The influence of end-user metadata on user attitudes toward, and use of, a data warehouse.

Neil Foshay
Assistant Professor
St. Francis Xavier University

Contents

Introduction and motivation for the study

While organizations today realize that information is a key asset that must be exploited in order to achieve success, unlocking the potential business benefits of this information remains an elusive goal for many firms. In order to unlock the value of organizational data, many organizations have implemented data warehouses and business intelligence applications in the last decade; often at a cost of seven figures or more. These data warehouse environments serve to collect and integrate data and to make it accessible for query and analysis to reveal insights that can fuel business decisions.

The primary consumers for the contents of a data warehouse and BI applications are decision makers and knowledge workers within the organization. Often, the performance of these individuals is measured by how effectively they are able to use available data to make management decisions. Many of these individuals are not technically oriented meaning that they need a good deal of support in order to use the data to do their job effectively.

> *What would it mean if many of these managers and knowledge workers don't fully understand and trust the data they are being provided? What are the consequences regarding the use of expensive business intelligence environments and, ultimately, on the quality of decisions made within organizations?*

There is good deal of evidence, based on the experience of data warehouse practitioners, that the situation described above is the reality today in many organizations. The primary evidence: the perception that many data warehouses are underutilized. While there are likely many factors at play to cause this situation (poor data quality, dissatisfaction with the BI tool used, and lack of data training, to name a few), one factor has been pointed out repeatedly: data warehouse users often don't understand and/or trust their data because they do not have access to tools available to help them do so. Consequently, these individuals are not willing risk making key decisions with data they have little insight into.

Data warehouse practitioners seem to understand that this situation exists and a good deal has been written regarding one method for supporting end-users: metadata. Metadata in this context helps users understand the various types of information available from a data warehouse/business intelligence environment. This information can take many forms including data elements, queries, reports and published documents. While practitioners seem to understand the value of metadata to end-users, there is a perception in the data warehouse industry that many data warehouses today do not provide good metadata.

This paper presents the results of a study conducted from April to October 2005. It was carried out through direct contact (through online surveys) with business users and data warehouse practitioners in order to:

- *understand the type(s) of information (metadata) that end-users need;*
- *develop a theory regarding how metadata helps end-users; and*
- *to determine, through feedback from business end-users, if metadata contributes to data warehouse success.*

The purpose of this white paper is to present an overview of the study and to discuss the implications of key study findings for data warehouse practitioners. IBM Information Integration Solutions has sponsored this research project, by providing access to potential respondents, and this white paper. The project has also been supported by Stu Carty of Gavilan Research Associates who made a significant contribution to this effort.

Metadata definitions and study background

Metadata has been described, generically, as "data about data". While true, this definition is not particularly helpful in understanding the value of metadata in an information systems context. Dempsey and Heery (1998) offer this definition:

"Metadata is data associated with objects which relieves their potential users of having full advance knowledge of their existence or characteristics. It supports a variety of operations."

Tannenbaum (2002) states that metadata serves to answer five important questions regarding information in an organization:

- *What do I have?*
- *What does it mean?*
- *Where is it?*
- *How did it get there?*
- *How do I get it?*

In the data warehouse industry it's been recognized that there are numerous types of metadata that serve the needs of different audiences. Metadata serves the needs of 'technical' stakeholders (those responsible for developing and maintaining the data warehouse) and 'business' stakeholders (decision makers and knowledge workers who 'consume' the information generated by a data warehouse). As mentioned earlier, this paper focuses on the latter.

Metadata is a topic of considerable interest within the data warehouse industry. A recent search of the online versions of leading practitioner publications DM Review and Intelligent Enterprise on the keywords ('meta-data' OR 'metadata') AND 'data warehouse' returned 55 and 274 articles, respectively. A search on the same keywords on the web site for the Data Warehouse Institute, an organization dedicated to data warehouse research and education, returned 78 articles.

A number of these articles discuss the value of metadata to users, but none rigorously examines the underlying reasons why this is true. Additionally, there does not appear to be a consensus regarding what types of metadata (because there are many) are of particular importance to end users. The goal of this project is to fill in some of the gaps in understanding regarding end-user metadata.

Project background and research model
Background
This project began with a review of existing practitioner books and articles. What became apparent quickly was that there exists a sizable body of practitioner literature on the topic of data warehouse metadata in periodicals

like DM Review, Intelligent Enterprise and the Business Intelligence Journal from the Data Warehouse Institute. A number of the authors of current work on metadata were contacted and interviewed to assist in setting up the theoretical framework for the study.

These individuals were posed a standard set of open ended questions during a series of telephone interviews, each of which lasted 30 to 60 minutes. Questions included:

- *How can the success of a data warehouse be assessed?*
- *Is end-user metadata an important contributor to the success of a data warehouse initiative?*
- *Can data warehouses be successful without end-user metadata?*
- *What types or categories of metadata are most important to end-users?*

Results from the interviews revealed consensus that, in most cases, end-user metadata is important to data warehouse success, but indirectly. There was agreement that a basic measure of data warehouse success is the degree to which the data warehouse is *adopted and used* by the target audience. Further, metadata encourages use of a data warehouse by facilitating understanding and trust of available data thus making users more willing to use the data warehouse for more and more creative analysis. This was a key insight − that metadata can influence user *attitudes* toward the data in the warehouse, which, in turn can influence the level of use of the data warehouse.

