



Introduction to Data Quality

A Guide for Promise Neighborhoods on Collecting Reliable Information to Drive Programming and Measure Results

Peter Tatian

with Benny Docter and Macy Rainer

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Data quality has received much attention in the business community, but nonprofit service providers have not had the same tools and resources to address their needs for collecting, maintaining, and reporting high-quality data. This brief provides a basic overview of data quality management principles and practices that Promise Neighborhoods and other community-based initiatives can apply to their work. It also provides examples of data quality practices that Promise Neighborhoods have put in place. The target audiences are people who collect and manage data within their Promise Neighborhood (whether directly or through partner organizations) and those who need to use those data to make decisions, such as program staff and leadership.

Promise Neighborhoods is a federal initiative that aims to improve the educational and developmental outcomes of children and families in urban neighborhoods, rural areas, and tribal lands. Promise Neighborhood grantees are lead organizations that leverage grant funds administered by the US Department of Education with other resources to bring together schools, community residents, and other partners to plan and implement strategies to ensure children have the academic, family, and community supports they need to succeed in college and a career. Promise Neighborhoods target their efforts to the children and families who need them most, as they confront struggling schools, high unemployment, poor housing, persistent crime, and other complex problems often found in underresourced neighborhoods.¹

Promise Neighborhoods rely on data for decisionmaking and for reporting to funders, partners, local leaders, and the community on the progress they are making toward 10 results. Crucial data for Promise Neighborhoods include required Government Performance Results Act indicators on academic achievement and family and community supports compiled from various sources, including

neighborhood and school surveys, school system records, and management and program data collected through direct interactions with service providers and people being served.² Without high-quality data, Promise Neighborhoods may not have the information they need to make good choices or to keep partners and allies accurately informed about their results. Promise Neighborhoods also receive and use data from partners who provide key services to children, youth, and families and need to ensure those data meet quality standards as well.

Data Quality Management

What Does Data Quality Management Mean?

Data quality management involves identifying the intended uses of data, creating criteria that are appropriate for identified data uses, and implementing practices to ensure data meet those standards. Data quality management aims to maximize the value of data for an organization. For a business, data quality management would maximize the value of data to generate profits. For a Promise Neighborhood, the focus would be on maximizing the value of data to make the best use of available resources to achieve successful outcomes aligned with the 10 Promise Neighborhood results or other community priorities.

There is no single, objective definition of what constitutes “good” data. Rather, data quality refers to an assessment of information based on its intended use and its suitability to serve that purpose. A Promise Neighborhood program may be based on an evidence model that requires a certain number of hours of classroom attendance. In that case, knowing total attendance time accurate within 15 minutes may be an appropriate standard. The data quality rules that Promise Neighborhoods put in place must reflect an understanding of why those data are being collected and how they are meant to help Promise Neighborhoods achieve their goals.

The rest of this brief describes basic data quality management activities, such as profiling data, creating data quality rules, and implementing data review processes. When building a data quality management process, it is important to understand that creating and maintaining high-quality data requires time and effort, and appropriate resources need to be devoted to these activities. Furthermore, everyone in the organization needs to be involved in ensuring data quality, which means many people will need to address data quality.

Allocating resources for data quality may be difficult in an environment where the priority is to channel funding to provide programming and services. Why spend money on data? In her article “How to Create a Business Case for Data Quality Improvement,” Susan Moore describes five steps for building consensus with an organization for investing in data quality.³ Her main advice is to not focus on data quality as an end in itself. Rather, proponents should emphasize how better data would benefit the organization’s goals and mission. Furthermore, these arguments need to be framed in terms that are meaningful to both organizational leadership and staff, emphasizing their priorities and goals and how

better data will allow the Promise Neighborhood to serve the needs of children and families more effectively.

A key starting point is to create a data profile, which gives an initial overview of data quality and identifies problems. By elevating current challenges, data profiling can create an impetus for action to improve data quality.

Why Should Promise Neighborhoods Care about Data Quality?

