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## AN ACTOR-NETWORK THEORY PERSPECTIVE ON DATA QUALITY IN MEDICAL PRACTICES

Medical practices in the healthcare sector are today subjected to the same pressures as other businesses. They accumulate large amounts of patient data yet, in most cases, they do not utilize its potential value. Data can only be utilized once its complex nature and flow and the different views and perceptions of all stakeholders are understood. This includes the concept of data quality, which embodies technical and social issues. This paper argues that Actor Network Theory is a suitable theoretical lens to investigate the actors and their activities in a medical practice in order to improve our understanding of data quality issues. A data network infrastructure is proposed showing the data stakeholders and how they would interact during a consultation. This data network infrastructure can be used to research the complexities of data representation and usage to arrive at a deeper understanding of the data quality issues in medical practices.

*Keywords:* patient care, patient data, data stakeholder, data, information, social data quality.

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## 1. Introduction

It is generally agreed (Wang et al. 1995; Abate et al. 1998; Tayi and Ballou 1998; English 1999; Gendron and D'Onofrio 2000; Karr et al. 2001; Eckerson 2002) that data quality is a non-trivial problem, which increasingly deserves more attention. Furthermore, like most serious problems, it is highly unlikely that it will resolve itself. In other words, something must actively be done to improve data quality.

In this paper we pursue this goal by proposing to use actor-network theory (ANT) as a theoretical lens to look at the actors and activities that influence data quality. In order to ground our discussion in realistic terms, the context of a medical practice, seen here as a small business enterprise, is used. Although the arguments presented are of a conceptual nature with some results, empirical investigations will be continued to ground our approach, and this will be reported on in future work. It is argued in the conclusion that focusing on medical practices places no restriction on our results – in other words, the context could be generalized or extended.

It should be noted that our point of departure is that data quality has already been shown by Gendron and D'Onofrio (2000) to be an important issue for stakeholders in the healthcare sector. In other words, we are not using ANT to show this, but rather assume this importance of data quality as a given. From this we proceed to show how ANT could be used to develop a deeper understanding of the problems related to data quality.

The paper is organized as follows: In sections two and three the first two concepts introduced above, viz., data quality and ANT are discussed. Next, in section four, the data infrastructure of a medical practice is represented to focus more clearly on the actors and activities pertaining to data quality. This aspect is then explored in section five, where we show how the ANT lens enables us to arrive at a much-improved understanding of data quality and its associated problems. In particular, we draw on this analysis to make recommendations with regard to improving data quality in a medical practice. We conclude by discussing how these results could have more generic implications.

## 2. Data quality

Data is of high quality if it satisfies the requirements stated in a particular specification and the specification reflects the implied needs of the

user. This is in terms of conformance to its intended use, where the utility and users are the qualifying indicators for data quality (Abate et al. 1998; Vassilidadis et al. 1999; Atkins 2001; Loshin and Inbar 2002). The concept of quality is relative depending on the different perceptions and needs of the different data stakeholders. Redman (2003) emphasizes the pre-eminence of the “customer” and argues that due to the different needs of customers, these needs also change all the time. Understanding changing customer needs can therefore be time-consuming and difficult. There are three data roles: data producers, data custodians and data consumers (Strong et al. 1997). Data producers (people, groups or other sources who generate data) have to deal with data generation and externalisation problems or deficiencies. Data custodians (people who provide and manage computing resources for storing and processing data) are concerned with data storage, maintenance and security problems. Data consumers (people or groups who use data) need access to data. Different data roles might assign different priorities to data quality dimensions, for example, the timeliness dimension could be considered as very important by data custodians, but less important by data consumers; or ease of use considered as important by data consumers but less important by data custodians (Strong et al. 1997; Wand and Wang 1996; Pipino et al. 2002). Data quality cannot be assessed independently of data consumers who choose and use these data products.

Much of the existing work on data quality describes list of desirable data quality dimensions (Wand and Wang 1996) and sees data quality as an organizational asset that has to be managed. The problem then becomes a management problem and the ‘solution’ an attainable feat in terms of standard management approaches. That data quality is not so simple is borne out nicely by the framework of Shanks and Darke (1998), quoted in (Lederman et al. 2003). Their framework distinguishes four levels of data quality: syntactic, semantic, pragmatic and social. Syntactic data quality is concerned with the structure of data and attempts to achieve consistency of representation. Semantic data quality is concerned with the meaning of data as assigned by the users of the data and attempts to ensure that data is complete, accurate and up-to-date. Pragmatic data quality is concerned with the use of data and attempts to ensure usefulness and usability. Social data quality is concerned with the shared understanding of data by various social groups within organizations (Shanks and Corbitt 1999) and is relevant for organizations that have multiple points of contact with customers.

