A study using a graphical syntax for actor-network theory

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Structured Abstract:

Purpose

Actor-network theory (ANT) is considered to be both a theoretical position and a methodology. ANT has been the centre of vigorous debates regarding its ontological viewpoint but has also been found to have some drawbacks as a methodology. This paper uses a graphical syntax for ANT to describe the development and implementation of a health information system in order to assess whether the graphical syntax improves the use of ANT as a methodology.

Design/methodology/approach

An extensive example derived from a case study, describing the development and implementation of an electronic patients' records system, is illustrated using this graphical syntax. This serves to makes the actors, translations and black boxes in the case visible.

Findings

The syntax is found to help the researcher to conceptualise the research, to highlight assumptions as black boxes, and to follow the actor but above all it encourages the researcher to understand the translations being made between actors and to make them explicit. Hence the syntax is found to assist at the analytical phases of a research project. The graphic syntax found to address the criticisms identified for ANT as an IS research methodology.

Practical implications and limitations

The visualisation of the actor-network provided by ANT-gs provides a relatively simple representation while at the same time it makes key ANT concepts explicit. This is expected to address the issue of superficial understanding of ANT and selective use of its constructs; it makes the actor-network boundaries immediately visible. Thus we propose that ANT-gs will be useful both by IS researchers and as an educational tool but future research is required to verify both these practical implications. The development of a computer-based modelling tool based on this syntax is proposed to facilitate effective and efficient modelling.

Originality/value

This paper proposes a unique tool to support ANT as a methodology. Its use encourages the researcher to focus on constructs that are essential elements of ANT and, by making each of the translation instances explicit, it strengthens the analysis in a way that is true to the view of ANT as a sociology of translation.

Keywords:

Actor-network theory; research methodology; Health information system; Conceptual model

Article Classification:

Conceptual paper

1 The adoption of actor-network theory in IS research

Actor-network theory (ANT), which originated in sociology and anthropology, denies any difference between human and non-human entities (actors) at an ontological level and explains that alliances between actors change, are bilateral and are unpredictable. Technology, the organisation, groups, individuals, culture, policy documents and other artefacts are all actors and are intertwined in constantly changing relationships (Mitev, 2009). This has as a logical outcome the rejection of all of the following: techno-deterministic views; beliefs that the human actors fully control non-human actors; and assumptions that non-human actors are neutral. Thus ANT proposes a fundamental change in thinking and a new way of looking at groups of actors and their relationships. Indeed, as Hanseth et al. (2004: 119) note, "[a] central idea and motivation behind ANT is to study the construction of things normally taken for granted. The border between social and the technical is one such".

Since Information Systems (IS) research concerns itself with the interaction between humans, technologies and information systems, a theory that deals with this sociotechnical divide by denying that such a divide exists in the first place is a perspective that provides interesting new insights for IS researchers. This paper sets out to assist IS researchers and others using ANT by illustrating the use of a graphical syntax based on ANT concepts.

In many cases ANT is used to examine the development of a network of actors in order to address an IS issue, such as technology adoption, where the stability and durability of the network indicates the viability of the "solution". Hence the emerging process, involving the recognition and establishment of shared interests (translation) by means of which strong, enduring alliances are built between actors, is studied. The four stages of translation originally proposed by Callon (1986) are used to describe this process (Tatnall and Lepa, 2003, Silva, 2007, Stanforth, 2007). The first stage is problematisation, which occurs when actors identify a problem and propose a solution. Interessement occurs when additional actors are attracted to become part of the solution. Enrolment, where actors become part of the solution, occurs when interessement succeeds. Finally mobilisation occurs when the solution gains wide acceptance. This can be interpreted as striving for stability and order where the outcome of power is required to be "productive" and to achieve concrete results (Moser and Law, 2006).

However, these more functionalist uses of ANT in IS research have been superseded by the "after ANT" approach (Moser and Law, 2006). Here the complex and dynamic nature of the networks of which ICT is part are recognised to an even greater extent than before, and "… rather than alignment and stabilization and closure, the keywords are now multiplicities, inconsistencies, ambivalence, and ambiguities … Mastering this new world is not about stabilization and closure, but rather about more ad hoc practices …" (Hanseth et al., 2006: 566). In addition, looking not only within the organisation but including a wide variety of local and global actors, not all of which are overtly powerful, challenges managerialist approaches (Mitev, 2009, Stanforth, 2007). The graphical syntax proposed in this paper is intended to assist researchers in recognising and working with this complexity without being overwhelmed by it.

ANT is both a theoretical position (Avergerou 2002 cited by Stanforth, 2007) and a methodology (Cordella and Shaikh, 2003, Walsham cited by Mitev, 2009). There have been lively debates regarding the theoretical aspects of ANT including its initial premise, its use by researchers and how interpretations of ANT have evolved, but these are beyond the scope of this paper. Instead this paper is in response to reports of the practical difficulties that researchers face in using ANT as a methodology particularly when identifying intertwined relationships. Other researchers have had similar goals, for example, Latour and others developed the cartography of controversies "… to observe and describe social debate especially, but not exclusively, around technoscientific issues …", is said to serve as "an educational version" of ANT and also focusses on "the practice of ANT unburdened of all theoretical subtleties" (Venturini, 2010: 258). This confirms the need for some practical assistance for those using ANT as a methodology, although, as Venturini (2010) stresses, the cartography of controversies is not a simple "recipe" for applying ANT, and despite the reduced emphasis on theory, the application of the cartography is by no means easy.

Reflecting on an extensive example derived from a real case study, this paper sets out to determine whether the utility of ANT, specifically in analysing an actor-network, can be increased *for IS researchers* by expressing ANT in a graphical format. Hence the methodological aspects of ANT are the focus. The reported challenges that IS researchers using ANT experience will be discussed briefly in the following section and then the graphical syntax

(referred to hence forth as ANT-gs) used to depict the constructs that we consider to be essential elements of an actor-network will be introduced. This precedes a formal discussion of the research aims, methodology and background information regarding the study. The definitions and conceptual understandings of basic ANT elements are assumed and hence do not form part of the Literature Review. Instead these concepts/elements will be examined indirectly by analysing the example which uses ANT-gs to describe in some detail the actor-networks identified at various times over the life of the case. This series of actor-networks models will form the basis of the reflection that follows to see whether ANT-gs helps us address the practical challenges identified.

2 Literature Review

This section identifies a number of criticisms and challenges the IS researchers face when using ANT. The first is a general criticism regarding insight and quality. Concerns have been raised regarding the quality of research using ANT, which on occasion is judged to be mechanistic and instrumentalist, to be selective regarding aspects used and even to misinterpret the theory (Stanforth, 2007, Mitev, 2009, Hanseth et al., 2004).

A lack of insight as suggested above can be seen in research where one actor or type of actor is given precedence over others. IS researchers need to be aware of a temptation to put non-human actors (IT) "in the centre" or as the focal point of the actor-networks without sufficient justification (Mitev, 2009). Such a tendency inclines the researcher to interpret the outcomes of the study as being determined by the technology. On the other hand, the ability of particularly influential human actors to "ensure" or even enforce a uniform and unchanging interpretation of the non-human actors by "less powerful" actors has been shown in numerous studies to be unlikely (Silva, 2007). This seems to be particularly true within the health sector, with reference to the adoption of Health Information Systems in general and electronic patient records in particular (Moser and Law, 2006, Petersson, 2011, Braa et al., 2007, Cho, 2008, Hanseth et al., 2006). Although the "owners", funders and designers of such systems expect the end users to have a view of the system that is similar to, or at least compatible with their own, this is frequently not the case. Hence a managerialist bias needs to be avoided.