The phrases “data driven” and “evidence based” are often used to describe how organizations try to conduct their operations in ways that produce measurable results. For nonprofits, data are starting to drive decisionmaking not only about what services should be in place but also in what manner, to whom, in which locations, and at what intensity. Data are also crucial in assessing whether interventions are achieving desired results—that is, whether programming is producing intended impacts. Being able to use data effectively is critical for nonprofits, including Promise Neighborhoods, that want to produce positive results for the people and families they serve.⁴

But while high-quality data can help Promise Neighborhoods improve outcomes, poor-quality data can do harm. As data become more influential in how people and organizations make decisions, the for-profit and nonprofit sectors increasingly recognize the damage that bad data can do. High-quality data can help Promise Neighborhoods in three significant ways.

- **Make good use of time and funding.** Having good data can save valuable resources. Even though federal grants for Promise Neighborhoods are large, resources are never sufficient to address all community needs. Those limited resources must be used effectively. Poor data can create wasted effort because time has to be spent correcting data before they can be used. The research and advisory company Gartner reported that organizations believe poor-quality business data are responsible for an average of \$15 million a year in losses.⁵ IBM estimated the annual cost of bad data to the US economy at \$3.1 trillion.⁶ Generally, it takes 10 times a much effort to complete a task using poor-quality data compared with using high-quality data because of the extra effort needed to find and correct errors.
- **Make better decisions.** Good data can lead to good decisions. The more that decisionmaking is data-driven, the greater the risk that poor-quality data will lead to wrong choices. If Promise Neighborhoods use data to decide which community needs should be addressed and which interventions are working, bad data can cause them to fail to identify crucial needs, direct resources to the wrong places or populations, or invest in the wrong solutions.
- **Enhance trust and credibility.** Promise Neighborhoods commit to transparency by using data to communicate with funders, partners, and the community about the efforts they are making, where they are expending resources, and what results they are achieving. Unreliable information can harm the trust that people and institutions are willing to place in the Promise Neighborhood. The resulting loss of credibility could severely damage a Promise Neighborhood’s ability to sustain and expand its work. But if a Promise Neighborhood is known

for being a good steward of data, it can build trust and credibility among partners and the community.

Roles and Responsibilities

Data quality should be the responsibility of everyone in the Promise Neighborhood who collect, enters, reports, or otherwise uses data. Nevertheless, assigning specific roles, responsibilities, and authorities for data quality is also advisable to ensure good data quality management practices are created and followed.

These roles include a *data quality manager*, someone in a leadership position who oversees quality efforts and helps create and communicate the Promise Neighborhood's data quality vision and goals. The Promise Neighborhood may also have one or more *data analysts*, who provide expertise in processing, checking, and reporting on data.⁷ In collaboration with leadership, program staff, and partners, data quality managers and data analysts should conduct data profiling, develop rules and protocols for data quality, lead data quality reviews, and provide necessary training and support for people entering and processing data.

Managing Data Quality with Partners

Because of the wide range of services needed for a community-based, cradle-to-career pipeline, Promise Neighborhoods must work with partner organizations who can provide solutions the grantee backbone organization cannot. This makes data quality management even more challenging because, to some extent, Promise Neighborhoods must rely on partners to collect and report data without direct control or oversight.

Despite those challenges, Promise Neighborhoods should work with their partners to ensure quality standards are being met for all reported data. Along with other aspects of performance, Promise Neighborhoods should consider including data quality standards in their agreements with service providers. This brief can be a guide for how to structure those standards for partners, including establishing data quality rules and metrics. In addition, Promise Neighborhoods can use this brief as a training resource to help build the capacity of partners to collect and report high-quality data.

Data Profiling

Data profiling is the foundation of data quality management. The purpose of data profiling is to gain insights into current data quality and to provide a baseline against which future improvements can be measured. Data profiling consists of five steps.

- **Catalog all data being collected and used.** The first step is to document all data sources. Information should include the data source, when and how the data are collected, where the data are stored, what information is included, what the acceptable values for specific data elements are, how the data are used to meet business needs or goals, and which people are

responsible for collecting, entering, analyzing, and reporting on these data. This information is sometimes referred to as *metadata*, or data about the data. Metadata should be reviewed and updated regularly to make sure they accurately describe the data being collected.