Conceptual model
Two dimensions were developed regarding end-user metadata: quality and use. The quality dimension was included to measure the effectiveness of metadata. The use dimension was included to reflect the fact that the quality of metadata cannot have an impact on user attitudes toward data unless it is actually put to use in the data warehouse environment.

The study's conceptual model was created by synthesizing information gathered in preparation for the study with an existing, proven information systems model called TAM: the Technology Acceptance Model. TAM was developed to understand factors that influence the level of use of an

information system and has been used on numerous research studies for this purpose. Figure 1 presents a simplified version of the conceptual research model developed.
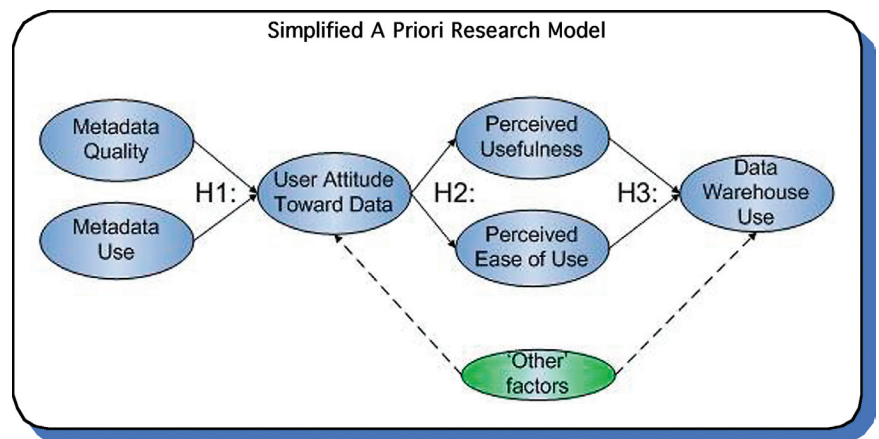

Figure 1

Please note that Figure 1 is a highly summarized view of the actual research model, but presents the core hypotheses for the study which are:

> *H1: End-user metadata quality and use have a positive impact on user attitudes toward the data in their data warehouse.*
> *H2: User attitudes influence user perception of both the usefulness and ease of use of the data warehouse.*
> *H3: User perception of ease of use and usefulness of the data warehouse influence the level of use of the warehouse.*

The study also evaluated the influence of 'other' factors on user attitudes and data warehouse use. These include user perceptions of:

- *the level of quality of the data in the warehouse;*
- *the usefulness of the Business Intelligence tool used to access the data warehouse; and*
- *the quality of training received about the content of the data warehouse (data training).*

These 'other' factors have been called out within the data warehouse industry as being important to data warehouse success. As such, their impact on attitudes and use will be examined and the relative impact of these factors vs. metadata factors will be discussed.

Although not highlighted in the model above, the study hypothesizes that there are a number of factors that mediate the core relationships. These include:

- *the complexity of the data warehouse environment (size, subject areas, number of data sources);*
- *the degree to which the use of the data warehouse is mandatory for individuals to perform their job function;*
- *the experience of the data warehouse user in accessing the warehouse; and,*
- *the complexity of the task that users are performing using the data warehouse.*

Metadata classification

One of the objectives of the study is to suggest a standard frame-work for classifying end-user metadata. A review of available literature and the interviews with industry thought-leaders led to a standard framework for categorizing end-user metadata, as presented in table 1. The table details the explanations of each metadata category provided to technical and end-user participants in the study (through the survey instruments used).

Table 1. Metadata categories for the study

Category	Explanation to technical respondents	Explanation to end-user respondents
Definitional	Definitional metadata is any information that conveys the meaning of data in the warehouse (or, for example on reports or OLAP cubes) to end users. Included in this category are business definitions, calculations, business rules and allowable values. Definitional metadata answers the question: what does this data mean, from a business perspective?	Business Definitions convey the business meaning of data to end-users, for example, within the reports they use. Included in this category are definitions, calculations, business rules and allowable values. Business definitions answer the question: what is the business meaning of the data?
Data Quality	Data quality metadata advises users about the currency (freshness), accuracy, validity or completeness of the data in the warehouse (or on reports, queries or OLAP cubes). Quality metadata answers the business user's question: does this data possess sufficient quality for me to use it for a specific purpose?	Data quality information gives users the ability to assess the freshness, accuracy, completeness and validity of data. It allows users to ascertain whether or not they want to use certain data for a specific purpose, based on its overall quality. Quality information answers the question: is this data of sufficient quality (as measured by freshness, accuracy, completeness and validity) for me to use?
Navigational	Navigational metadata provides users with a means to search for data (or other resource, such as a report). In other words, navigational metadata lets users 'Google' the data warehouse to search for what they need and to get an understanding of relationships between data objects of various types. Navigational metadata answers the question: where can I find the data I need?	The ability to search means that users can 'Google' the data warehouse to locate the data or other information (for example, a specific report) they need. The ability to search allows you to answer the question: where can I find the data I need?