A serious challenge facing IS researchers using ANT is which actors to include in the network, as the following quote by Kaniadakis (2012: 262) explains.

"Although the actor-network as a concept is undoubtedly useful in capturing an actor within a broader environment and has been used extensively in IS (Hanseth et al., 2004; Walsham, 2001; Monteiro, 2000; Elbana, 2007), it seems not to be able to capture the limits or the boundaries of an actor-network, leaving the impression of uncontrollable and unlimited expansion. When implementation and use are taken into account, the range of social groups involved and affected by technological change seems to expand enormously, going far beyond anything recognisable as a technological community (Russell and Williams, 1988)." (Kaniadakis, 2012: 262)

The resulting overly large and complex networks become difficult to analyse. In addition, the equality of all actors, how to select actors without categorising them and how actors at different levels of analysis can be handled similarly makes analysis difficult and may result in superficial analysis (Mitev, 2009). So intractable did Mitev (2009) find these problems to be that she notes that ANT is a good way to start but that reaching conclusions was difficult until she adopted other theory. There does not seem to be much general confidence that the explanation will "emerge once the description is saturated" as Latour claims (Latour 1991 cited by Stanforth, 2007). Hence, authors would like clearer guidelines regarding how to analyse the actor-network (Lee and Brown 1994 cited by Stanforth, 2007) even though the advice to "follow the actor" is found to be useful and, as references to the undesirability of instrumental and mechanistic research in the first paragraph imply, a "recipe" for analysis cannot be provided.

Analysis includes understanding the relationships between actors. ANT is very valuable for making visible the different and sometimes contradictory ways in which different actors present or see technology and project failure is a good way of making different translations visible. Although at least one paper mentions the possibility that ANT over-emphasises disagreements and contradictions the same authors say, "ANT taught me not to assume that I will see disagreement, separation and failure, instead giving me the eyes to see reparations that occurred over time. … Much Actor-network theory did highlight controversy, but it also helped me to focus on repair work designed to restore order "(Ramiller and Wagner, 2009: 42)

Finally, this paper hopes to lessen the perception that ANT is a complex sociological theory whose vocabulary and definitions of concepts are difficult to understand. The ANT vocabulary can overwhelm or replace the vocabulary of the actors' own practice (that is, the vocabulary familiar to the actor and used in his or her working environment) (Stanforth, 2007). As a result many papers that use ANT "… make rather eclectic use of the conceptual vocabulary" (Stanforth, 2007).

The criticisms of ANT as a theory, namely, whether human and non-human actors can really be considered to be of equal importance, its relativism and whether it concentrates on superficial issues rather than underlying causes are beyond the scope of this relatively "practical" paper.

3 A graphical syntax for actor-network theory

Actor-networks change continuously; therefore two different types of diagrams are required. The first set of diagrams, which we will call the ANT models, all have the same form. Each of these depict the actor-network of a particular case at a particular time and there will usually be several such diagrams, allowing us to see how the actor-network changes over time. Tsohou et al (2012) refer to their own rich pictures of an actor-network at a particular moment as freeze frames. In the subsection that follows the individual symbols making up the ANT-gs syntax are introduced and reasons are given for differentiating between these ANT concepts by giving them separate symbols. The second diagram, Encounter-Episode frameworks that we will use is a time line that simply locates the ANT models in a time sequence. The framework and lexicon of ANT-gs are intended for use at the analytical phases of a research project.

3.1 Core syntax of the ANT model

< Table 1: ANT-gs (ANT graphical syntax) to be positioned here>

Translation

The most important philosophical concept in ANT is that of translation (ANT is sometimes called the sociology of translation (Law and Hassard 1999 cited by Pentland and Feldman, 2007) and hence this features prominently in ANT-gs. The importance to the IS researcher of making the translation visible and explicit is explained by Mitev, who says that not only do translations highlight differences in the way different actors form alliances with one another but "… having to include a wide range of actors and formulate corresponding translations made me study discourses and contextual conditions critically" (Mitev, 2009: 22). There are three different roles that actors can take during translation and these are depicted in the first three rows of Table 1.

- *A source actor*: the actor that is being translated (will be abbreviated to Source).
- *A target actor*: the actor that is being translated for (abbreviated as Target).
- *A translating actor*: the actor that translates the *source* actor for the *target* actor (abbreviated as Translator).

For example, Microsoft (Source) hires software engineers (Target) through lucrative salary packages (Translator). The software engineers (Source) build the Windows operating system (Target) through the use of a programming language (Translator). The Windows operating system (Source) runs on the computer hardware (Target) through an assembler (Translator). As noted earlier, the translation goes through stages: The Translator translates the Source into a format that is "understandable" by the Target (problematisation). Upon successful translation, the Target is introduced into the actor-network (interessement) and an alliance is forged between the Source and the Target (enrolment). The alliance may strengthen or weaken over time and the strengthening of translation and alliances with a larger group of actors is mobilization and the strength of the alliance is depicted as shown in row 4 of Table 1. ANT-gs does *not* show the stage of translation for each Translator.

Black boxes

Black boxes are a way of reducing the complexity of the actor-network by condensing a section of the network, whose composition is believed to be uncontested and relatively unchanging, into a single element. At the same time, by using a symbol that makes it clear that a complex entity is being presented as a single actor, the *assumption* that a "fact" is uncontested is acknowledged and the possibility that the black box can be "opened" and interrogated at any time is allowed. The importance of black boxes is emphasised by Venturini (2012: 806) who says, "The basic tenet of ANT is that every actor can be decomposed into a network and that every network can be connected tightly enough to become a single actor." The use in ANT-gs of a specific symbol for Black box as shown in row 5 of Table 1, is a way of remaining true to one of the aims of ANT, which is to expose assumptions and "raw facts" on which the entire empire of science and "scientific progress" is built (Latour, 1987).

Actors at a distance

The use of a symbol to show actors acting at a distance (row 6 of Table 1) also has particular significance in ANT as it allows local and global actors to be differentiated. In its simplest form, action at a distance illustrates how one actor can act upon another that is far away (physically or conceptually). For an actor to be able to act at a distance, that actor has to find a way to render other actors mobile. A mobile actor should be able to move between actors relatively easily (Latour, 1987). For example, a telephone is a mobile actor because it transports information between people. Secondly, a mobile actor needs to be durable so that it can be moved about without losing its shape. For example, the telephone network must not break down or relay incorrect information due to technical issues. Finally, a mobile actor needs to have a strong alliance with actors using or interacting with it. For example, staff members need to understand how the telephone works, otherwise it is useless. An immutable mobile is considered to move around but "hold its shape" not simply its physical form but rather in terms of function and how it is used by other actors (Law and Singleton, 2005). However, the idea of the immutable mobile has been contested (Moser and Law, 2006). In an era of continuously updated information, information is proposed as a *mutable* mobile actor. Since mobile technologies, such as tablet computers and even individual mobile applications, are designed to be customizable and to match the current needs of the user they could also be seen as mutable mobiles.

Research foci and exemplary instances

Two pragmatic extensions to the set of concepts are depicted as rows 7 and 8 of Table 1. Both are intended to counter the problem of actor-networks that become unmanageable because of the difficulty in determining scope and boundary. The first places a visual emphasis on the main research focus of a particular analysis. For example, a researcher studying technology adoption is likely to discover a multitude of actors in her empirical dataset. The focus of the analysis, however, is only on the actors that have a direct bearing on the adoption of a particular technology. A visual distinction for the actors constituting the focus of the analysis would be useful. This is not meant to be a "dominating central actor" who aligns the network as has been criticised as a managerialist and out-dated view of ANT (Hanseth et al., 2006) but rather as a practical measure to counter the problem of the scope and boundary of the actor-network. However, by requiring the modeller to indicate a focus, ANT-gs makes actors that may inadvertently be privileged obvious.