- **Compare the data with their metadata.** After compiling the metadata, the next step is to see how well the actual data match the assumptions made about what those data should look like. For example, if the data are to be updated monthly, is that what actually happens? Or if a data field is supposed to consist of dates (month, day, and year), does it sometimes have other types of information? Or does it have irregular or improperly formatted values?
- **Run tests on the data.** An additional step is to examine basic summary statistics, such as averages or extreme values (highs and lows) to see if data values are consistent with expectations. For categorical data that have fixed values (e.g., “yes” or “no”), do any values fall outside accepted responses? Or are there inconsistencies in the data, such as numbers that do not add up to totals? The next section on data quality rules will give more examples of the kinds of problems for which tests can be run.
- **Report on data quality.** Reporting on data quality is an important part of data profiling. It is not sufficient for only a few people to know about data quality problems. Everyone needs to see them as an organizational challenge. The initial data quality report should include metrics of data quality and can be a baseline against which future improvements can be measured and reported on.
- **Repair the data.** Depending on the problems uncovered, the last step is to come up with a plan for addressing data issues. This should include not only fixing existing data and revising the metadata but taking actions to prevent the same problems from emerging in new data. To be effective, preventive actions need to be based on an understanding of the sources of data errors—that is, when, where, and how problems entered the data in the first place. Preventive steps include simplifying paper forms so they are easier to fill out and enter data from, as well as building in review steps so data problems are caught earlier.

These data profiling steps are the start of implementing a data quality management process, but they should be revisited periodically to track progress to ensure that improvements are made and that previously corrected problems do not reemerge.

BOX 1

Grantee Spotlight: Camden Promise Neighborhood

The Camden Promise Neighborhood in Camden, New Jersey, takes a proactive approach to data to ensure their accuracy. The team ensures the data are clean as they are input rather than fixing errors after they are in the system. Camden has a data management system that couples technical training with guidelines for navigating potential pitfalls. For example, the team tracks ages of clients and household members across various partner solutions for reporting purposes. If staff encounter unknown birthdays, they know to input 1/1/1900 so it is immediately obvious upon later review which clients need to be followed up with. Staff are trained to update data, including contact logs and DAP (data, assessment, plan) notes, on a consistent basis, and the team runs monthly reports as an additional check on their data quality assurance.

Data Quality Rules

Data profiling will reveal both underlying assumptions about and challenges in a Promise Neighborhood's data. Using this information, the Promise Neighborhood can develop data quality rules that define what high-quality data represent for the organization. Data quality rules specify the conditions the data must meet to be useful and can be grouped into five categories based on the issues they are meant to address: accuracy, consistency, completeness, integrity, and timeliness.⁸ Data quality rules can also be used to set standards for partners on data reporting quality.

Accuracy

Accuracy refers to whether the data adequately reflect real conditions—that is, whether they are sufficiently correct and precise. Accuracy can have different meanings depending on how the data are used. At a basic level, accuracy is simply whether entered data match source records, such as intake forms or questionnaires. In table 1, information recorded on the paper student enrollment form has not been entered correctly into the database, making those data inaccurate. Although some incorrect entries may be obvious (for Maya), it may not be possible to detect other errors without comparing the database with the original source (for Sam).

TABLE 1

Accuracy Example

<i>Enrollment form</i>		<i>Entered data</i>	
Student	Age	Student	Age
Ana	12	Ana	12
Sam	11	Sam	10
Maya	9	Maya	90
Ken	10	Ken	10

Further checking accuracy might involve verifying data against independent documentation. For example, one could look at birth certificates or school records to verify student ages. But it may also be possible to simply consult intake forms or talk with staff who know the families. Regardless of how it is done, incorrect entries must be resolved in the final data before they are used.

Consistency

Consistency means that data from the same or separate sources should agree with each other. For example, client home addresses should be the same across separate program records. Or, as in the example in table 2, the number of students listed in an after-school program participant roster should match the reported count of students enrolled. Inconsistent information can lead to confusion and may result in wrong or contradictory decisions being made based on which version of the data are being used. And even if data are *consistent*, they may still be *inaccurate*, so checking for consistency is not a replacement for verifying accuracy.

