis needs. An electronic bridge was created between these two systems in order to export the data from the DHIS2 to the national data repository, where the reports were required to be stored. The DHIS2 is Web-based software designed and developed under a large and ongoing global action research project which has endorsement of the World Health Organization. The DHIS (versions 1 and 2) is being used in about 20 different developing countries. The system has evolved over 15 years of extensive testing and use experience, enabling significant public health knowledge to be inscribed in it. The software is developed in a modular approach, allowing for both online and offline use to accommodate infrastructure variations across health facilities, as well as within and across countries, and is multi-language enabled to promote local identification.

In the country studied, the application has been customized in a manner which meets all the national reporting requirements, while still being able to give states the freedom to add their own locally-required data elements and indicators. The multi-language facility made it easy for the field staff to use the application, as some of them were not as well-equipped to use English. Districts with limited or no Internet connectivity could install the software locally on their desktop, enter the data, and transfer or upload to the state server through the export/import functionality inbuilt in the DHIS2.

The DHIS2 offered two clear benefits to the states. First, because of the ability provided to customize the organization unit hierarchy to the level desired (including to the lowest level of the outreach facility), states could collect data to levels of management relevant for them rather, than just to the district level, which the national portal provided. Secondly, all the state data was stored on a server which the state could easily access, thus making it easy for them to use their data—something that

was very difficult to do from the national portal, which was described by one state official as a “black box.”

Detailed and intensive technical support was organized not only for the software’s use, but with a strong public health focus on using information for local action. Engineers were always on hand to respond to user queries and requests for customization. This stood in contrast with the national system, where users were asked to send requests for technical support to an impersonal email ID which gave an automated response amounting to a thank-you and a promise of a future review.

**Data visualization.** A well-equipped dashboard is an integral module of the DHIS2. It allows users to conduct various kinds of analysis and visualizations. A two-option strategy is adopted for reporting. Through the functionality of predefined reports, user could generate all the reports specified by the Central and State authorities. Through the dashboard, the user could generate all kinds of ad hoc reports, view them by periods or organization units, and drill down to diagnose problem areas. Users could generate these reports either by data elements or by indicators, and could also view them as tables, charts, graphs, or maps offered through the GIS module, which is integrated with the DHIS2.

#### **4.2.4 Design for Monitoring**

Maternal and infant mortality are key public health problems facing the country under study, which is striving hard in making progress toward their MDG benchmarks. One intervention in this regard, taken by the national ministry, has been to monitor by names all pregnant women and children for immunization. Two approaches to this monitoring are described below.

##### **a. Centralized identification of individual beneficiaries**

The national level is concerned with the idea that the local level peripheral nurses are manipulating numbers of antenatal care and child immunization, which is skewing their statistics. As a form of surveillance and control, they now want all the cases under care to be monitored using a unique identification number. To enable this, mobile phone numbers of both the care providers and the beneficiaries are to be recorded, and the national level plans to give these numbers to a call center, which will randomly call them to cross-check

whether the service which has been recorded has actually been received by the beneficiary. An Excel workbook having a table with multiple columns has been created, one for pregnancy tracking, and the other for immunization. States have been instructed to download those sheets and start to fill the data for each case. All this data is expected to be uploaded on the national portal every month, including the names of individual pregnant women and children.

Elaborating on the magnitude of the complexity of this task is worthy of a separate paper, but in summary, it can be said that challenges relate to infrastructure, work practices of the field staff, tracking of migration cases, absence of privacy safeguards, and the need for a uniform and unique identification system where none exists right now in the country. As seen from the national lens, the aim of the system is primarily seen as improving the quality of data by imposing a regime of individual-level monitoring, and instilling a sense of fear in the field workers whose work is now made visible and trackable by placing data on a Web portal, including their phone numbers.