The second pragmatic extension aims to visually differentiate instances directly relevant to the study from instances that are only included for exemplary purposes. The presence of such an exemplary actor is noted in the model but since data has not been collected from the actor references to the actor will not be analysed in the research for which the model is created. An example in the Microsoft scenario referred to above might be industry standards whose influence is acknowledged but not really considered further in the analysis of the actor-network.

3.2 The encounter-episode framework

A time line is required as a second graphical tool, as an analytical problem stems from the seemingly static perspective when a single graphical ANT model is studied on its own or when the differences in time or view point are not clear. It is only in relation to other models that the dynamic nature of the actor-network becomes apparent. The other ANT models in the set could be of the same situation at different times, or the same situation modelled from different perspectives or by different researchers.

The encounter-episode framework proposed by Newman and Robey (1992) and used by Cho et al (2008) to structure their ANT analysis will be used. This framework shows a process as a sequence of encounters and episodes. Encounters are events that challenge the expected path of a particular process, and episodes occur between encounters. Each set of ANT models would now be associated with a progressive sequence of encounters and episodes, rendering a perspective of the actor-network as it changes its alliances over time.

The form of the framework has no semantic bearing on the ANT elements depicted by ANT-gs. In addition, ANT-gs and the encounter-episode framework are completely independent from (yet complementary to) each other. Each ANT model must contain four specific pieces of information that locate it in terms of the framework:

- A unique identifier for the particular model
- The date that the situation modelled pertains to
- The name of the person who produced the model
- The encounter or episode that the model is associated with

Figure 1 depicts an overview of what graphical ANT analysis within the encounter-episode framework might look like conceptually.

<Figure 1 should be positioned approximately here>

4 Research goals, methodology and case

The purpose of this paper is to demonstrate how actor networks can be presented in a visual way through a graphical syntax and how this assists analysis. Hence the case studied focusses on the use of ANT-gs by IS researchers to depict and analyse the example. Having done so we evaluate ANT-gs in terms of how successfully it addresses the analytical challenges faced by IS researchers using ANT as a research method.

This study presents a series of actor-network models based on an example, involving the design and implementation of an electronic healthcare record system (EHRS) at different stages in its development. The example used relates to the adoption by a community of healthcare professionals of a particular EHRS, in the form of a tablet computer application. The EHRS was initially studied as a proper case study but is used here simply to provide a real example in which there are a variety of actors including some mobile actors. The example demonstrates the search for a stable network but that the reality is that the network is forever changing. The emerging alliances all reflected our own understanding of ANT. However, the purpose of this paper is not to provide a full analysis, using ANT, of the adoption of the EHRS in the example or to reach conclusions regarding the adoption process.

Data related to the example was obtained through a series of semi-structured interviews conducted with a senior business stakeholder and a senior IT stakeholder of the developer, and the data is therefore necessarily biased towards these individuals' perspectives. Furthermore, the data is used at face value and no attempt has been made to verify it further. Explicit permission to record and use their responses in this study was obtained from each interviewee. Where permission was not obtained, responses were treated as 'off record' and were not included in the study. Transcripts of the recordings were sent to the interviewees so that they could confirm the contents. The events described by the interviewees span a period of about two years, but the interviews themselves took place over four months. Although the limited nature of the data might appear to diminish the empirical basis of the study, it should be kept in mind that the example only serves as a means to provide empirical data for the evaluation of the use of the graphical syntax by IS researchers using ANT as their research methodology and ANT-gs as a tool.

5 ANT-gs models of various actor-networks over the life of the EHRS

5.1 Encounters and episodes

The first logical step is to identify the main encounters and episodes present in the example. A high level overview of the timeline is presented in terms of the encounter-episode frame work (see Figure 2).

<Figure 2 should be positioned approximately here>

- Episode 1: Sometime in 2010, the idea for the EHRS application was conceived and refined by the management of an organisation providing medical insurance.
- Episode 2: A rudimentary application was developed.
- Episode 3: The rudimentary application was piloted with 10 healthcare professionals early in 2011. Information from the pilot phase was used to build a solid business case in order as a proof of concept.
- Episode 4: Once the concept was sufficiently proven, the updated application was released to 100 healthcare professionals in a second pilot study towards the end of 2011. During this period several challenges emerged and various strategies were employed to solve these challenges.
- Episode 5: The application was launched to the public in early 2012. The organisation collected usage data to inform their strategy for the EHRS application.

5.2 Episode 1

Figure 3 depicts a basic interpretation of Episode 1 in the graphical syntax for ANT.

<Figure 3 should be positioned approximately here>

The following observations can be made from the model for Episode 1:

- The “Management” *Source* was translated for the “Idea for EHRS application” *Target* by the “High level conceptual design” *Translator*.
- Broadly speaking, management got the idea for the EHRS application when the rising trend in the use of tablet computers, such as the Apple iPad, caught their attention and they saw the potential for exposing the organisation’s vast stores of patient data to healthcare professionals through tablet computers. The “Rising trend in tablet computers” *Source* was translated for the “Management” *Target* by the “Knowledge about the trend” *Translator*, while the “Patient data stores in organisation” *Source* was translated for the “Management” *Target* by the “Potential of patient data when exposed to healthcare professionals” *Translator*.
- Managers’ performance appraisals are based on their balanced scorecards which track the realisation of the organisation’s strategic objectives, such as to improve managed care (the holistic service rendered to members, from providing hospital cover to processing claims). The “Strategic objective to improve managed care” *Source* is translated for the “Management” *Target* by the “Balanced scorecards” *Translator*.
- Should the EHRS application idea prove to be feasible, it would be developed into a fully-fledged application which, if successfully adopted by healthcare professionals, would provide them with patient information that is comprehensive and accurate. This would, in turn, contribute towards fulfilling the strategic objective of improving managed care. The “Idea for EHRS application” *Source* is thus translated for the “Strategic objective to improve managed care” *Source* by the “Use of application” *Translator*. Note that this is still a relatively weak alliance, as denoted by the dotted lines, since the application is yet to be developed.
- Since the case study specifically focuses on the adoption of the EHRS application, the “Idea for EHRS application” constitutes the primary research focus. Similarly, the “Strategic objective to improve managed care” is a primary actor behind the conception of the idea, and also forms part the primary research focus.

5.3 Episode 2

The following observations can be made from the model for Episode 2 (Figure 4).

<Figure 4 should be positioned approximately here>

- In this episode a project team was assembled to develop the idea into an application. The goal and expected outcomes were documented in the Project Brief. The idea for the EHRS application from Episode 1 is thus an actor in this episode as well. The project team and Project Brief are other actors. Specifically, the "Idea for EHRS application" *Source* is translated for the "Project team" *Target* by the "Project Brief" *Translator*.
- The project team had to engage stakeholders from several business and information technology areas across the organisation. Specifically, the "Project team" *Source* is translated for the "Business stakeholders" and "IT stakeholders" *Targets* by the "Project engagement" *Translator*.
- The project team had to develop the rudimentary version of the EHRS application based on the requirements elicited by the project team and documented in the System Specifications. The "Project team" *Source* was translated for the "Rudimentary EHRS application" *Target* by the "Systems Specification" *Translator*.
- As in Episode 1, there is still a relatively weak alliance between the "Rudimentary EHRS application" *Source,* the "Strategic objective to improve managed care" *Target* and the "Use of application" *Translator* since the full application has not yet been adopted and used.
- Also similar Episode 1, the "Strategic objective to improve managed care" *Source* is translated for the "Project team" *Target* by the "Balanced scorecards" *Translator*.