Table 1. Metadata categories for the study *(continued)*		
Lineage	Lineage information tells users about the original source of data in the warehouse (or on a report) and describes what has been done to the data (for example, cleansing, transformation or aggregation) prior to being loaded into the warehouse. Lineage information answers the user's questions: where did this data originate, and what was done to it prior to being loaded into the warehouse?	Lineage information tells users where the data in the warehouse originally came from and how it was changed (transformed, cleansed or aggregated) prior to being placed in the warehouse (or on a report) Lineage information answers the question: Do I understand where this data came from and what has been done to it sufficiently to use it?

In creating this categorization, the intent was to identify categories that are applicable to a broad spectrum of data warehouse users. As such, there are a number of 'niche' categories that are not included (e.g., audit metadata for Sarbaines-Oxley compliance or metadata only useful to technical stakeholders of a data warehouse).

Surveys

In order to operationalize the model presented in figure 1, and to include questions related to the categories of metadata presented in table 1, two surveys were created − one aimed at technical respondents (data warehouse practitioners) and the other at end-users. The goal of the technical survey was to assess the metadata support provided to users and the complexity of the data warehouses in the study. The end-user survey was designed to assess end-user perceptions of the metadata support they receive and a number of factors regarding the data warehouse/business intelligence environment they use.

Note that in the technical survey, data warehouse practitioners were asked to comment on the appropriateness of the metadata categories described in table 1. While there were a number of comments and suggestions, overall, technical respondents indicated that the categorization was reasonably inclusive and appropriate.

Findings

Respondent Overview

Over the course of the study, executed from April through October 2005, responses were received from 268 <u>technical</u> respondents (data warehouse practitioners) from 266 organizations and 621 <u>end-user</u> respondents from a total of 104 organizations (a subset of the 266). Note that the 'unit of analysis' for this study is a data warehouse, not an entire organization. As such, this study received input regarding 268 data warehouses (each technical response described a distinct data warehouse) from within 266 organizations. Generally, technical respondents played a managerial or technical role in supporting one or more data warehouse within their organization. The most common job titles for technical respondents were: Data Warehouse Manager, Data Warehouse Architect and Data Warehouse Project Manager.

Figure 2 presents an industry breakdown for responses. Note that responses were received primarily from organizations within the US. Approximately ten (10) responses came from Canada, and 3 from elsewhere in the world. Responses were received across a wide spectrum of industries, with the highest percentage from the manufacturing and financial services sectors.
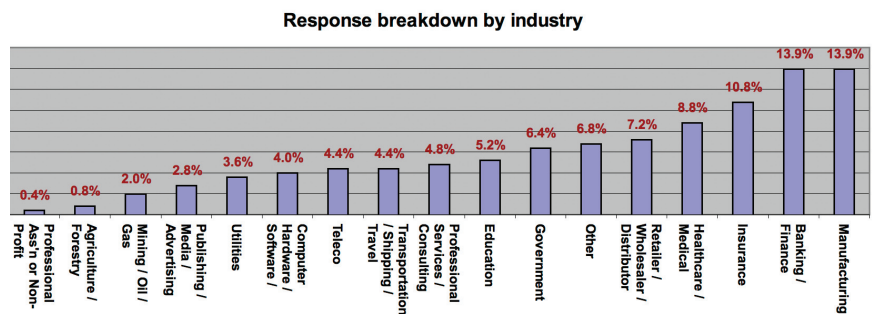
Response breakdown by industry

Figure 2

Figure 3 presents the size of responding organizations in terms of revenue (USD).

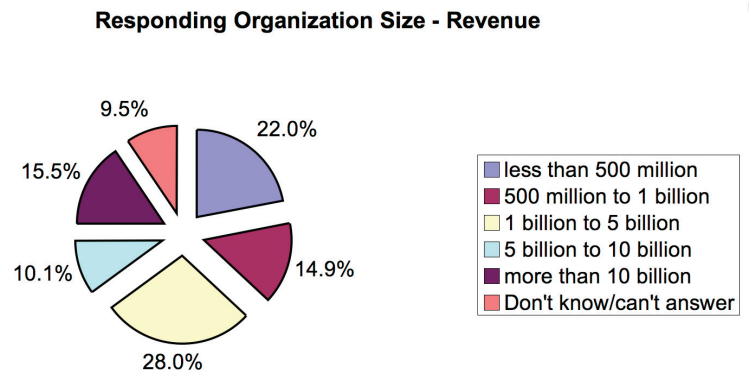**Responding Organization Size - Revenue**

Figure 3

Figures 4 and 5 provide an overview of the characteristics of the data warehouses included in this study, in terms of size and number of users. As presented in these figures, the study covered a wide spectrum of data
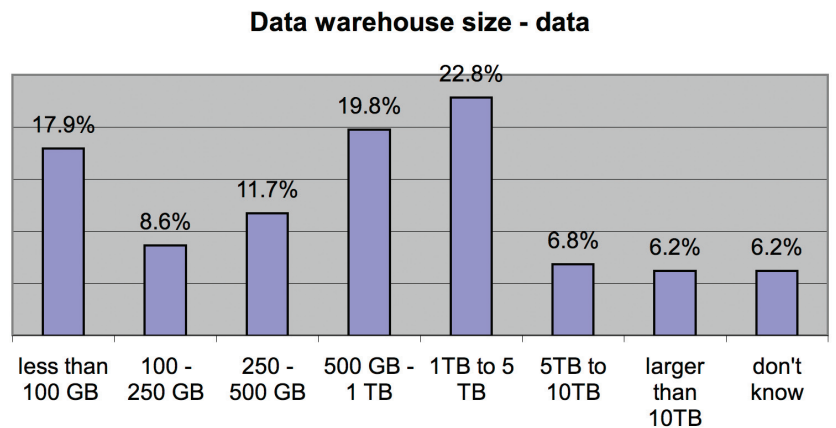
Data warehouse size - data