### **b. Localized support to improve service delivery**

The logic adopted in the tracking system developed here is similar to that of the DHIS2 in that, at the local level, the forms are designed in a way to support improved local service delivery, while at the same time, ensuring compliance to national reporting standards.

The system is based on a detailed understanding of the work practices of the outreach worker who is responsible to provide care to a population of about 5,000. The outreach worker is supposed to maintain and update all the name-based information on pregnancies and immunization-related services in her catchment area. In the past, such information was maintained in her primary registers, and what the nurse reported upward was the aggregate information out of her facility for each specified period. Now, the new system demands that she sends all the name-based records to the levels above. Naturally, this system instills a sense of fear and apprehension in the outreach staff. First, they believe that it will add on to their already heavy work schedule, and second, as their work becomes visible, they will be subject to discipline and punishment, which is the normal practice in the health sector in the country.

To assuage her fears, the system designed comes with two promises. One, that the work done will not go above and beyond what the worker already does, as in the longer run, the name-based data will be aggregated and imported into the facility reports. This way, the worker will not have to enter data twice. The second is that the system is not only designed for national reporting, but will provide local reports, which will help both improve the worker's quality of care and also help her to schedule her activities in a better way.

### **4.2.5 Knowledge Spread**

#### **a. A centralized approach**

The national-level software uses an external and expensive statistical package to support processes of data analysis. Some underlying characteristics of this package encourage a centralization of knowledge. First, being Web-based software, it can only be accessed over the Internet. Due to the paucity of good Internet connection (especially to access a heavy package like this one), the use of the package naturally gets limited to the national level. Second, being extremely expensive and restricted by licenses, the package can only be accessed by a small number of users. Third, the package is complex and not easy to use, and only those who have received specialized training on it are able to use it. Since training is also expensive and restricted, just a few staff members have received training to date, and even fewer (less than a handful) actually have the capacity to use it. Given this scenario of restricted and complex access, knowledge of analysis becomes extremely limited and centralized. In practice, then, if a district manager requires a locally-specific analysis, he or she must send a request to the central ministry (the "expert"), who is then expected to generate the analysis and send it back by email. The next time a similar analysis is required, the process must be repeated.

#### **b. A decentralized approach**

The entire DHIS2 implementation approach is based on the ideology of "promoting local use of information for action." The guiding principle here is that the user knows best which analysis they need, and that we must provide the tools and capacity necessary to carry out local analysis and use it for everyday action. Also, it supports the principle that data quality will be improved if it can be interrogated and used at the point of collection. Further, the

approach is not to use complicated statistics for analysis, but more simple analysis and comparison of indicators and infrastructure across periods and facilities. This primarily involves aggregations and computation of indicators using percentage and other calculated factors.

The focus here is to provide appropriate tools for carrying out such report generation and data visualization in the form of graphs, charts, and maps. This is accomplished using the functionalities of the dashboard and GIS described earlier. Through continuous capacity-building programs, the aim is to equip the users with the ability to be able to use the tools for his own local action area.

## 5. Discussions

This article is concerned with the capacities of dealing with health information, which can contribute to better utilization of information aimed at strengthening public health care delivery. Specifically, the focus on capacities is around the nurturing of practical skills—a form of metis that are capable of taking on the more complex problems of public health, such as designing interventions for reducing maternal deaths, by leveraging the ability to use rules of thumb to arrive at meaningful and relevant decisions. The assumption made here is that public health practitioners are the experts in their own field, and that, based on their experience and local contextual knowledge, they have an in-depth understanding of both the health situation and the kinds of interventions that may work in practical field situations. However, the further assumption made is that this in-depth knowledge of the field situation on its own is inadequate, and that it requires information support provided that is appropriate and well-designed. This can then help to **complement**, not **replace**, their metis, so that more effective action can be taken. Information is taken as a necessary condition to strengthening public health systems, but however, not a sufficient one. Sufficiency will come when the information is combined with the existing practical skills of the user, contributing together to a more powerful metis.