5.4 Episode 3

Episode 3 (Figure 5) included the first pilot phase and involved the launch of the rudimentary EHRS application to ten medical doctors who hold influential positions within their respective specialist communities. Feedback was collected mainly through one-on-one feedback sessions that were conducted with some of the doctors. These sessions included the doctor, a senior business analyst and a system developer from the project team.

<Figure 5 should be positioned approximately here>

There are new actors compared with Episode 2 ("Feedback session", "10 doctors"), one focal actor is no longer shown ("Idea for EHRS application") and some still have the same name but might be radically different, such as the "Systems Specification" which is an information document which might be seen as a "mutable mobile". The rudimentary EHRS application was updated by the project team based on the feedback received from the doctors in the first pilot phase, as well as requirements elicited from business and IT stakeholders from within the organisation. All the requirements were documented in a new version of the Systems Specification document.

5.5 Episode 4

An important occurrence of Episode 4 was the second pilot phase, which entailed the launch of the updated EHRS application developed in Episode 3 to 100 doctors. Feedback from the second pilot phase was collected from the participants The EHRS application was updated by the project team based on the feedback from the doctors and after this the application was ready to be released to the public.

<Figure 6 should be positioned approximately here>

During the first pilot phase, four major issues emerged that challenged the feasibility of the idea and threatened the application's adoption by doctors:

- Time is very important to general practitioners, the main target user group, and this posed a challenge as doctors will only use the application if its usefulness appears to outweigh the time costs. Whereas currently doctors have to contact the organisation's call centre to request patient records, the EHRS application allows

access to patient records on the tablet computer. It was predicted that the EHRS application would demand more time from doctors initially than the call centre equivalent, but would lead to a greater amount of time saved in the long term. Records obtained through the call centre might be incomplete or not updated, often requiring more than one request and taking up time. The "Challenge of time demands" *Source* is translated for the "100 doctors" *Target* by the "Perceived usefulness in relation to time" *Translator*. Note that the notion of "perceived usefulness" is borrowed from TAM.

- Many, particularly older doctors, are not used to working with mobile applications and this raised a second challenge as his or her perception of how easy the tablet computer was to use depends on skill and prior experience. The "Challenge of technical skill" *Source* is translated for the "100 doctors" *Target* by the "Perceived ease of use" *Translator*. The notion of "perceived ease of use" is also borrowed from TAM.
- A third challenge was the cost of the tablet computer on which the application was to run. Doctors were concerned that they would not get value for money as they were unsure about the EHRS application's usefulness. This can also be seen in the ANT model for this episode.
- The fourth challenge is related to patients' privacy and confidentiality in terms of their medical information. Legislation dictates that a patient must give consent to the organisation before access to his medical records can be granted to any doctor. Doctors could perceive these legislative requirements as barriers to their autonomy and effectiveness. This challenge is also made visible in the ANT model.

The strategies used by the organisation to address each challenge can also be seen in Figure 6:

- To counter the time demands, the marketing department emphasized that there would be long term time savings and the tablet computer and EHRS application would make doctors more productive.
- To mitigate the challenge of technical skill levels, the IT department designed the application user interface according to internationally accepted design standards. The "Design standards" actor is a black box, denoted by the cube-shaped graphic, since the standard is maintained by a third party. The organisation using it is only concerned with its inputs and outputs.
- The cost of the tablet computer was addressed by the organisation's change management team's decision to introduce incentives. Doctors could buy the device at a subsidised price and received "rewards" for actively using the EHRS application.
- Patients' privacy required that consent was given to the organisation before allowing doctors to access their medical information. The organisation's legal and IT departments jointly designed a sophisticated but elegant process whereby patients' consent could be collected via the EHRS application itself. This process was expected to significantly reduce the legislative barrier perceived by doctors.

To deploy these strategies the project team had to direct and coordinate several areas within the organisation, including marketing, change management, legal and IT departments. Specifically, the "Project team" Source is translated for the "Marketing department", "Change management team", "Legal department" and "IT department" Targets by the "Project engagement" Translator. The "Project team" actor can be classified as acting at a distance with respect to the doctors who are located across the country and have very little direct contact with the project team. This is denoted by the lightning bolt symbol above the label. The "Strategic objective to improve managed care" actor is also identified as acting at a distance, as denoted by the lightning bolt symbol of the label.

5.6 Episode 5

In Episode 5, the EHRS application version 1 from Episode 4 was launched to the public, and doctors are using it to access patients' electronic healthcare records. Figure 7 shows the model from Episode 5 as before.

<Figure 7 should be positioned approximately here>

- The corporate image of the organisation that developed the EHRS application (or what people think about the organisation) might be positively affected by the EHRS application. If the EHRS application leads to more patient visits for doctors, doctors might form a positive attitude towards the organisation's corporate image. Specifically, the "Corporate image" *Source* is translated for the "Doctors using the application" *Target* by the "Experience of more patient visits" *Translator*. Note that the "Corporate image" actor was included only for exemplary reasons, as indicated by the cloud-shaped graphic.

- If the EHRS application leads to doctors giving better care to patients, patients might form a positive sentiment towards the organisation's corporate image. Hence, the "Corporate image" *Source* is translated for the "Patients" *Target* by the "Experience of better care" *Translator*.
- Prospective customers might start to see the organisation as the medical insurance provider of choice, due to the EHRS application. The prospective customers and their perception about the organisation are thus actors. Specifically, the "Corporate image" *Source* is translated for the "Prospective customers" *Target* by the "Perception as medical insurance provider of choice" *Translator*. Note that these two actors were included only for exemplary reasons, as indicated by the cloud-shaped graphic.
- Market competitors might start to see the organisation as the leaders in the medical insurance market. Specifically, the "Corporate image" *Source* is translated for the "Competitors" *Target* by the "Perception as market leaders" *Translator*. Note these actors are shown to have been included for exemplary reasons only.
- Finally, the strategic objective to improve managed care is fulfilled by the successful adoption and use of the EHRS application. The organisation collects statistics on the usage of the application to measure the adoption. Finally, the "EHRS application version 1" *Source* is translated for the "Strategic objective to improve managed care" *Target* by the "Usage statistics" *Translator*.

6 Evaluation

6.1 Strengths

Possibly the most important strength is that ANT-gs remains true to ANT and hence encourages the researcher also to remain true to ANT. This addresses to some extent the problem of researchers using ANT superficially, selectively, or misusing concepts. Since ANT-gs is merely a way of expressing ANT's semantics, it inherits the strengths of ANT itself, such as its inclusion of heterogeneous actors in an analysis.

A weakness of ANT that is often noted is vague boundaries, This is addressed, to some extent, by the ANT-gs notations that denote the primary research foci, actors acting at a distance, black boxes and exemplary actors. The presence or absence of actors in an ANT model is obvious and a need to reduce the number when they become unmanageable also becomes clear. The modeller needs to use a level of detail that is fit for purpose. Consider for example the "Strategic objective to improve managed care" and "Business stakeholders" actors in Episode 2 that are related to each other through a string of other actors. The chain of translations can be reduced to or expanded as required. The use of black boxes assists with this as does the main research focus pragmatic extension as it indicates why certain actors were included and others not.

ANT-gs provides modellers with a tool to visually structure large amounts of data that is more concise, clear and succinct than its textual equivalent. An important outcome is that the ANT model exposes relationships between actors that would appear counterintuitive or are indirect. For example, in Episode 4 an indirect relationship exists between "Strategic objective to improve managed care" and "EHRS application version 1" via a chain of translations and through a multitude of other actors. A second important outcome is that the clarity allows the modeller and other readers to see whether there has been a tendency to over emphasize human or non-human actors. In fact one of the reviewers of this paper pointed out that the models in the example are overly human-centric and that the tablet computer, money or capital could or should be included. This clearly illustrates the value of having different models prepared by different people. Differing perspectives including viewpoints, assumptions, opinions or any other cognitive construct can be associated with a particular encounter or episode within the encounter-episode framework proposed.