It is to be expected that a standard management approach (even if this is based on a Total Quality Management approach) to data quality will at most address some of the technical issues involved – in terms of the above framework, some of the syntactic, semantic and pragmatic data quality issues. The non-technical issues, i.e., the social issues, will escape attention and, most probably, will thwart all attempts at bringing order in the data quality household.

In order to come to a deeper understanding of the data quality problems of an organization, it is also important to understand why an organization has quality problems in the first place and to what extent the environment contributes to these problems. The latter aspect will be addressed in further research. To address the first aspect, it is therefore necessary to study an organization in a real-life situation in an attempt to understand its data quality needs and problems. Reality can only be accessed through social constructs such as language, consciousness and shared meanings and by recognizing that people are constrained in their actions by various forms of cultural and political domination (Meyers 1997; Tatnall and Gilding 1999). This reality is a socio-technical reality, which we propose to study by means of ANT. We have seen above that data quality embodies technical and social issues within an organizational context and environment, and ANT provides a convenient theoretical lens through which to study the complex interplay between the various actors that contribute to, and influence data quality.

### 3. Actor-network theory

ANT evolved from the work of Callon and Latour at the Ecole des Mines in Paris (Callon and Latour 1981). ANT is concerned with the creation of a stable network, which comes into being when the interests of all the actors in a single collective are aligned (McMaster et al. 1998). The different actors in an actor-network have, as Monteiro (2000) puts it, "... from the outset a diverse set of interests, (and) stability rests crucially on the ability to translate – that is, re-interpret, re-present, or appropriate – others' interests to one's own. In other words, with a translation one and the same interest or anticipation may be presented in different ways, thereby mobilizing broader support". Translation consists of the following four moments: problematization, interessement, enrolment and mobilization of different actors, both human and non-human with neither dominating the other (Sidorova and Sarker 2000; Callon 1991).

Problematization is the first moment of translation where actors seek to identify and define the obligatory point of passage and attempt to impose their definition of the problem on others. Problematization is an indispensable moment as it implies that the problem resolution can only be negotiated through the obligatory point of passage. Intersement involves convincing other actors that the interests defined by the focal actor are in fact their interest and creating such incentives for actors that they are willing to overcome obstacles in the way of successful enrolment. During enrollment alliances are consolidated through negotiation and pragmatic concessions. Enrollment requires the key actors to persuade and convince the other actors to join them. Mobilization is where spokespersons emerge who represent the actors and who are authorized to speak legitimately on behalf of all the actors, even the 'silent' ones. The objective of ANT is to describe the creation and maintenance of a stable network to represent the aligned interest of all actors.

The medical practice is discussed next followed by a discussion on how ANT could be used to explore data quality issues further.

#### 4. Medical practice

The medical practice can be considered as a network in which relationships between patients and staff members of the medical practice are established and managed. In order to manage data it is important to distinguish between data and information and their roles in the organization within this context. This aspect is dealt with in this section first, followed by a discussion of the other nodes of the medical practice data network infrastructure.

##### *4.1. Data, Information and Reality*

Data is defined as a collection of symbols that signify real world system states and are brought together because they are considered relevant to some purposeful activity (Shanks and Corbitt 1999). Information is defined by Boland (1987) as the inward-forming of a person that results from an engagement with data. Data is the representation of the real world and any given real-world entity, process, or phenomenon can be modelled by many different data views, depending on one's purpose (Rothenberg 1996). Every organization usually has its own information system depicting its view of the real world applicable to it. The environment of the organization will determine this view as well as its context based on its use of the data in its business processes.



#### *4.2. Data Stakeholders and Roles*

The patient, the “customer”, is the real-world object within the context of the healthcare sector. Persons interested in patient data will be the data stakeholders of a medical practice. The following data stakeholders can be identified: patient, medical practitioner, medical proxy (the person authorised to process patient data), administrative staff member and external parties. An external party is a person or organization that shares patient data with the medical practice. All the data stakeholders interact with data in the role of data producer, consumer or custodian. All data stakeholder roles are played by human actors. It is important to note that a patient, for example, could be both a data object (its virtual representation) but also a data producer (capturing his/her own data) or data consumer (using his/her own data in the case of e-commerce).