Figure 4

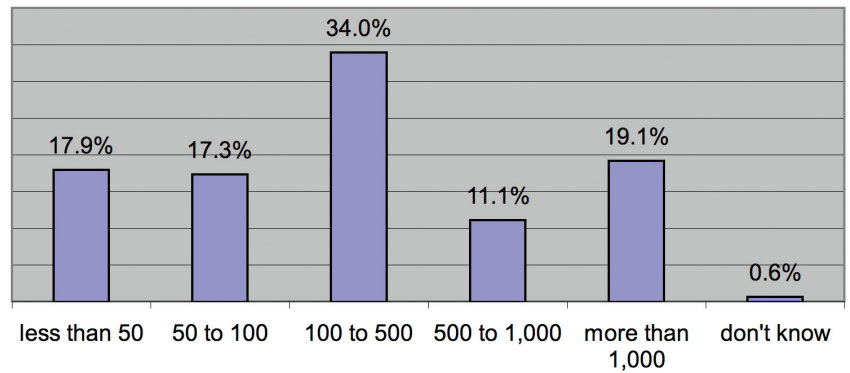**Data warehouse size - number of users**

Figure 5

warehouses in terms of size and number of users.

Table two summarizes a number of key characteristics of the 621 end-user respondents. As presented in the table, the average user respondent had 16.5 years of professional experience, had been in their current position for slightly more that four years and had been using their current data warehouse for about three years.

Table 2. End user respondent characteristics

	Min	Max	Average
Total professional experience (years)	1	42	16.5
Tenure in current position (years)	< 1 month	32	4.3
Experience with current data warehouse (years)	< 1 month	13 years	3.1

Technical approaches to providing end-user metadata
Technical respondents (data warehouse practitioners) were asked to list the methods used within their data warehouse to capture, store and present metadata to users. As presented in Figure 6, a wide variety of techniques have been used to perform these activities.
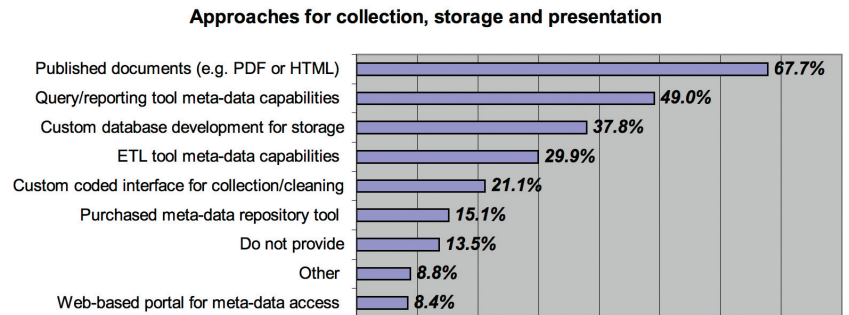
Approaches for collection, storage and presentation

Published documents (e.g. PDF or HTML)	67.7%
Query/reporting tool meta-data capabilities	49.0%
Custom database development for storage	37.8%
ETL tool meta-data capabilities	29.9%
Custom coded interface for collection/cleaning	21.1%
Purchased meta-data repository tool	15.1%
Do not provide	13.5%
Other	8.8%
Web-based portal for meta-data access	8.4%

Figure 6

Please note that the techniques presented in this figure are not mutually exclusive. In fact a majority of respondents indicated that they use a variety of techniques in their metadata management strategy. An analysis of this table reveals a number of interesting findings:

- *13.5% of data warehouse practitioner respondents indicated that they do not provide any metadata to end users.*
- *Almost 68% of respondents indicated that published documents (Word, Excel, HTML, etc) are used for metadata presentation. Additionally, 49% of respondents indicated that they leverage the metadata capabilities of query and reporting tools for presentation. Clearly, these two methods (singly or in combination) are the dominant methods for metadata presentation. A very small percentage of data warehouses are providing access to metadata through web-based portal products (8.4%).*
- *Only 15.1% of warehouses in the study use a metadata repository product for collection and storage. It appears that a 'home grown' approach is the dominant paradigm for the collection and storage of metadata. 35% of warehouses in the study maintain end-user metadata in a custom developed database and 21% collect metadata through custom coded solutions.*
- *In the 'other' category several respondents indicated that they use the ERWin data modeling tool to capture end-user metadata.*

Types of end-user metadata provided

Figure 7 presents an overview of the types of metadata most (and least) commonly provided to end-users. Not surprisingly, the most common is definitional metadata − 77.7% of warehouses provided basic data definitions.

