ITRC has developed a series of fact sheets that summarizes the latest science, engineering, and technologies regarding environmental data management (EDM) best practices. This fact sheet describes:

- software and hardware selection
- data storage and security
- allocating staff responsibilities

1 INTRODUCTION

The execution of a field data collection program involves many practical decisions that will influence the ease of implementation and ultimately the program's success. Technological advancements will affect many of the decisions over time. Gathering and maintaining updated information and being alert to changes in hardware, software, and project needs are critical to the longevity of a field data collection program. Staff beyond the data practitioners can contribute their knowledge for decisions related to purchasing, information technology, and applicable organizational policies. Short-term and long-term planning related to budgets, data storage, hardware, and software encompasses many important decisions and considerations.

2 BUDGETS AND COSTS

The cost of field data collection hardware is highly dependent on the complexity of field data being collected and the environment where the device will be used. Something as simple as a cellular phone can potentially retrieve and store data just as well as an expensive electronic tablet. A relatively affordable midlevel tablet may be an ideal size and computing power. Other devices may be more expensive but can offer more flexibility and potentially have longer lifespans. Harsh field conditions may warrant ruggedized devices. If field devices are already available, the new costs are reduced to wear and tear and maintenance time.

The cost of the software or programming and training time for digital field data collection is another added expense and can vary widely depending on the software manufacturer. These are major decisions with many variables to consider.

3 HARDWARE AND SOFTWARE CONSIDERATIONS

There are many factors to consider when choosing hardware and software, including compatibility, functionality, data storage, and ease of use. These choices may involve input from multiple groups within your organization, including information technology (IT), procurement specialists, project managers, and field staff. As with all hardware and software, long-term maintenance should be considered, including updates, repairs, and replacing software or obsolete equipment.

When purchasing a mobile device like a smartphone or tablet, there are many factors to consider and many options. Research and obtaining information from your hardware and software suppliers can help guide your decision.

Options to understand prior to purchasing devices include operating systems (OS), ports, internet connectivity, global positioning system (GPS) functionality, ruggedness, daylight readability, and accessories such as carrying straps, styluses, and keyboards.

Software may be compatible only with specific operating systems, which can affect the selection of hardware. For this reason, it is best to purchase hardware only after determining which primary software will be used for field data collection and on which OS it will run.

Consult with staff about other hardware and software requirements for data collection, such as sensor data, which may require a wired connection and specific port or adapter, or data transferring applications that will run only on a particular OS. As technology changes, your options may change, so contacting the equipment, sensor, or software manufacturer can provide insight into possibilities for interoperability during planning and in the future.

The adoption of new workflows can be adversely affected by technical or logistic issues. Here are some questions to consider as you navigate the hardware and software decision-making process:

Compatibility and connectivity:

- Will the data collection application(s) that you've decided to use work on the OS of the device? Off-the-shelf systems are not always compatible with common OSs (for example, Android, iOS, Windows), and the options and features available can differ between OSs.
- Are you planning to use the device for surveying in the field? Ensure that you have hardware and software that meets your data objectives.
- Does the device need to access servers, and if so, is the operating system compatible?
- Will you need to use cell networks for connectivity, or can you rely on Wi-Fi networks?
- If you need cell connectivity, does the device you've selected have the hardware to connect to the cell network that is available at the field location? Will you need a cell service provider and contract?
- What ports or connection options are needed? What devices need to physically connect to the device, if any? Will you need to plug in a USB drive or a wired connection to a data collector? Can a Bluetooth connection be used, eliminating the need for a physical connection?

Specific requirements:

- How long do you expect to use the device? Hardware costs can vary tremendously. Inexpensive tablets with minimal features may be suitable for a simple, short, clean field project at a greatly reduced cost, possibly a tenth of the cost of a full-featured device.
- How long per day will you need to use the device? Will you have enough battery life? If you must use a battery pack to supplement the battery, how will that be charged and how do you change it? Can you use a vehicle charger?
- Is the device ruggedized or is there a rugged case available for your device? How rugged does it need to be based on your most extreme weather and field conditions? Do you need a waterproof, drop-proof, dirt-proof, or shockproof device or case?
- Will you need a screen protector that will help prevent screen fracture but not get so scratched up from heavy use that the screen is unreadable?
- Where will the device be used, and are there requirements specific to that site, such as intrinsically safe equipment only, or no cameras permitted?
- If you are using the device in sunny environments, does it have a daylight readable screen? Is there a shade cover available for it?
- How heavy and bulky is the device? If your field team will be carrying it around all day, will they want a harness, shoulder strap, or hand strap? Or is it small enough that they can fit it in a safety vest pocket?
- What size screen will you need to effectively see the fields and enter data? If your forms are long and complicated, will the team have to endlessly scroll to see what they need to enter? Will pop-up forms fit on the screen?
- If your field team is wearing gloves, will the on-screen keyboard be large enough to use fingers or will you need to provide a stylus? If you need to use a stylus, is there a way to connect it to the device so that the user won't lose it while doing field activities?
- Does the screen react too readily to touch? For example, will rainwater dripping on the screen from leaning over the tablet while wearing a hard hat cause data to be erroneously entered? How is the touchscreen recalibrated?