Our underlying argument is that only if practitioners find information systems locally relevant to them will they identify with them and commit to their use, and that only then will the efforts to implement these systems be effective. Also, only

with continuous and committed use can the practitioner be able to inform the designer of the kind of information needed to further strengthen his or her metis, inputs which can then lead to making improvements in the system. With these underlying principles, we have, through the case study examples based on our empirical experience, tried to highlight different approaches to designing, developing and supporting health information systems in five thematic areas. In each area, two contrasting types of examples were presented. The first represents a more traditional approach in developing countries, an approach which contributes to promoting a form of state surveillance and control system using simplistic design assumptions (such as “building a single window of truth”), which, we argue, effectively kills metis. The second set of examples seeks to illustrate how the onus of responsibility is placed on the user (not the state), and how the information systems then try to provide information support in ways so that existing metis can be strengthened, not replaced or killed. From these examples, we discuss two sets of implications on metis. The first concerns the underlying design characteristics of systems that help to either cultivate or suppress metis, and why. The second relates to the role of the institution in this regard.

### 5.1 System Characteristics and Implications on Metis

Different characteristics of information systems have implications on how information generated from the system is geared toward supporting public health action and interventions at various levels. A key aspect here is how the system supports the nurturing of user capacity in data management, including skills to carry out data analysis, health status analysis, and being able to integrate this analysis into practical health program improvements. An important characteristic, then, is where the primary focus of the system lies—on the means (the supporting technology), or on the ends (what the generated information is to be used for). Typically, we find that the means become more important than the ends, usually by constraining the perspective and efforts to issues of data, rather than to how this data can be converted to useful information, and more importantly, into knowledge which implies putting the information into practice and action. Further, along with this focus on technology, another key

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end is the reporting needs of the central ministry, which displaces local action.

While a state-supporting statistical system focuses primarily on data, with the outlook that “more data is better,” a metis-supporting system will focus on “information for local use,” with the goal of supporting contextualized action. It becomes important, then, to unpack the characteristics of health information systems and how they go about nurturing or suppressing metis. The following characteristics are discussed:

1. **Focus on information use—technology for information and information for action:** A metis-supporting system, by definition, will have its primary focus on enabling information use, rather than on the tool and on upward reporting. Supporting this information’s conversion into action and knowledge requires motivating the user and privileging his or her local knowledge and experience, rather than resorting to the use of fear and reprimand—a tactic common among systems designed to promote a pan-optican environment. In contrast, central supporting systems do the reverse in terms of metis. For example, identifying statistical outliers at a central level and sending the report back to the levels below for “corrections” is ineffective in building a local, process-related understanding of why data problems arise. This also goes against the basic principle that data quality problems are best understood by those who collect the data, at source.
2. **Promoting decentralized information for decentralized action:** Decentralized information is based on the globally-established principle of hierarchy of information (representing a pyramid) discussed earlier, where the lowest level requires the most disaggregated information (e.g., the field-level health service providers need to know the names and addresses of pregnant women), while the national level requires its information to be the most aggregated (e.g., indicators such as percentage of institutional delivery). The cylindrical structure of information flow, where all data (including disaggregations) flows to the highest level is counterproductive, as the national level does not have the technical capacity to process this information, nor do they have the conditions to influence action. Structuring the information flow as a pyramid, based on the varying information needs of different levels, can help achieve a model of decentralized information for decentralized action, rather than one of centralized information for limited or no local action. An upward-focused system runs counter to this thinking and suppresses metis.
3. **Integration of information flows in the data warehouse approach:** Globally, research has established that integration of information systems represents the largest challenge to effective health information management, and some have advocated the data warehouse approach (Titlestad et al., 2009). Integration of information from different sources allows richer decisions. For example, by combining service data (e.g., of institutional deliveries) with infrastructure data (e.g., the number of beds available), the user is allowed to probe into effective utilization of facilities which single data sources do not enable. A state-sponsored approach of creating “a single window of truth” which does not interoperate with other systems runs counter to this thinking of integration, leading to further fragmentation in the long run. As fragmentation tends to decontextualize and compartmentalize, there are adverse implications on metis which by definition is concerned with contextualization.
4. **Collaborative participatory design—Promoting flexibility and user control:** Research has emphatically established the key role of participation of end users into processes of system design helping to promote ownership, build capacity, and make design more relevant (Titlestad et al., 2009). Further, research has established that more than 90% of health information systems are complete or partial failures because of “design-reality” gaps, implying a deep schism between the worlds of technology development and use (Heeks, 2002). This gap relates to the design assumptions that are inscribed in the technology and their dis-