Approximately half (51%) of the warehouses in the study provide Data Quality metadata. Lineage (36.3%) and Navigational (31.9%) are the least commonly provided. Other findings:

· *Approximately 88% provide one or more categories of metadata; Definitional metadata is not one of those provided in only 10.3% of cases.*
· *The most common combination of categories: Definitional and Quality (only) - 42.6%*
· *The least common: Navigational and Lineage (only) - 0%*
· *Percentage of warehouses providing all four categories - 13.9%*

Types of end-user meta-data provided

Lineage — 36.3%
Navigational — 31.9%
Quality — 51.0%
Definitional — 77.7%
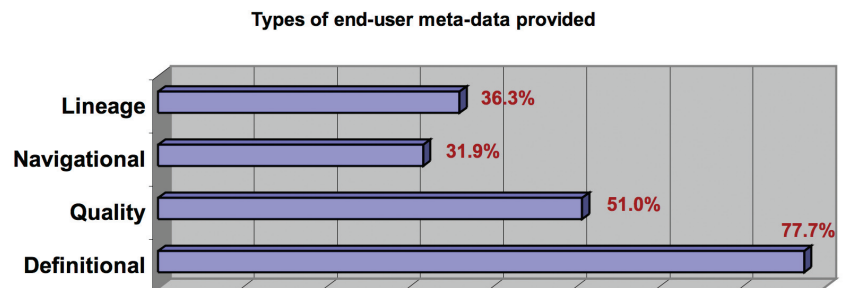
Figure 7

Perceived usefulness of end-user metadata

Both technical and user respondents were asked their opinions regarding the usefulness of various categories of metadata. There was consensus between the groups that end-user metadata is quite useful. However, the views of the groups diverge in terms of the relative usefulness. These differences can be seen in figure 8. Technical respondents indicated that they believe that the most useful category of metadata to end-users is definitional (8.0 on 9-point scale), followed by quality (7.5), Navigational (6.9) and Lineage (6.6). The users' perception of usefulness was quite different. In fact, users ranked definitional metadata last (tied with lineage metadata with a 6.7 score). In the eyes of responding users, quality metadata is the most useful (7.5), followed by navigational (7.2) then definitional/ lineage (6.7).

Usefulness of end-user metadata Technical vs. End-user respondents
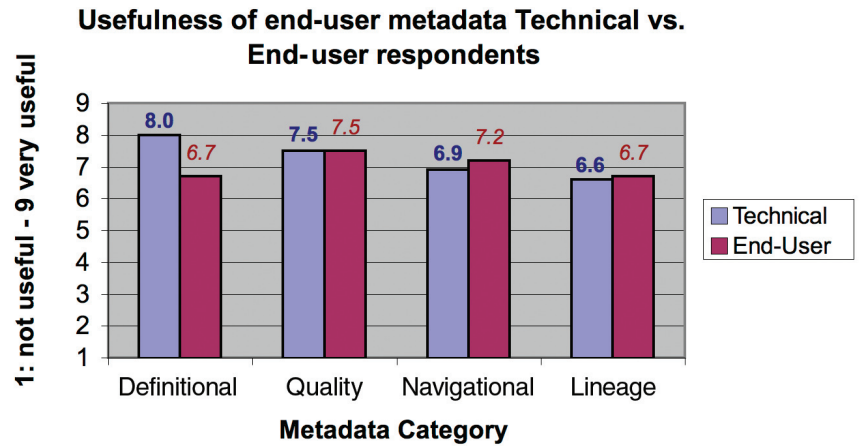
Figure 8

Interestingly, users provided a slightly different response when asked to rank the relative usefulness of various types of metadata, as presented in Figure 9. Users were asked to rank the four types of metadata from most (value = 4) to least (value = 1) useful. Based on this ranking, users clearly indicated quality metadata is the most useful to them, followed by definitional, navigational and lineage.
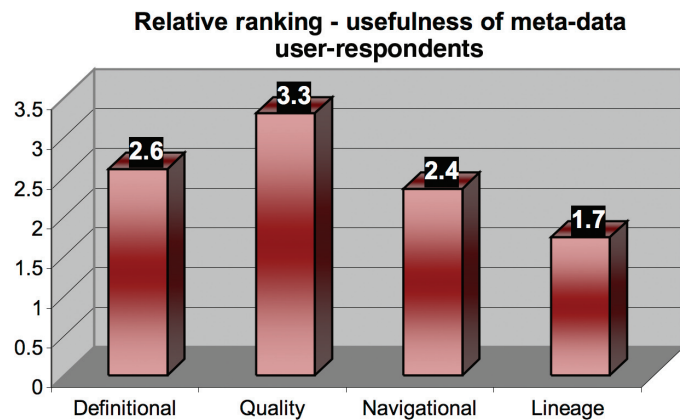
Relative ranking - usefulness of meta-data user-respondents