In addition to the physical details related to equipment selection, there are software compatibility considerations, along with any device management rules from your IT department.

- How will OS and software updates work? Will it be automatic? Only when connected to your organization's network? Will it warn you? Will users have any control over or responsibilities for updates?
- Will regular updates interfere with custom programming in your data collection application? Is it a system that will never be updated, potentially leading to incompatibility with off-the-shelf applications?
- What will the login requirements and user permissions be like? Can users install software and add hardware devices without IT involvement?
- If the device is not working, who will help troubleshoot remotely during field operations? How should they be contacted? Who is their backup?
- Will you have a service contract and warranty with the device manufacturer? What is the process for sending a device in for repair?
- Where do the devices "live" between uses, and how are they reserved and loaned out? Do they have a schedule? What if all the field teams want them at once and there are not enough devices?
- How will hardware be incorporated into a tracking system?

4 DATA STORAGE AND SECURITY

Temporary and long-term storage of data collected in the field is determined up-front and varies based on applicable data standards, hardware, and software selected. If you are collecting data that is confidential or under contract for an entity that has data storage requirements, it is most efficient to fully understand how this will affect your planning prior to any other major investments. Each specific workflow and data storage or transfer procedure can be planned out and reviewed to ensure the best possible outcome.

These decisions can be made or reviewed by technology staff who may provide input on security requirements and standards for data storage. Software providers may also help determine the best data backup plan for your situation. Generally, data will be stored locally (on the hard drive) for a predefined amount of time, such as one workday or half of a day. Some kind of data submittal and/or backup procedure follows. Ideally, this can be a submittal that transfers the data into its final destination or database. In other situations, a backup option in addition to local storage might be warranted. Possible options include backing up data to your company's network, cloud storage, or external storage, such as a USB drive. Local storage on your device or on an external drive can also be used for periods when internet service is not available, including the possibility of hardware failure, like a malfunctioning network device or a dead battery.

5 ALLOCATING RESPONSIBILITY

Regardless of how carefully a field data collection system is planned and executed, a serious threat to its ongoing success is a lack of long-term commitment of the people managing and supporting its use. The system will not run itself, it will not solve problems, train new employees, call for repairs, update field forms, or redesign end products such as tables and maps. Without ongoing support and funding, and a team to diligently maintain the system, there is a serious risk of derailment by one of many possible issues that can arise. Plan for ongoing planning.

Many common potential considerations and issues have been highlighted above. A specific field data collection system will have its own unique list. As part of the planning work, it is critical to identify key staff with specific responsibilities covering as many potential issues as possible. Depending on the size of your organization, this can be two people or fifty. Regardless, assigning specific responsibilities will help ensure problems are addressed when they arise. Periodic planning meetings can be held to go over new ideas, problems encountered, training needs, and lessons learned. Staff to consider including may include database managers, project managers, field staff, upper management, and IT staff. External contacts at software and hardware companies can also maintain an important role, especially as technology progresses.

One of the most important roles in a field data collection system is someone available to receive troubleshooting calls and texts from field staff at any time. Ideally, at least two people should fill this role, preferably more. One of the fastest routes to disaster is to have the field staff abandon their technology because no one helped them at a potentially critical and time-sensitive moment. Prevention is key to realizing the benefits of a successful system: saved time, increased efficiency, improved data quality, and hopefully an easier workflow for field staff. Technology ideally will benefit field staff, not add stress to an already challenging job.

Maintaining software such as a field data collection system is a time-consuming task and requires specific skills and subject matter expertise. Changing systems or software can also be a significant undertaking if your initial system is unsuccessful. Consider this carefully when selecting a commercial software solution or deciding to build a custom solution within your organization. Seek input from as many sources within, and external to, your organization as possible. Interview multiple vendors and ask for references. Expect an ongoing need for support and development. Can this be supported long-term within your organization, or does the support of a software company offer a more sustainable option? It can be difficult to make this decision correctly because it is decided early on when knowledge is limited about how your organization's field data collection journey will unfold. A careful software selection process is essential to your system's success.

Planning ahead, allocating responsibility, and ongoing follow-up are essential to a successful field data collection implementation. Complete, standardized data sets that enable easier and more efficient data analysis are the successful end point. Putting in the time and effort needed to get a system in place at the beginning will pay off in the end.

6 REFERENCES AND ACRONYMS

The references cited in this fact sheet, and the other ITRC EDM Best Practices fact sheets, are included in one combined list

that is available on the ITRC web site. The combined acronyms list is also available on the ITRC web site.