ANT-gs graphically depicts the distribution of work in an actor-network. For example, without a model one could easily attribute the work behind the development of the rudimentary EHRS application in Episode 2 to the project team. However, by including other actors in the model, it is clear that work is also done by management and the organisational strategy; any one of these might impact the development of the application in a material way.

Following the actor over time and across a multitude of ANT models is an important means of analysis. For example, the EHRS application was introduced in Episode 1, developed into a rudimentary application in Episode

2, updated in Episode 3, and the first public version of the application, based on the feedback from the second pilot study, was launched in Episode 4. The public usage of the EHRS application was tracked in Episode 5.

Finally, there are diagnostic possibilities; if actors at a distance are considered to only be able to be translated by other actors via mutable or immutable mobiles the symbol that shows which actors are at a distance is valuable.

6.2 Weaknesses and suggested improvements

Just as the graphical syntax inherits the strengths of ANT, so too does it inherit its weaknesses. The graphical syntax is primarily descriptive but this is consistent with the goals of ANT. Mitev " (2009: 19) says that "the description is the explanation" and that "causality is in contradiction with ANT. Nevertheless, as noted previously ANT-gs assists with structuring data and analysis. The explicit recording of translations is generally an idiosyncratic interpretation of a given phenomenon. Analysis cannot follow a fixed process; explanative and predictive capacity depends on the researcher's own insight.

Due to limited space, an ANT model can often not include all the information that is necessary to sufficiently explain a relationship. One way to mitigate this weakness is to include supplementary annotations and notes that could serve to explain a particular relationship in more detail, or record the modeller's thoughts around a particular element in the model. In addition, an explicit goal statement in the information box that contains the model identifier would contribute towards making ANT's vague boundaries more solid. An explicit goal statement would also clarify other choices.

In ANT-gs a Translator indicates a unidirectional relationship between a particular Source and a Target. Translation is in essence, however, always bidirectional, the Source becoming the Target in turn. This particular weakness is in many respects also a strength. Indicating both directions in a model might be redundant to the modeller's particular analytical goals and including bidirectional translations as a rule clutters the model. For example, in the context of understanding how the EHRS application was developed from the perspective of the organisation, it makes sense to see how the feedback from the ten healthcare professionals in the first pilot phase was translated for the project team who had to develop the application in Episode 3 (a unidirectional relationship from healthcare professional to project team). It is arguably less useful to see how the project team was translated for the healthcare professionals, since this shifts the perspective away from the organisation.

The graphical syntax does not denote actors that reoccur in multiple models. For example, the "Strategic objective to improve managed care" actor reoccurs in all five episodes. This in itself indicates that the particular actor is significant in some way, yet this significance is not highlighted graphically in any way. A way to denote actors that reoccur from previous models would enable the modeller and reader to clearly keep track of the reoccurring actors, and would aid in tracing trajectories. This could most easily be done if a computer-based modelling tool was developed that facilitates effective and efficient modelling. For example, the tool could provide a library of previously defined actors that the modeller could use in subsequent modelling. This systematic identification would ensure that actors are kept consistent across models and automatically create links between models that contain the same actor instances. Actors can then be tracked across any number of models. A computer-based modelling tool could also automatically check the semantic and syntactical correctness of models, producing better quality models that conform to formal standards. A full consideration of the implication of such a computer-based modelling tool is beyond the scope of this research study.

The graphical syntax does not make provision for a Translator to be directly related to another Translator in the same model. For example, should a modeller wish to explore the relationship between the "Perceived value for money" actor and the "Perceived usefulness in relation to time" actor in Episode 4, a new model needs to be created that frames these two Translators in terms of a Source and a Target respectively. A new Translator will be introduced that connects these two actors. A new model is therefore required to explore the relationships between any two Translators in an existing model.

7 Conclusion

The graphical syntax is based on a full set of ANT concepts and can be seen as new knowledge as it expresses some concepts in a different way, but it is not an alternative for ANT, it is an alternative format for expressing ANT. The syntax highlights translation, black boxes and actors at a distance and is believed to be unique in this respect. This makes it particularly useful as an educational tool, as examples illustrating key ANT concepts and using the notation can be created, the provision of the notation highlights the importance of the concepts, and students' work can be evaluated by looking specifically at how the concepts are used.

The visualisation of the actor-network provided by ANT-gs is an abstraction of the network and as such it provides a relatively simple representation while at the same time it emphasises aspects that are considered relevant. In this particular case it makes key ANT concepts explicit and this makes ANT easier to understand. This is expected to address the issue of superficial understanding of ANT and selective use of its constructs; it makes the boundaries immediately visible. Thus we propose that ANT-gs will be useful both by IS researchers and as an educational tool but future research is required to demonstrate both these practical implications. The development of a computer-based modelling tool was proposed earlier to facilitate effective and efficient modelling. This would be Design Science Research for future attention.

The evaluation of the artefact was based on the graphical syntax's application to an example derived from an empirical case study but only limited reference is made to the empirical data and the original case study. The strict confidentiality agreement between the researcher and the research subjects presented a challenge. Honouring this agreement has meant that certain information had to be kept confidential and entities had to be kept anonymous. This severely limited the actors that could be included in the analysis.

As noted earlier, ANT is difficult to handle well and prone to being used in a way that does not truly reflect the underlying philosophy. Research including analysis cannot, however, be automated and ANT-gs should not be seen as a crutch or even a tool that can make decisions on behalf of the researcher. It simply helps the researcher structure data, highlights translations and makes the chain of relationships visible. Many challenges identified in the literature review, such as what actors to include and where the boundaries of the network are, remain a matter of researcher's judgement.

An interesting aspect of actor-networks started to visibly emerge in the ANT models. Every actor-network seemed to possess a degree of equilibrium as every actor in any given actor-network is always a Source for some actor and a Target for some other actor. These form a chain of translation and a connection between multiple actors results. This pattern replicates throughout the entire actor-network to render one long chain of translation. Furthermore, this chain is circular since there are never any "external" actors in a model that are only Sources or only Targets. When viewed from the perspective of an entire actor-network, the circular nature of this chain of translation conveys a sense of equilibrium, a sense that the actor-network is stable. If any actor is removed or another is introduced to this actor-network, the entire network configuration will change to maintain the equilibrium. Since this equilibrium implies that all actors (for the purposes of a particular analysis) are deliberately included in any given stable actor-network as they are deemed necessary, it gives the modeller a mechanism with which to explore the more subtle influences that affect actors (both human and non-human). It gives the modeller an opportunity to listen to the "other side of the story" by tracing the actors that are often hidden or taken-for-granted, but that still exercise influence over other actors (often unknowingly). These concealed actors are often critical to information systems research, development and implementation efforts, and to take cognisance of them might make a crucial difference to the outcome. Being able to visibly expose these normally concealed actors undoubtedly increased the utility of ANT for information systems research for the author of this study.

The last aspect upon which to reflect relates to this study's overall contribution. The main question that this study attempts to answer is whether the utility of ANT can be increased by the proposed graphical syntax. The evaluation of ANT-gs provides an argument for its use but a more reliable argument would be made by collating and analysing feedback from independent modellers who actually use the graphical syntax. This is an important part of future research.