Figure 9

End-user satisfaction with metadata provided

Both technical and end-user respondents were asked questions regarding end-user satisfaction with metadata provided. Figure 10 presents technical respondents' opinions regarding their user's level of satisfaction with available metadata and end-user respondent stated level of satisfaction.
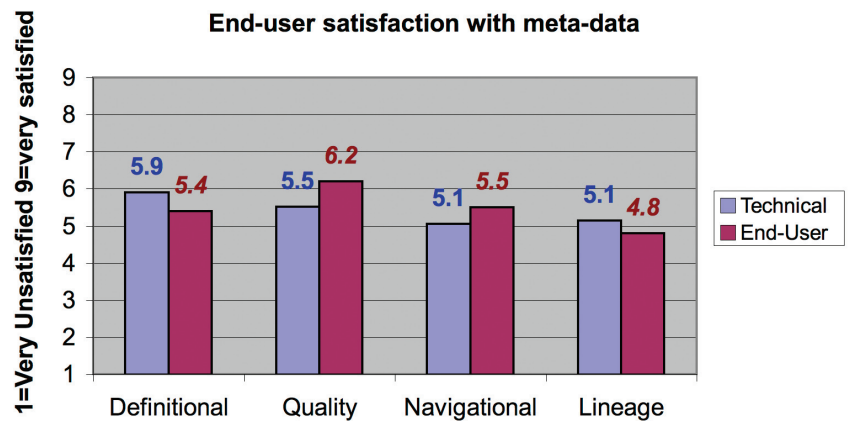

Figure 10

As highlighted by figure 10, user-user respondents are fairly 'neutral' in their level of satisfaction with the metadata they have access to today. Users indicated that they were most satisfied with quality metadata provided and least satisfied with lineage metadata. Interestingly, technical respondents, many of whom play a role in providing metadata to end users, seem to realize that their users are somewhat ambivalent about the metadata they use. This chart seems to indicate that users are looking for 'better' metadata and that many of the data warehouse practitioners who responded to the survey know this.

End-user views regarding 'other factors'

As stated earlier in the paper, an objective of the study is to understand the influence of 'other' factors on user attitudes and data warehouse use. These include user perceptions of:

- *the level of quality of the data in the warehouse;*
- *the usefulness of the Business Intelligence tool used to access the data warehouse; and*
- *the quality of training received on the content of the data warehouse (data training).*

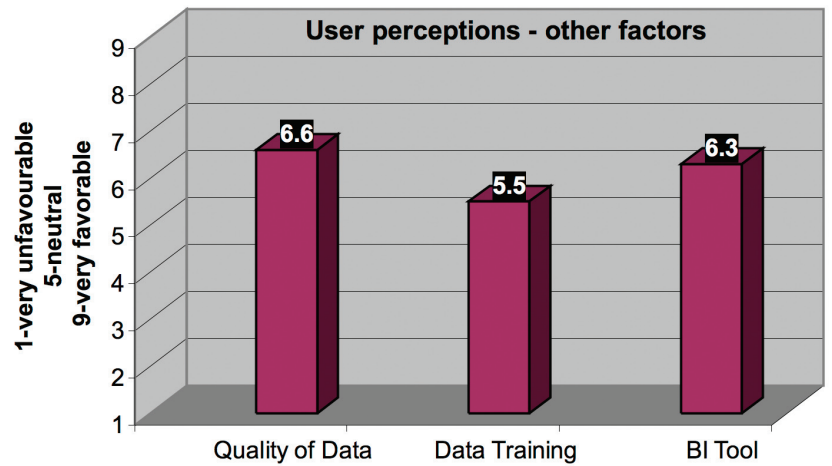Figure 11 presents an overview of end-user perceptions of these factors.

Figure 11

User perceptions of data quality and the BI tool they use are somewhat, but not overwhelmingly favorable. Probably the most significant observation that can be made based on the above data is that user perception of data training is almost 'neutral'. It appears, that data warehouse teams, in general, need to do a better job in training users regarding the data content of the data warehouse that they use.

The Influence of Metadata Quality and Use on User Attitudes and Use
This section provides an overview of some of the most significant findings related to the study's core hypotheses and on the effect of moderating variables.

Main Hypotheses (H1 – H3)

A series of regression analyses were performed to test the study hypotheses (summarized earlier in this document as H1 – H3). Figure 12 presents the preliminary results of the analysis. As presented in the figure, preliminary results indicated that the three core hypotheses in the study are supported.
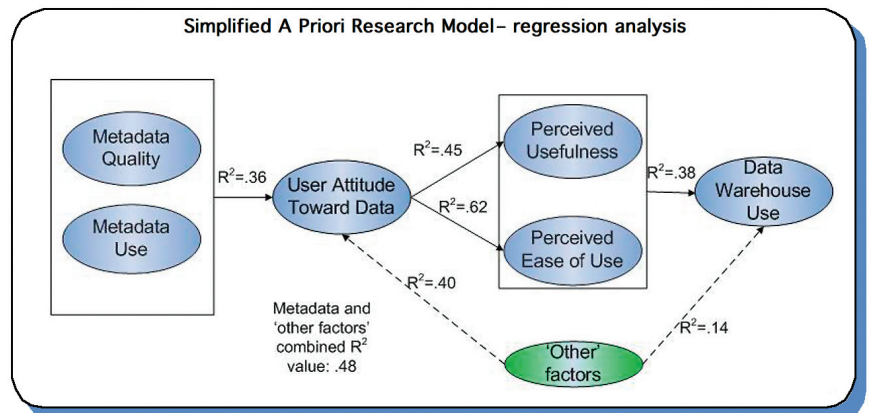

Figure 12

The figure highlights the relation between the independent variables (those to the left of the arrows to dependent variables (those to the right of the arrow). The measure of the strength of this relationship is the 'R^2' value. R^2 provides a rough approximation of the percentage of variance in a dependent variable that can be explained by the independent variable(s). Please note that all of the relationships presented in the above model proved statistically significant at $p < .01$ level.