TABLE 2

Consistency Example

<i>After-school tutoring program roster</i>		<i>Total enrollment</i>	
Session day	Student	Session day	Student
Monday	Ana	Monday	5
Monday	Sam	Tuesday	4
Monday	Maya	Wednesday	6
Monday	Ken	Thursday	8
Tuesday	Dara		
...	...		

Completeness

Completeness is based on whether a record is a full entry. Does it have enough information to draw necessary conclusions? Incomplete data may not be useful, making them less reliable and less valuable. For example, clients in means-tested programs should have recent income amounts so proper eligibility can be determined. For measuring average daily attendance and chronic absenteeism, one needs to record whether all students are absent or present every school day. Gaps in the record, such as in table 3, affect the ability to calculate attendance measures accurately. In the example below, it would be particularly important to try to understand what happened on October 7, when attendance was not reported for any students, as well as why Ken's attendance is missing on so many days.

TABLE 3

Completeness Example*Student attendance records*

	School Daily Attendance								
	10/1	10/2	10/3	10/4	10/7	10/8	10/9	10/10	10/11
Ana	Y	Y	Y	Y	?	Y	Y	Y	Y
Sam	Y	Y	?	Y	?	Y	Y	Y	Y
Maya	N	N	N	Y	?	Y	Y	Y	Y
Ken	?	?	N	Y	?	?	?	?	?

Note: Y = in school; N = not in school; ? = attendance not reported.

Integrity

Integrity is based on whether data are stored properly based on the database structure. The metadata should describe what type of information is expected in different data fields. Is a field expected to contain numbers or text? Phone numbers or dates? Coded values (“Y” and “N” for yes and no)?

Deviations from expected values need to be noted, as they can cause interpretation problems. In the example in figure 4, a Promise Neighborhood partner has provided a roster for families enrolled in one of its programs, but phone numbers are inconsistently formatted, which makes it hard to identify invalid numbers, such as for the Fernandez family (no area code) and the Johnson family (too few digits). The field for Promise Neighborhood residency also contains different types of answers, which will make those data harder to query or summarize later.

TABLE 4

Integrity Example*Family roster*

Family	Home phone	Promise Neighborhood resident
Allen	202-555-0100	Yes
Fernandez	555-0101	Yup
Wang	2025550102	N
Garcia	(202) 555-0103	7
Johnson	202-555-010	Not sure???
Lee	202x555x0105	Uh huh

Having good metadata can ensure data integrity because the metadata will describe what data values are allowable for different entries. Sharing the metadata or user guidelines for data entry can also help partners and people responsible for collecting and entering data understand what is expected.

In addition, many formal database systems support data validation rules for specific fields so data integrity can be enforced when information is entered. For example, a rule can be created requiring all phone numbers to have 10 digits and preventing users from entering something with fewer or more numbers. Sophisticated systems can automatically validate street addresses by comparing them against a known list.

For Promise Neighborhoods or partners who use spreadsheets to store data, however, enforcing data integrity can be more challenging. By default, spreadsheets allow people to enter a mix of information (numbers and letters) into cells within the same column (figure 4). Nevertheless, spreadsheet programs such as Apache OpenOffice Calc, Google Sheets, and Microsoft Excel also support creating validation rules for entries like phone numbers and coded values or for checking ranges of values (minimums and maximums). The Promise Neighborhood data manager could set up and apply appropriate rules to data cells before making worksheets available to program staff for data entry.⁹

BOX 2

Grantee Spotlight: Hayward Promise Neighborhood

Hayward Promise Neighborhood in Hayward, California, collects data at the intervention level, noting student ID; full name; intervention type, date, and duration; and miscellaneous notes. These data are stored in an Excel spreadsheet, and the data team manually checks for errors, understanding that certain critical fields (e.g., eligibility status) require an additional check. But the team is transitioning to Salesforce next year to make data input and cleaning smoother. In the past, the neighborhood has had a designated group of “data champions” that created norms and culture around data. Because of staff rotations, the level of excitement and organization around data has fluctuated, but Hayward emphasizes that partners are responsible for accurate data entry and reporting.

Timeliness

Timeliness reflects how long it takes between when data are expected and when they are available for use. Promise Neighborhoods can establish quality rules for the time it should take for data to be entered into their systems. Rules might specify that intake data on clients should be entered and be available for reporting within one business day or that student attendance data should be uploaded weekly. Making sure data are accessible quickly is an important aspect of ensuring their value to the Promise Neighborhood and others.