#### *4.3. Data Objects*

Data objects - data representations of real-world objects - are generic templates of the different organizational objects obtaining their values from data sources when instantiated. Data objects are identified and defined during systems development by systems developers as they perceive the real-world object as well as the needs of the users (data consumers) of the data objects. A data object consists of a structure, i.e. the properties of the patient that are stored, e.g., name, age, address, diagnosis, etc. This will differ from one medical practice to another because different people perceive the properties of a patient differently. Data values are assigned to the data object every time there is an interaction between a patient and a representative of the medical practice. This interaction can be in the form of a consultation when the medical practitioner consults with the patient. The data regarding the patient's condition and diagnosis is captured by the medical practitioner according to the practitioner's style and interpretation. The medical proxy processes patient data, updating appointment details, medical aid, payment details, etc. Data objects (data representation of patients) are all non-human actors in the actor-network.

The nature of a medical practice's data determines how it is structured and used. In a medical practice, details about the customer (patient) are mostly provided from time to time by the customer (patient). In contrast in a business environment customer details, in the form of transaction data, are the result of the overall interaction between the business and the customer over time. Furthermore, patient data is created by the medical

practitioner, according to his/her interpretation of the patient's condition. Whether in medical practices or general businesses it may be useful to distinguish between different sectors of data, e.g. demographic, financial, customer related, etc. because each sector has different processing needs and restrictions.

In addition the medical practice also deals with either families or individuals. A general practice deals mostly with families with files as a common term used for their data reference whilst certain specialists, e.g., orthopaedic surgeons, neurologists, etc, deal with individual patients. Medical aids usually deal with a family. Household data is a term used when the data structure represents a grouping such as a family structure that evolves with husband, wife and children.

Another aspect about medical practice data is the time aspect. Demographic data might only represent the current snapshot in time, e.g., the latest address; telephone number; medical aid number; marriage status; etc., whereas financial and clinical data have a definite history with all these events being represented by the data, e.g., appointment details with the progression of the illness(ess), treatments, etc.

#### *4.4. Data Storage*

Data objects need to be stored within the organization's environment. Most organizations use databases to store their data objects, but the data storage should be extended to include other data sources such as paper, audiotapes etc. Data objects need to be investigated in terms of their storage because the use of technology introduces more complexities.

#### *4.5. Data Sources*

Data sources (operational, legacy, external, unstructured and electronic, audio, paper) are non-human actors in the actor-network. Data sources are dependent on their storage media that influence their structure and usage. The data source not only has the data captured by the data producer but also data from external sources that need to be integrated with the medical practice's data.

The list of actors within the medical practice network may be extended depending on the needs as identified by the research to include more stakeholders, e.g., technology, medical practice manager, or external partners to provide for externalisation of data such as medical aids and pharmaceutical companies.



#### *4.6. Medical Practice Data Network*

Having described above the three concepts central to our discussion, we now turn to the interplay between them. In ANT terms, we have to identify the network of aligned interests and the actors that would form this network. This is addressed in the next section, when we propose that the aligned interest in this network is patient care, with data quality being the obligatory point of passage to achieve a network with properties of irreversibility. The medical practice as a data network infrastructure is shown in Figure 1.