Based on the preliminary analysis of the data collected during the study, the following observations can be made:

- *The relationship between the quality and use of end-user metadata and user attitudes toward data in the warehouse is moderately strong ($R^2 = .36$ – approximately 36% of the variance in user attitudes can be explained by metadata quality and use).*
- *Although not represented in the above diagram, the metadata quality factors proved to be more significant in influencing end-user attitudes than the metadata use factors. The most significant factors proved to be: (in order of relative significance) quality, definitional and navigational.*
- *The influence of end-user metadata on user attitudes is roughly the same as 'other factors': training on data warehouse content, user perceptions of BI tool usefulness and user perception of data quality ($R^2 = .40$).*
- *Combined, metadata and other factors account for almost 50% of variance in user attitudes toward data ($R^2 = .48$). While the relationship is fairly strong, there are clearly are other factors that influence user attitudes toward data.*
- *The direct relationship between other factors on data warehouse use appears to be quite weak ($R^2=14$). It appears that factors like quality of data and appropriateness of the business intelligence tool operate on user attitudes in a manner similar to the metadata factors – their influence on use is indirect.*
- *The relationship between user attitudes and the perceived usefulness and perceived ease of use of the data warehouse is quite strong ($R^2 = .44$ and .61 respectively).*
- *Somewhat surprisingly, the relationship between the perceived usefulness (PU) and perceived ease of use (PEOU) of the warehouse and the level of use of the warehouse is only moderately strong ($R^2 = .38$). This relationship is fundamental to the Technology Acceptance Model. On many other published studies (none of which were data warehouse oriented), the R^2 values tended to be much higher. This is an indication that data warehouses are different than other information systems in that factors other than PU and PEOU are involved in determining the level of use of the data warehouse.*

The Influence of moderating variables on Core Relationships

As stated earlier in the document, an objective of the study is to determine the effects of 'moderating' variables on hypothesized relationships. Those variables include:

- *the complexity of the data warehouse environment (size, subject areas, number of data sources);*
- *the degree to which the use of the data warehouse is mandatory;*
- *the experience of the data warehouse user in accessing the warehouse; and,*
- *the complexity of the task that users are performing using the data warehouse.*

Of these variables, preliminary findings indicate that end-user experience with using the data warehouse has the most significant moderating effect on the relationship between metadata and user attitudes. Figure 13 illustrates the impact of experience.
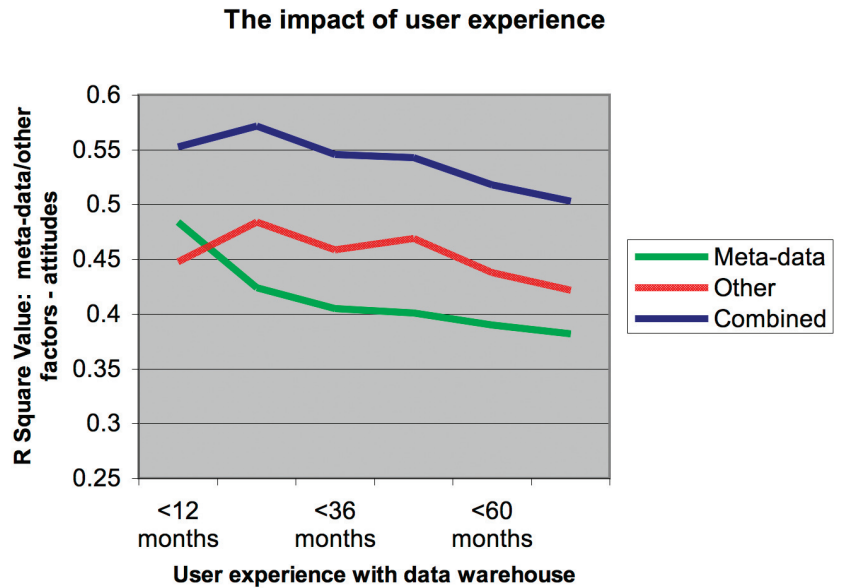
The impact of user experience

Figure 13

As highlighted by the figure, the strength of the relationship between end-user metadata and user attitudes 'ages' (becomes less significant) over time. When users have 12 months of experience or less, the R^2 value of the relationship is almost .50. In fact, for these relatively inexperienced users, metadata appears to be more significant that the combination of training, BI tool usefulness and data quality in influencing attitudes (R^2 of .45).

As time goes by and users gain experience with using the data warehouse, it appears that metadata plays less of a role in shaping their attitudes toward data. Although not highlighted in the figure, it appears that different categories of metadata age at different rates. Definitional, Navigational and Lineage metadata appear become less significant in influencing attitudes over time. The influence of Quality metadata, however, seems to retain its value to end-users for longer period of time. This probably reflects the fact that the quality of data in a given warehouse may vary somewhat over time and necessitating the need for quality metrics to help users understand the current quality of data.

Implications for practice

This study offers a number of useful insights to data warehouse practitioners. This section presents key findings from the study that may be of particular interest.

The end-user metadata categories proposed by the study are a good starting point for practitioners

Based on feedback from study participants, the basic categories of metadata suggested in this study seem to make sense for the majority of data warehouse end-users. The categories (Definitional, Data Quality, Navigational and Lineage) may offer a useful framework for data warehouse practitioners in developing and communicating their metadata strategy to various stakeholders and for prioritizing metadata development projects.