Data Quality Metrics

For each of the data quality rules described above, it is possible to count the number of times rules are violated in a portion of data (e.g., data collected over the past three months) and report these as metrics of data quality. Quality metrics can be expressed in many ways to gain insights into the extent of data problems.

- **Errors in dataset.** Number of distinct data quality rule violations in all data fields and records. Measures the volume of data problems.
- **Errors in dataset by category.** Separate counts for accuracy, consistency, and completeness problems. Identifies the most common data errors, which can be used to prioritize corrective and preventive action.

- **Errors in dataset by quality rule.** Separate counts of problems by quality rule. Identifies problematic data fields.
- **Records with errors.** Number of data records (i.e., observations for individual people or families), with one or more data quality rule violations. Shows how many data records are compromised and how many are clean.

Data quality metrics should be related to potential impacts of poor-quality data on Promise Neighborhood programming and the neighborhood’s ability to provide effective services and produce positive results for children and families. Metrics should be reviewed regularly to assess the current state of the data and compared over time to measure progress. The frequency of reviews should depend on how critical these data are to the program’s success and how likely the data are to have problems.

Data quality metrics should be included in regular reporting to Promise Neighborhood leadership, staff, and partners to keep everyone informed about the state of data quality and to generate buy-in to the idea that data quality affects the entire organization and is everyone’s responsibility. Promise Neighborhood partners should be able to conduct their own reviews and report on their data quality, and data quality review tasks and reporting can be written into partner agreements.

Data Quality Review

In addition to reporting on data quality metrics, a Promise Neighborhood can implement regular data quality review with staff. Such a process will create an opportunity for people to interact directly with the data, which can facilitate coming up with strategies for improving data quality. Promise Neighborhoods could also include data quality reviews as part of their regular work with partners to improve the quality of their data.

Friday Afternoon Measurement is an example of a data review process that can be incorporated into a Promise Neighborhood’s regular practice.¹⁰ The process can be used by managers and others whose work depends on data collection and consists of four steps.

- **Step 1.** Assemble the most recent 100 data records used or created for some part of the Promise Neighborhood’s work. These might be survey data, intake data from staff or partners for a particular program, or administrative data from schools or other agencies. Focus on 10 to 15 critical data elements—that is, specific pieces of information that are most relied upon for operations, reporting, or evaluation. Put all these data in a spreadsheet or print them.
- **Step 2.** Convene a two-hour meeting with several people with knowledge of the data. These people should be familiar with how the data are collected or used and who must rely on these data for part of their work.
- **Step 3.** Working record by record, highlight obvious errors (e.g., misspelled names or incorrectly placed information) in a noticeable color, like red or orange. Do this quickly, spending no more than 30 seconds on a record.

- **Step 4.** Summarize the results by adding a “Perfect record” column to your spreadsheet. Put a “yes” in this column if no errors were found or “no” if any red or orange appears in a row. Add up the number of perfect records.

TABLE 5

Data Quality Review Example

Student attendance records

Rec #	Student	Date enrolled	Sessions Attended					Pre score	Post score	Perfect record?
			1	2	3	4	5			
1	A	1/2/19	Y	Y		Y	N	40		No
2	B			Y	Y	Y	Y	20	40	No
3	C	2/7/19	Y	N	N	N	Y	30	20	Yes
4	D	2/12/19	Y	Y	Y	Y	Y	2	50	No
5	E	2/12/19	Y	Y	Y	N	Y	60	80	Yes
...
100	ZZ	3/12/18	Y	Y	Y	Y	Y	50	50	No

Number of perfect records = 52.

Notes: Enrollment dates should be between 1/2/19 and 3/31/19. Pre and post scores should be between 40 and 100.

During data quality review, participants found several issues, including missing data (e.g., enrollment date, attendance, and post score in records 1 and 2) and invalid entries (e.g., pre score and date enrolled out of range in records 4 and 100, respectively). Only 52 records had no detectable data quality issues.