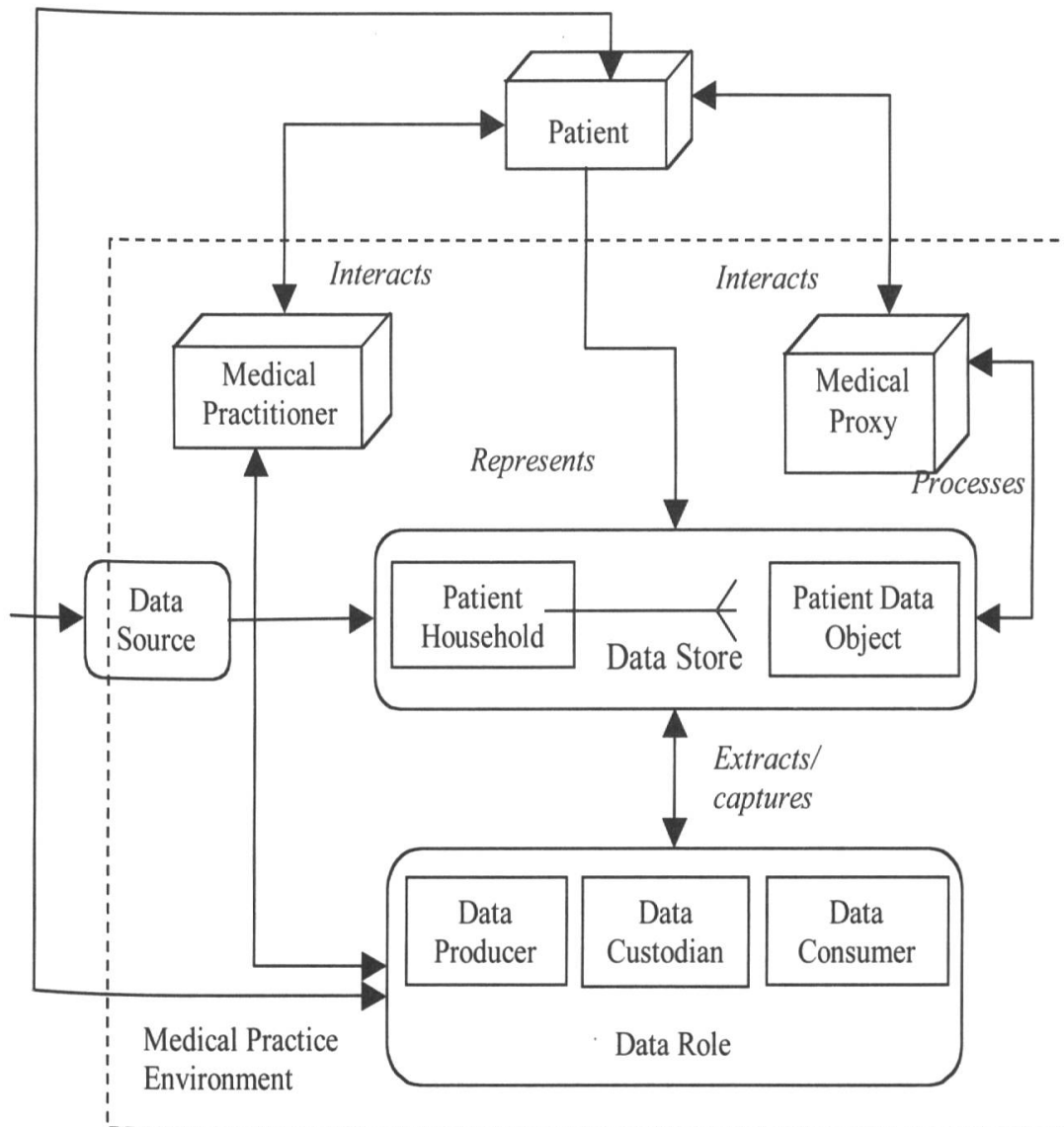
### 5. Use of ANT to understand Data Quality

Different data users in the medical practice will use data objects to collect, capture, update, extract, process, analyse, secure and represent data values to support their organizational functions. Different data users use the same data object and different data objects are used by the same data user all according to their own needs. Data consumers use data objects as they perceive them in terms of the real-world objects, e.g., patient data to handle an inquiry of a particular patient.

It is clear that the environments of different medical practices will have an impact on how data is shared. Each environment has its own technology, management style, definition and understanding of data objects, roles and storage. The same real-world object, the patient, is perceived and stored differently in the different medical practice environments making data integration very complex. The interaction between the real-world object and data stakeholder is highly dependent on different perceptions. This aspect is more difficult to research since the actions of the different data stakeholders have meaning in relation to their understandings, purposes and intentions and their interpretations of the significance of the context of their action. It is here, we believe, that the ANT lens can provide significant assistance to the researcher to study the formation of a stable network of aligned interests.

We propose that the aligned interest in a medical practice is the concept of patient care, and that the obligatory point of passage to this aligned interest, is data quality. In section 5.5 below we describe the different moments of translation within a medical practice. Our discussion is partly descriptive in terms of what has been observed in medical practices, and partly normative in terms of what should take place in order to increase the likelihood of achieving a stable network with properties of

irreversibility – i.e., where the concept of data quality has become institutionalized (black boxed).