tance from the reality of the use context. The example of using a high-priced statistical package which is centrally designed and allows only Web-access is indeed distant from the reality of the user who does not have required access. The DHIS2 approach has been founded on a participatory methodology, where design is seen to be never frozen, but representing versions which are fluid in time and space. A guiding principle of participatory design is to have flexible systems aimed at developing user control—where users can customize their data and reporting needs within their local context while simultaneously adhering to the mandatory requirements of the levels above. Inflexible systems, both in terms of technical design (one fixed dataset for all districts, for example) and contractual arrangements, will suppress metis entirely.

5. **Learning by doing—Promoting networks of action:** Some guiding principles of metis are those of learning by doing and of sharing similar experiences with other people engaged in like pursuits. The networks of action approach surrounding DHIS2 (Braa et al., 2004) seeks to create collaborative linkages wherein users and developers of the technical and public health systems support and strengthen each other by sharing experiences, advocacy, ideas, products, software, and training resources. This network model necessarily stands in contrast to the centralized bureaucracy model based on principles of discipline, surveillance, and reprimand—all of which contribute to the suppression of local learning. The DHIS2 network model is enabled through the active use of “open source” systems, implying no license restrictions. This allows all to have access and contribute to the growth of these community resources, and it also allows learning to grow in a cumulative manner.

Thus, system design has implications on metis. In the next section, the role of the institution in contributing to the nurturing of metis is discussed.

## **5.2 Institutional Implications on Metis**

While the institution has various roles and responsibilities when it comes to nurturing or not nurturing metis, such as leadership, capacity building, estab-

lishing infrastructure, providing resources, etc., we focus on one aspect which is significant—establishing a sense of trust and confidence in the routine health information systems, so that users develop the freedom and practice to use information. What research has repeatedly pointed out is that the lack of a culture of local information use in developing countries serves as a serious impediment to the use of information. How such a culture gets nurtured is a very pertinent question to address.

There tends to be a vicious cycle of lack of trust and data non-use, a historical problem in which routine health information systems data is seen to be of poor quality and thus not to be trusted or used. As a result, for reporting purposes, governments tend to rely on survey data, rather than on the routinely collected data. Such data is, however, not of the required granularity to be of relevance for conducting everyday action. The more that routine data is not used and is formally ridiculed, the less attention is given to its process of strengthening metis. Breaking this vicious cycle of data non-use is a key responsibility of the institutional leadership.

An approach of “satisficing,” rather than optimizing, is the required use of existing data, which is also primarily about learning to live with the limits of historical inefficiencies that health information systems are so often confronted with. This is not at all to be seen as an argument for doing nothing to improve, but for focusing on what is there, seeing how it can be used, and that, with use, the quality of data will also improve. Satisficing can be done in a number of ways. First, it is often seen that the district level has higher coverage of data than the facility level. As a starting point, then, district-level analysis can be encouraged, and once district users see the value of this process, they will initiate efforts to improve data quality from the levels below. The second principle of satisficing would be to focus on essential data elements. Typically, we see that, while the routine system could be processing about 1,000 data elements monthly, maybe only 15–20% of those are essential and required for program management. These could be related to antenatal care, immunization, deliveries, and infant and maternal deaths. The remaining data could concern stocks, outpatients, childhood diseases, etc.—which, by their very nature, are difficult to collect with qualitative certainty. Typically, because of national reporting requirements, we find that these essential items are of reasonable coverage and quality. By focusing on

what is there, and not on the bad quality of the remaining “non-essential” data, we can try to promote use.