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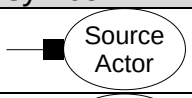
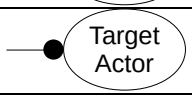
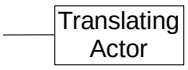
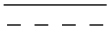
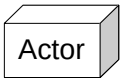
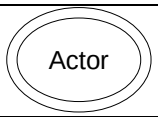
Concept		Definition	Graphic symbol
Source	Core concept	Any entity that is included in an ANT analysis.	
Target	Core concept	Any entity that is included in an ANT analysis.	
Translator	Core concept	Any entity that is included in an ANT analysis that translates between a *Source* and a *Target*.	
Relationships	Core concept	Indicates the relationship between a *Source*, *Translator* and *Target*.	
Black box	Complex ANT concept	A *black box* is a well-established network of allied actors that is so strong that the assemblage is *counted* as only one actor	
Action at a distance	Complex ANT concept	Action at a distance identifies an actor that can act upon another that is far away from itself (physically or conceptually)	
Main research foci	Pragmatic extension	Actors that directly have a bearing on the primary purpose of the research	
Exemplary instances	Pragmatic extension	Actors that do not explicitly form part of the empirical dataset, but which she believes might nevertheless form part of the actor-network	

Table 1: ANT-gs (ANT graphical syntax)