*Figure 1: Medical Practice Data Network Infrastructure: Nodes and Associations between different Data Stakeholders during a Consultation.*

### 5.1. Medical Practice Data Network Infrastructure

The diagram in Figure 1 is a representation of all the possible nodes of a data network for a medical practice and the possible interplay between the nodes (actors) during a consultation. Technology, more specifically Information Technology, is not shown as a separate actor. Indeed, tech-

nology provides the platform for all the actors and is regarded as pervasive and present in this approach. Depending on the focus, it could be identified as a separate actor.

### *5.2. Patient Care as an Aligned Interest*

It is necessary to point out that the ANT concept of 'alignment' should not be confused with the concept of alignment that is used in the management literature. As Monteiro (2000) points out, "An ANT perspective makes it strikingly clear that this 'alignment' is neither straightforward nor controllable in any strict sense. As ANT instructs us, it is not so much an exercise in juxtapositioning two neatly packaged entities as an attempted orchestration of all the elements of a truly extensive, heterogeneous actor network." To state that the aligned interest in the medical practice actor network is patient care, just provides us with a starting point for studying the translation of the diverse interests of the different actors into a common interest – that of patient care.

### *5.3. Data Quality as Obligatory Point of Passage*

Data quality is a requirement for successful data usage, sharing, etc., in order to support organizational information needs. The quality of data is highly dependent on the use of the data for a specific purpose resulting in it not only being perceived and used differently by different organizations, but also within the environment of the organization between the different actors. The different actors understand data quality differently and not all of them might accept it as being an important organizational resource due to their different expectations and uses of data. In terms of Latour's Due Process Model (McMaster et al. 1998) an approach could be to investigate the translation process to determine to what extent the different data stakeholders were identified and consulted, whether all the perplexities were identified and dealt with and whether there were any "enemies". All of these could be the cause of the perceived unsuccessful institutionalisation of data quality as a fact.

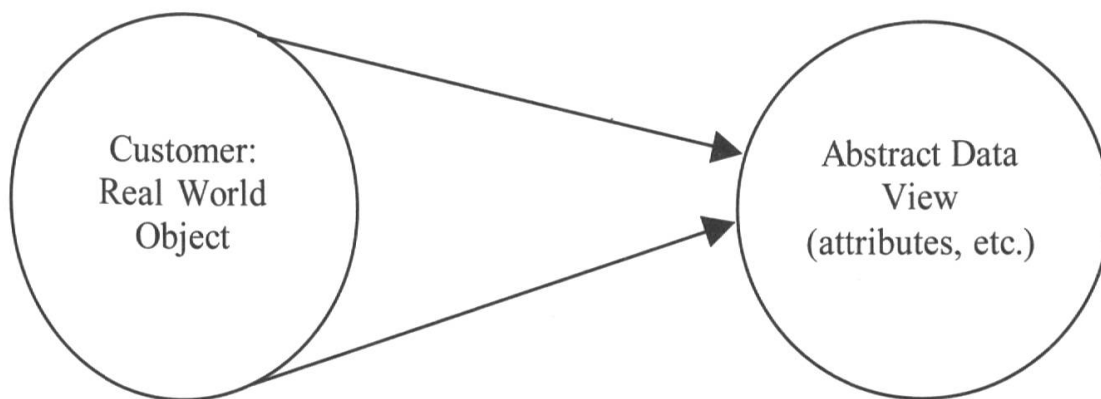
### *5.4. Patient Data and the Network Infrastructure*

Patient nodes are mostly inactive and become active when a particular need for contact such as an appointment or inquiry is required. Data regarding the patient "nodes" and the interactions with patients are required in order to manage the data network to the advantage of the medical practice. There is an interaction between the patient and the

medical practitioner every time a patient consults a medical practitioner resulting in the forming of a network between the patient, medical practitioner and/or medical proxy and patient data object. This interaction results in the exchange of data and information between the different data stakeholders.

The medical practitioner exchanges data and information with the patient when interacting with both the patient and patient data object by contributing values to the patient data object based on his/her perception of the patient's condition. When considering the definitions of data and information, this means that the medical practitioner is engaging with the patient's data, integrating data from both the patient and patient data object, internalising these facts together with his/her observations and perceptions. Data obtained from the patient are the facts provided by the patient and observation of the patient's condition. Data from the patient data object are the facts previously recorded and stored. This information is communicated by the medical practitioner to the patient and captured and stored in the patient data object in the form of clinical data.