Further, from a planning perspective, the question can be pertinently asked whether we really need the levels of data which the national statisticians demand? For answering this, we need to examine the kind of information support that is required for health planning. Taking maternal mortality in high-focus districts as an example, we still need to have figures on district and sub-district facilities provision of deliveries, emergency obstetric services, health worker-to-population density, estimated pregnancies, and such related data. Within the essential data perspective, we will tend to find most of this data available in the health information system. And often, that which is not can be easily obtained by a phone call to the district. There thus arguably exists a level of sufficiency in the existing system to meet the required level of information support for urgent planning needs.

We can further attempt to break out of this vicious cycle by having districts report only on actionable indicators, rather than on raw numbers. For example, with respect to deliveries, it may be more effective if districts give figures in terms of percentage of different facility types which are not providing the expected level of services. The details about raw numbers of deliveries will always be available at the local levels, and they can still be called upon when needed.

Such a satisfying focus will also help to redirect attention away from being continually locked in data, and onto the data’s transformation into information and knowledge, bringing the project closer to improved public health delivery. The argument, thus, for a satisfying, rather than optimizing, approach is that it could help to break the cycle of lack of trust and data non-use, helping, instead, to create another trajectory or cycle of data use leading to improved quality and more use. Such a cycle will help to usher in an environment where metis can flourish and prosper.

## 6. Conclusions

While our case has specifically related to the context of health information systems in developing countries, we acknowledge that these issues are of wider relevance, and that they also apply to many devel-

oped countries, as well as to sectors outside health. For example, in a recent book by Dunleavy et al. (2006), the authors argue that technology is providing the driver to usher in a new paradigm of public management that focuses on “self service” rather than state-controlled services. The authors argue that many states are failing in their attempts to manage vast amounts of information due to problems of their own making, problems primarily concerned with the relationship between government and private IT corporations. Dependency on the private sector—because the modern technology requires the empowerment of expertise—leads to a breakdown of many initiatives. Further contributing to this is the presence of monopolistic markets and the lack of activism on behalf of state offices. Countries like the UK have been heavily affected by the dependence of the state on a small number of private firms that have seriously undermined their new public management reforms.

Further, the authors argue that cloud computing offers possibilities of individual (rather than state) control, where personal data can be hosted and managed by individuals themselves. Technically, given the properties of scalability and portability, such models may be well-suited to developing countries. But if the likes of Google are supporting the cloud infrastructure, the question then arises: Can we trust them? Similar parallels can be seen with mobile computing and m-health, where vast amounts of individual data can be circulated through networks provided by mobile operators. But then, how much can we trust them, and are we protected from our data being made commercially available to pharmacy firms or the like? These issues, which have not been directly addressed in this paper, are linked to larger questions of democracy, the relationship between the state and the citizen, and models of governance not only in sectors of health, but also in others, such as education and development, where, to date, the state has played a defining role.

This paper has argued that the development and encouragement of metis is key to strengthening information support in public health. This argument is founded on the assumption that field practitioners—nurses, supervisors, medical doctors—have, as a result of their experience and practical knowledge, a good general understanding of the public health problems their local area faces,

as well as of how to deal with them. This practical knowledge, if combined with sensitively and relevantly designed information support, can contribute to the development of a more effective metis, which can, in turn, help address pressing public health problems faced by developing countries. Three important factors in creating this effective information support are appropriately designed systems, institutional agency that seeks to break out of the historical mistrust characteristic of health information systems, and basing the data approach on a principle of satisficing, rather than optimizing. ■

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