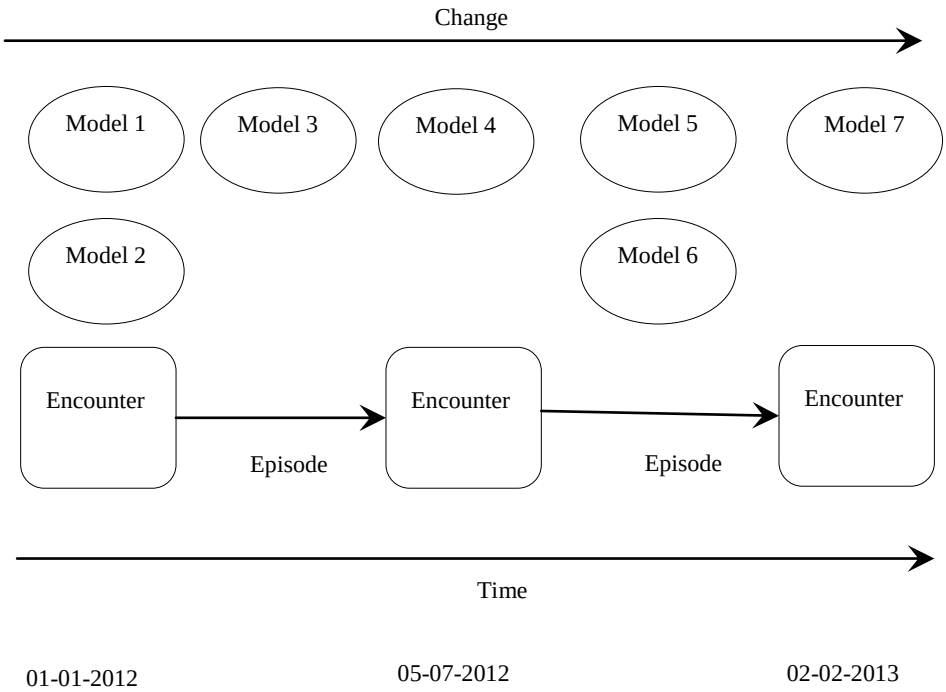


Figure 1: Encounter-episode framework for ANT analysis

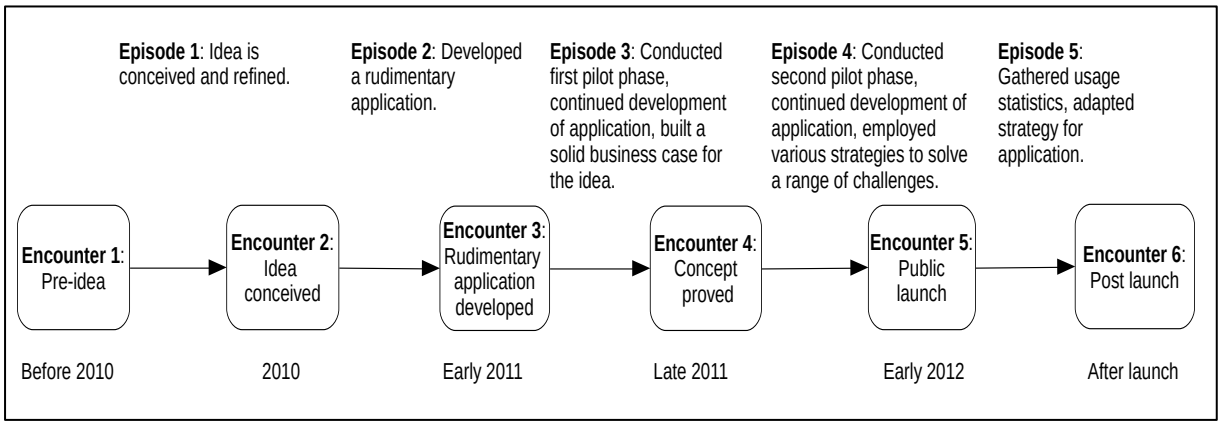


Figure 2: Case study encounter-episode framework

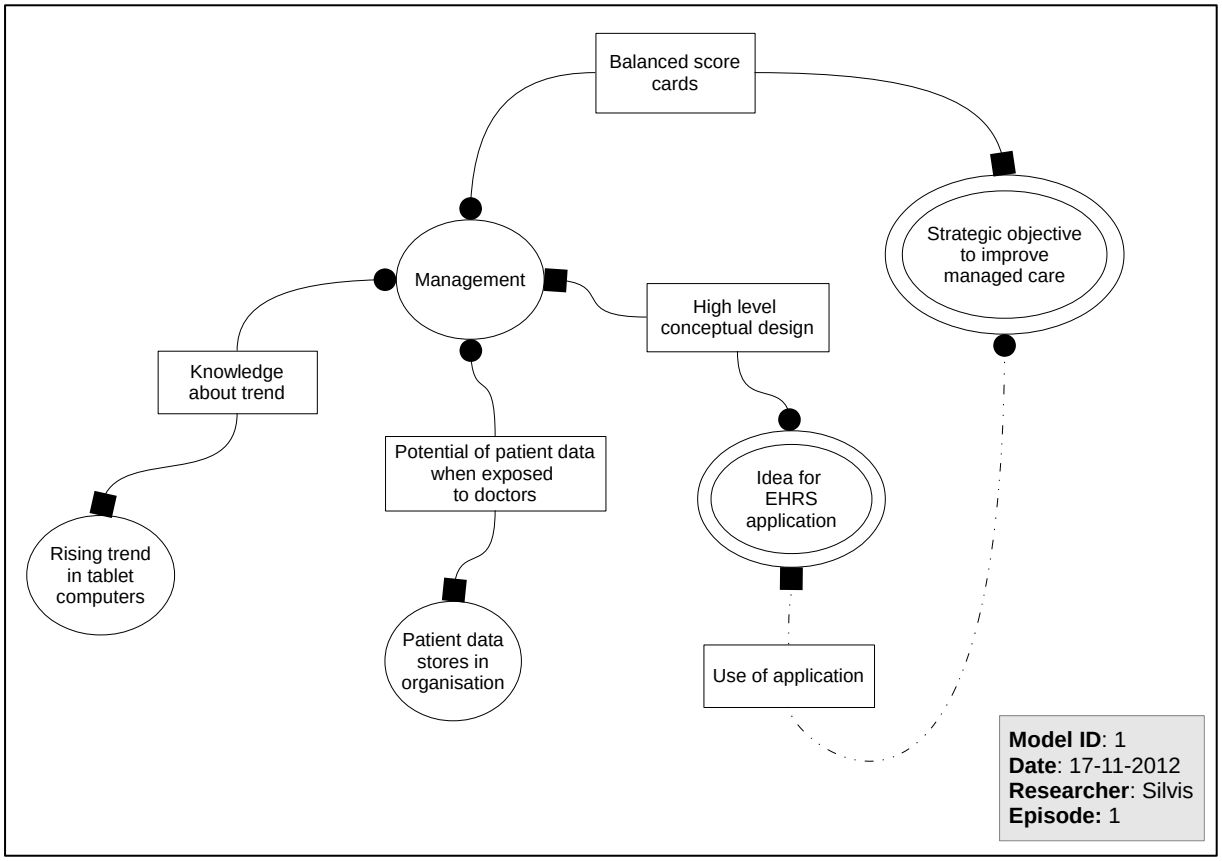


Figure 3: Graphical ANT model for Episode 1

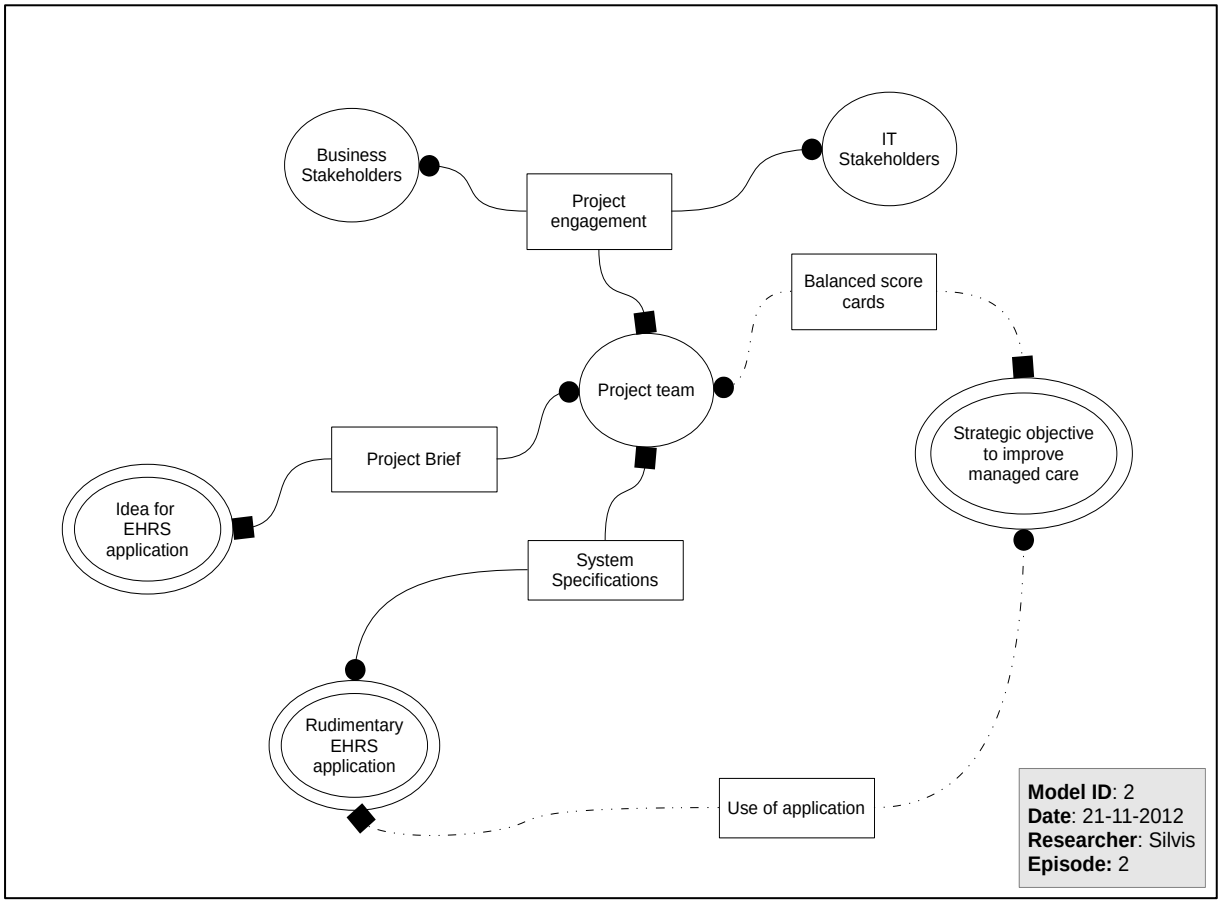