Rothenberg (1996) stated that data could best be thought of as modeling, i.e., the result of attempting to describe the real world as illustrated by figure 1. Any such description of reality is always an abstraction, always partial, always just one of many possible views of reality.



*Figure 2: Modeling the real-world (Rothenberg 1996).*

The choice of what kind of data to use to model reality is made prior to generating the data. The appropriateness of this choice is a crucial aspect of the quality of the resulting data; regardless of what data values are ultimately recorded.

Once the consultation is over the link between the patient and medical practitioner network is broken with that particular patient and the patient data object becoming inactive nodes of the network. When considering the medical relationships, once the nodes are in a network, they often require “care and feeding” and it is important to nurture these relationships (Nardi et al. 2003).

### *5.5. Moments of translation*

Following, a brief description is given of the different moments of translation in a medical practice. Note that although a sense of determinism might be present in the way these moments of translation are described, the intent is clearly not that actors will be told or instructed to do this or that. Rather, in the spirit of ANT, all of this is meant to be seen as situated social interactions between equal actors.

#### *Problematization*

The medical practice (or at least some key actors in it) must identify patient care as the focus for alignment of interest of the various actors. This implies an internalization of the concept and the development of a statement of intent, and the acceptance by the key actors, of data quality as an obligatory point of passage.

#### *Interessement*

Actors who might be experiencing problems of one kind or another with patient care must be convinced that the only way to resolve the problems they experience lies in addressing issues about data quality. These actors must be identified and “isolated” to prevent external influences challenging the legitimacy of the obligatory point of passage.

#### *Enrollment*

During enrollment alliances are consolidated through negotiation and pragmatic concessions. Enrollment requires the key actors to persuade and convince the other actors to join them. The network literally grows through the enrollment of actors who accept that data quality is indispensable in the provision of patient care.

### *Mobilization*

The mobilization of actors, according to Callon (1986), results in rendering mobile actors that were static beforehand in order to transit the defined obligatory point of passage of data quality towards patient care. Thus, through the mobilization of allies, actors become legitimate spokespersons of the groups they claim to represent – those that have already accepted data quality as indispensable in the provision of patient care. This helps to strengthen the network of alliances and enables the linking of actors that were not linked before.

In our further research within medical practices, the moments of translation described above provide us with a framework to “follow” the actors (as Latour put it) and their routine activities and to understand the implication of these actions in terms of the institutionalization of data quality within the practice. This would enable us to draw conclusions about the nature of the moments of translation, and about the likelihood of institutionalization. From this, certain recommendations of a specific and a generic nature could be formulated. Such recommendations would address issues such as data quality guidelines and policies, supportive of and complementary to traditional data quality approaches, which, as we mentioned earlier, mostly address only the technical side of a problem area that is deeply socio-technical. When all is said and done, medical practices must create and maintain a common understanding of data quality to cultivate a culture of conversation about data quality among actors that would be the backbone of the ongoing translation of interests necessary to maintain an aligned and stable network.

## 6. Conclusions

In this paper we showed how ANT might be used to arrive at a deeper understanding of the problems related to data quality. We refer to the context of a medical practice, to allow us the luxury of being specific. The approach we propose to follow in our further work will be based on the following:

It is useful to focus on the data infrastructure within which we identified the actor network of aligned interests (of patient care), with data quality as the obligatory point of passage. It could be argued that all of what has been said could also be achieved from first principles, without ANT. The point is that ANT, although it is a theory without a methodology, provides a powerful conceptual framework within which the focus



is placed equally on technical and social issues, and which allows us to identify the actors and activities that would constitute a successful approach to data quality. This goes far beyond the traditional way of identifying this as a management problem and implementing management procedures and controls.

ANT is a suitable lens to investigate, through the moments of translation, the acceptance by the actors of the importance of data quality and the alignment of their interests in patient care.

The proposed data network infrastructure could be used to investigate the moments of translation and how this plays out between the different actors. This data network infrastructure could be extended to include more actors as the research develops.

It should be clear that our approach allows for generalization to any other business environment. We believe, however, that such a simplistic generalization could be just that – too simplistic. We propose, therefore, to extend our research which has initially focused on medical practices, and which is still continuing, to other business environments as context for the investigation of the use of ANT to improve our understanding of data quality. It might be that the context has more profound effects than can be foreseen. We conclude, nevertheless, that the use of ANT as discussed here could add considerably to exploring problems related to data quality and could enable us to contribute to the body of knowledge in this sub-field.

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