Additionally, the categories provided offer a means through which specific end-user requirements can be defined. It is important to note that specific metadata requirements must be defined to serve the needs of various constituencies within each organization. Metadata is not generic; it needs to be tailored to specific organizational contexts.

End-users and data warehouse practitioners agree that metadata is important and useful, but…

The results of this study point to the fact that end-users and practitioners are in complete agreement regarding the usefulness of end-user metadata. Practitioners and users don't agree on what the most useful category is, but do agree that all types are useful.

Based on satisfaction scores and based on the approaches currently used to provide metadata to users, end-users are not satisfied with the status quo. As mentioned, published documents are still the dominant means for access and only 13% of the data warehouses in the study provide all four categories metadata to their end-users.

The Data warehouse practitioners who participated in the study seem to be aware that the metadata they provide today is not adequate; perhaps due to the fact that it's often too static and does not provide the informational depth end-users seek. Awareness of the issue is important – practitioners understand that there is work to be done in order to get users what they need. Hopefully the results of studies like this one can provide a conceptual foundation for choosing and investing in the right metadata driven data warehouse components.

Metadata can influence user attitudes
The empirical evidence from the study suggests that end-user metadata quality and use positively influences user attitudes about data and (indirectly) the level of use of the data warehouse. Its influence on attitudes and use is roughly equivalent to the influence of user perceptions of data quality, the BI tool in use and data warehouse content (data) training. This does NOT suggest that metadata is in any way a substitute for these factors. Rather, metadata should be thought of as complementary to data quality and training programs – metadata can play a role in such programs in addition to having intrinsic value.

Quality is king

Quality metadata emerged during the study as the most influential category of metadata. End-users stated, definitively, that they perceive it as the most useful form of metadata. This view is strongly supported by the empirical evidence – quality metadata emerged as the most significant individual (metadata) factor in shaping user attitudes toward data. Again, it's important to note that quality metadata is in no way a substitute for the actual quality of the data in the warehouse. Rather, it serves to inform users regarding quality so that they can make appropriate use of the data that is available to them. This means that users can employ good quality data with confidence and make informed decisions regarding whether or not they should use data of questionable quality for specific purposes.

Consequently, data warehouse practitioners should consider how to provide this form of metadata dynamically to their end-users in order to correctly represent the status of their data warehouse asset.

Additionally, metadata can be used as a means to facilitate communication between users and the data warehouse team regarding data quality issues. Using this information as part of an on-going data quality assessment program is an invaluable tool as it provides organizations with benchmarks by which improvements in quality can be measured and potentially, related to overall data warehouse customer satisfaction metrics.

End-user experience is a key factor
The strength of the relationship between end-user metadata and user attitudes 'ages' as users gain experience with using a specific data warehouse. This indicates that over time, user reliance on metadata diminishes as they come to understand the data. When users are inexperienced, the relationship between metadata and attitudes is quite strong. However, for data warehouse practitioners, this probably doesn't diminish the need for quality metadata overtime, and of course, when changes occur to the data warehouse all forms of metadata are important.

This fact presents a tremendous opportunity for practitioners to influence user attitudes and ultimately, adoption rates. If new users of a warehouse can be provided good quality metadata in conjunction with effective training, it seems there is a great likelihood that they will develop positive attitudes toward their data (other factors, such as actual data quality, being equal). This, in turn should encourage higher rates of adoption and use of the data warehouse. Given that higher data warehouse adoption rates are a significant goal for many organizations, it can be used as the business rationale to justify an investment in metadata infrastructure.

Conclusion

This study aimed to develope a better understanding of end-user metadata: what it is, and if it can be observed to add value in a data warehouse environment. The study proposed three main hypotheses:

> *H1: End-user metadata quality and use have a positive impact on user attitudes toward the data in their data warehouse.*
> *H2: User attitudes influence user perception of both the usefulness and ease of use of the data warehouse.*
> *H3: User perception of ease of use and usefulness of the data warehouse influence the level of use of the warehouse.*

The study results support these hypotheses. Implications of the study results are significant for data warehouse practitioners, as presented in the previous section. The study indicates that users perceive the value of metadata and suggests that there is a tremendous opportunity for practitioners to encourage increased levels of adoption and use of their data warehouses, particularly among new data warehouse users, by implementing effective metadata and integrating it into data quality and training programs.

About Neil Foshay

Neil Foshay is currently an Assistant Professor in the Department of Information Systems at St. Francis Xavier University in Nova Scotia, Canada. His areas of teaching expertise include systems analysis and design, data warehousing and ERP.

Prior to joining the faculty at St Francis Xavier, Mr. Foshay spent over 17 years as an Information Technology professional. He has held senior positions in the areas of: business systems planning, systems architecture, application development, and methodology development. Mr. Foshay has nine years of experience in the architecture, design and development of large-scale CRM and e-Business-oriented Data Warehouses within organizations in the High Tech, Finance, Telecommunications and Entertainment industries in the US and Canada.

Mr. Foshay can be reached at nfoshay@stfx.ca

For more information

To learn more about the technologies and products behind the IBM WebSphere Information Integration platform, contact your IBM representative or IBM Business Partner or visit **ibm.com**/software/data/integration

IBM®