Figure 4: Graphical ANT model for Episode 2

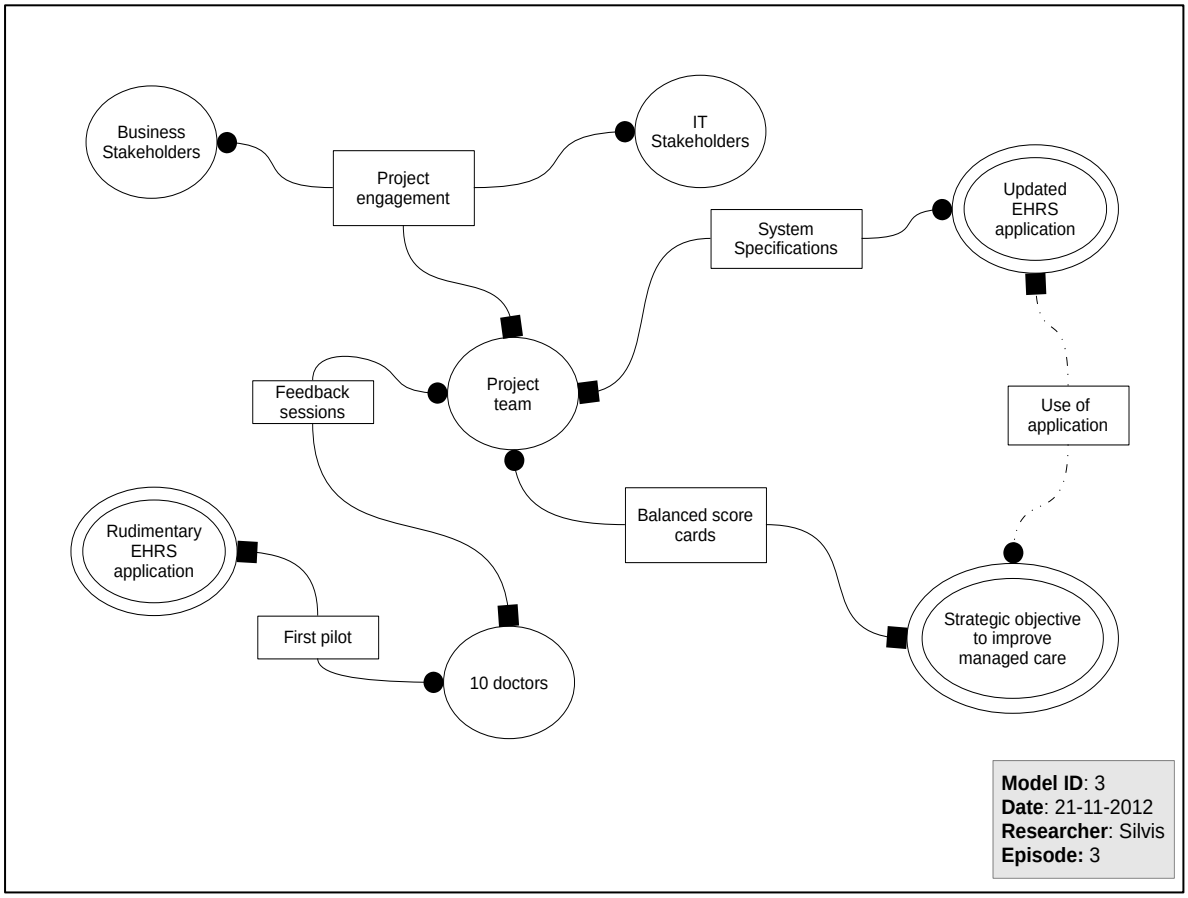


Figure 5: Graphical ANT model for Episode 3

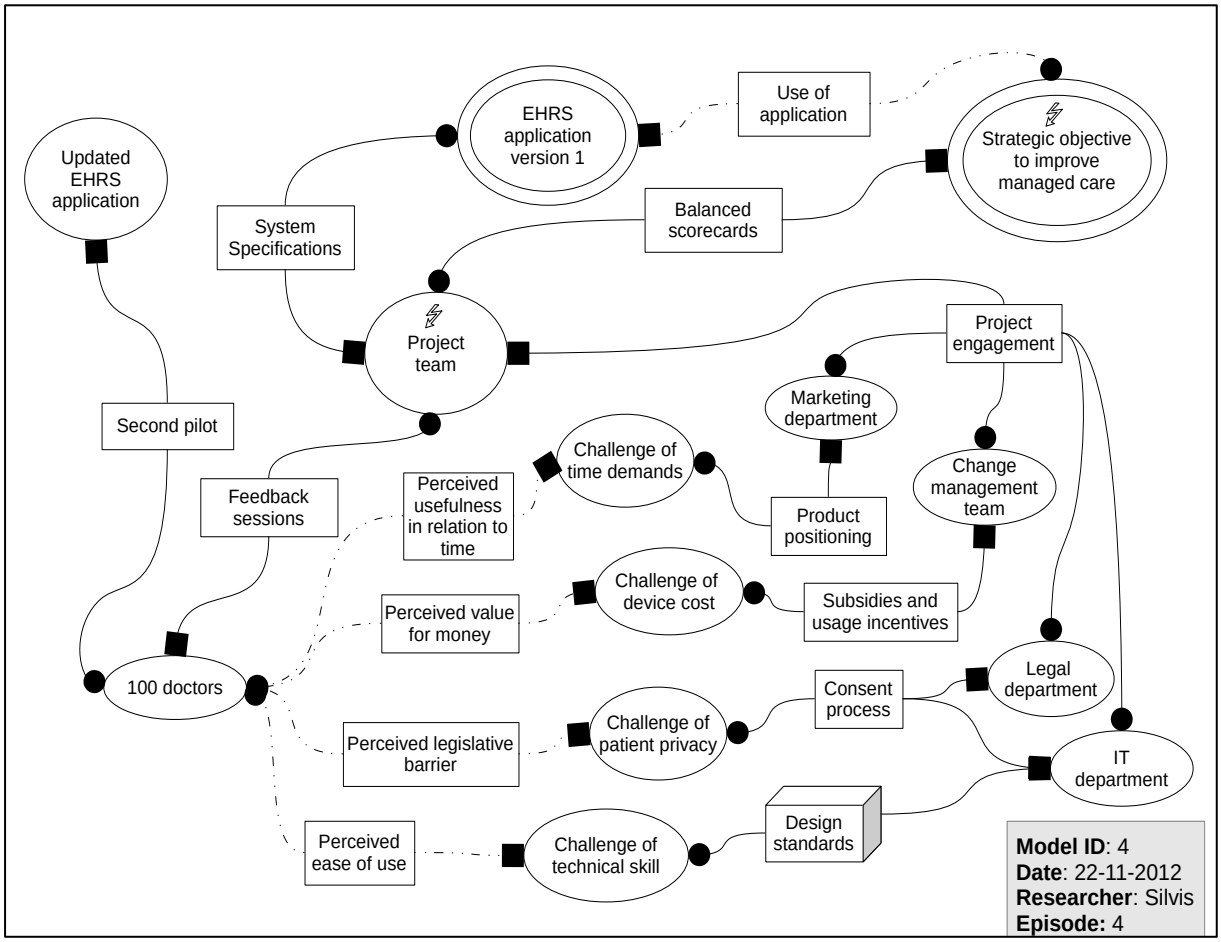


Figure 6: Graphical ANT model for Episode 4

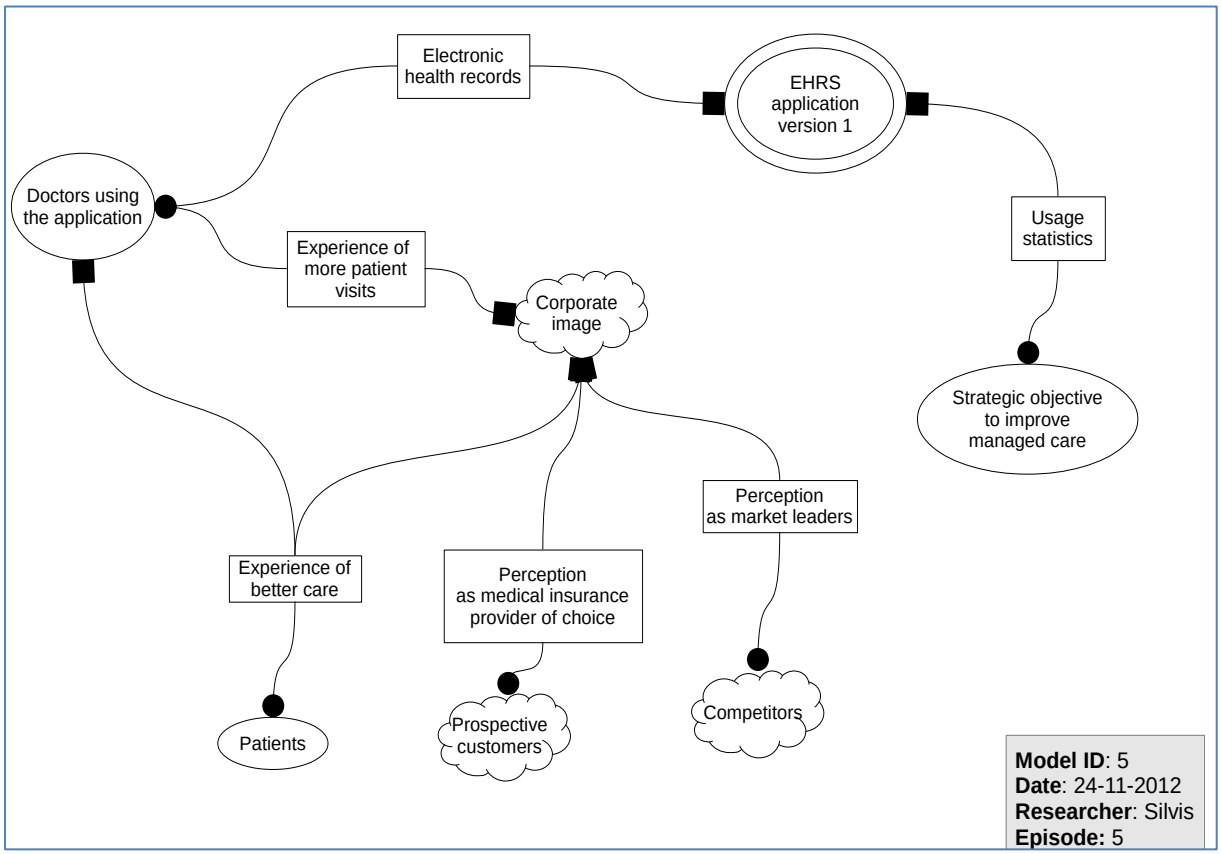


Figure 7: Graphical ANT model for Episode 5