Participants could then discuss the results. Was the number of problems surprising? What challenges do these data quality issues create for the Promise Neighborhood in understanding the program’s effectiveness and communicating the program’s value? What are the likely causes of the data challenges? What strategies could prevent the most prevalent or damaging data problems from occurring? How could those strategies be tried and tested? Ideas generated during the session could then be tried out, and progress could be assessed in the next data quality review.

As with all Promise Neighborhood performance review and accountability processes, the focus of a data quality review should not be punitive. The review is meant to identify challenges and develop solutions to ensure high-quality data to achieve robust results for the people and communities Promise Neighborhoods serve.

Conclusion

Robust data quality management will help Promise Neighborhoods better serve their communities by providing more reliable information that can be used to more accurately direct resources, assess results, and improve performance. To be successful, data quality management must be supported by leadership and built into regular practice. Data profiling is an effective place to start, because it will help everyone understand what data quality challenges exist and what impact they may be having on neighborhood

results. Once data profiling is complete, Promise Neighborhoods can add other elements of data quality management, including data quality rules and metrics. Regular data quality reviews, whether monthly, bimonthly, or quarterly, can culminate in strategies for improving data that can be implemented and tested. By following these recommendations, Promise Neighborhoods should be able to produce measurable improvements in data quality.

Notes

- ¹ “Promise Neighborhoods Program,” US Department of Education, Promise Neighborhoods, accessed December 14, 2019, <https://promiseneighborhoods.ed.gov/background/promise-neighborhoods-program>.
- ² For detailed information on Promise Neighborhood data collection and reporting expectations, see Comey et al. (2013).
- ³ Susan Moore, “How to Create a Business Case for Data Quality Improvement,” Gartner blog, June 19, 2018, <https://www.gartner.com/smarterwithgartner/how-to-create-a-business-case-for-data-quality-improvement/>.
- ⁴ Effective use of data is one of the core competencies identified in PNI (2014).
- ⁵ Moore, “How to Create a Business Case.”
- ⁶ “The Four V’s of Big Data,” IBM Big Data and Analytics Hub, accessed December 14, 2019, <https://www.ibmbigdatahub.com/infographic/four-vs-big-data>.
- ⁷ Mona Lebled, “The Ultimate Guide to Modern Data Quality Management (DQM) for an Effective Data Quality Control Driven by the Right Metrics,” Datapine, June 28, 2018, <https://www.datapine.com/blog/data-quality-management-and-metrics/>.
- ⁸ Adapted from Lebled, “The Ultimate Guide.”
- ⁹ For tips on setting up data validation rules in Apache OpenOffice Calc, see “Validating Cell Contents,” Apache OpenOffice, accessed December 14, 2019, https://wiki.openoffice.org/wiki/Documentation/OOo3_User_Guides/Calc_Guide/Validating_cell_contents; for Google Sheets, see “G Suite Pro Tip: How to Create a Dropdown List in Google Sheets (and Pointers on Conditional Formatting),” Google Cloud, October 17, 2018, <https://cloud.google.com/blog/products/g-suite/pro-tip-how-create-dropdown-list-google-sheets-and-pointers-conditional-formatting>; for Microsoft Excel, see “Apply Data Validation to Cells,” Microsoft, accessed December 14, 2019, <https://support.office.com/en-us/article/apply-data-validation-to-cells-29fecbcc-d1b9-42c1-9d76-eff3ce5f7249>.
- ¹⁰ The creator of this process, Thomas C. Redman, chose the name because “many people set up these meetings on Friday afternoon, when the pace of work slows.” For more information, see Thomas C. Redman, “Assess Whether You Have a Data Quality Problem,” *Harvard Business Review*, July 28, 2016, <https://hbr.org/2016/07/assess-whether-you-have-a-data-quality-problem>.

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About the Author

Peter A. Tatian is a senior fellow in the Urban Institute's Metropolitan Housing and Communities Policy Center and research director for Urban–Greater DC. He is an experienced researcher with over 30 years of experience working with and analyzing data from both public and administrative sources. He advises nonprofits on performance management and evaluation and coleads Urban's work providing technical assistance to grantees of the US Department of Education's Promise Neighborhoods initiative.

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500 L'Enfant Plaza SW
Washington, DC 20024

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