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MODELLING TRUST RELATIONSHIPS IN A HEALTHCARE NETWORK: EXPERIENCES WITH THE TCD FRAMEWORK

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Abstract

We report on the application of the Trust-Confidence-Distrust (TCD) framework of Gans et al. (2003) to the task of modeling trust relationships in a large metropolitan health service. We investigated the relationships between an acute stroke ward and a specialist stroke rehabilitation ward by examining the patient handover process that links each ward's activities. The case study provided evidence that the model works in real-life settings. In addition, we gained valuable insights in the applicability of the framework in a formal organizational, rather than more loosely connected network setting.

1   INTRODUCTION

In this paper, we describe the application of the Trust-Confidence-Distrust (TCD) framework defined by Gans et al. (2003) to the investigation of trust relationships between two hospital wards engaged in a patient handover process. This case study represents one of the first applications of the TCD framework to a real-life situation with real-life data. Given that the two wards were part of a large metropolitan health service which is more similar to an organization than to the social network described by Gans et al. (2003), we were particularly interested to see which aspects of the framework were still applicable, and which ones were not.

This paper is structured as follows: In section 2, we briefly describe the TCD framework for analyzing trust relationships. Section 3 gives an overview of the case study we performed, including the setting, and the data capture process. Section 4 describes our analysis of the trust relationships using the TCD framework. In section 5, we evaluate the applicability of the TCD framework to the context of our case study and conclude the paper.

2   THE TCD FRAMEWORK

The TCD framework was developed for application in a social network, which Gulati (1998) defines as "a set of nodes (e.g., persons, organizations) linked by a set of social relationships (e.g., friendship, transfer of funds, overlapping membership) of a specified type". Weyer (2000) expands on this idea by defining a social network as an autonomous form of coordination of interactions whose essence is the trusting cooperation of autonomous, but interdependent agents who cooperate for a limited time, considering their partners' interests, because they can thus fulfil their individual goals better than through non-coordinated activities. The "agents" in this definition can be organizations or people, or people representing, or working for organizations. According to Powell (1990), networks rely on reciprocal patterns of communication and exchange, and reciprocity and complementary are essential for the success of a network: "In essence, the parties to a network agree to forego the right to pursue their own

interest at the expense of others". Networks are well suited for situations where there is "a need for efficient, reliable information", as Powell (1990) states.

In contrast to those of a network, Powell (1990) lists stability, reliability, and accountability as the main strengths of an organization (also called a hierarchy). In an organization, management defines work roles and administrative procedures. Work is often highly specialized and therefore interdependent. As Powell (1990) states, "relationships matter and previous interactions shape current ones, but the patterns and context of intra-organizational exchange are most strongly shaped by one's position within the formal hierarchical structure of authority". In an organization, there is less freedom of choice for the individual agents, as they are constrained by organizational rules and policies. Given that our case study took place in an organizational, rather than a network, environment (cf. section 3), we were particularly interested to see whether the TCD framework was applicable to our setting.
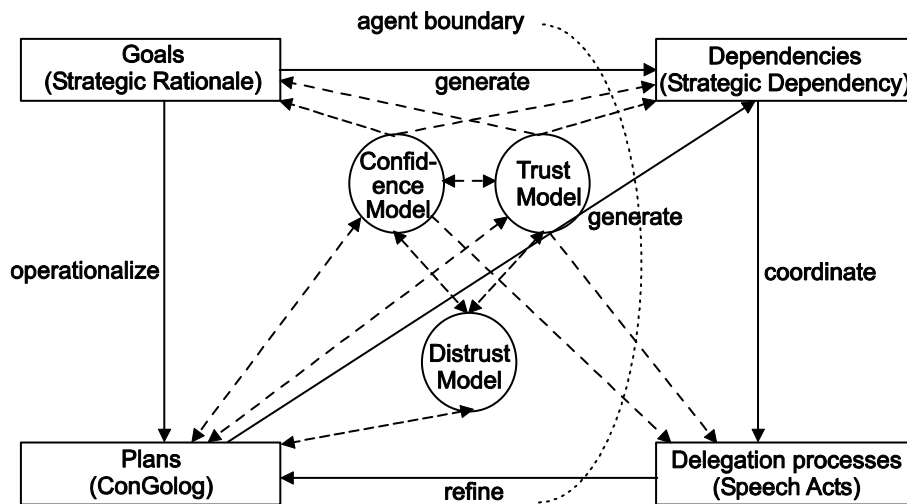

Figure 1: Interplay between modelling perspectives

In our investigation of trust, confidence, and distrust, we stay in accordance with the definitions given by Gans et al. (2003): We follow the definition of Mayer et al. (1995) of *trust* as "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party". Trust thus occurs between two agents, the trustor and the trustee, and has an element of risk, since the trustor cannot ensure that the trustee will perform the action. In social networks, trust needs to be distinguished from what Gans et al. (2003) call *confidence*, and Luhmann (1988) calls system trust, in the network as a whole. This is because a network's mesh of dependencies is not completely visible to, let alone manageable by, the trustor. Thus, participation in a social network results in a double vulnerability: to identifiable opportunists, and to the generally incomprehensible mesh of dependencies between all the network partners. Participation in such a network therefore requires confidence in the network (e.g. its rules and stability) as a whole. The third relevant concept described by Gans et al. (2003) is *distrust*, which the authors distinguish from lack of trust, cf. also Lewicki et al. (1998). For example, a dissatisfied network member can cultivate, but hide her distrust while still exhibiting trustful behaviour. This means that the agent continues as a network member, postponing her decision for voicing dissatisfaction or exiting the network, but starts to collect information (which can be costly and time-consuming), by, for example, monitoring other network members' actions. The agent then typically interprets this information in a subjective way that is strongly influenced by her distrust. According to Luhmann (1988), distrust therefore has an inherent tendency to become stronger.

Gans et al. (2003) call the model describing the interplay of trust, confidence, and distrust, and its effects on the relationships within the network the *TCD framework*. Figure 1 shows how the TCD framework can be formalized as a multi-perspective framework. The left side of Figure 1 depicts the

intra-agent modelling aspects of the framework, that is, an agent's goals, which are represented by i* strategic rationale models described by Yu (1995), and plans. Plans are based on the strategic rationale diagrams together with pre- and post-conditions using the ConGolog formalism. ConGolog, described in De Giacomo et al. (2000) is a high-level programming language which is suitable for describing and representing processes. The right hand side of Figure 1 shows the inter-agent aspects, namely, the strategic dependencies between agents, represented as Yu's (1995) i* strategic dependency diagrams, and the implementation of these dependencies in delegation processes formalized as Speech Act diagrams (see Schäl (1996)). We prefer the i* formalism (strategic rationale (SR) and strategic dependency (SD) models) to other languages like UML, ER diagrams, or Petri nets, because it is explicitly designed to cope with strategic goals and agents' intentions, and furthermore is equipped with formal semantics. Thus, as a main feature, it allows not only to reason about the "how" but also about the "why" of different alternatives. The solid lines in Figure 1 indicate the nature of the interrelationships between these different perspectives. For example, strategic dependencies shape and lead to delegation patterns, and the latter are evaluated partially with respect to the former. Conversely, strategic goals lead to operational plans, which then potentially generate strategic dependencies on other agents. Trust, confidence, and distrust, depicted in the middle part of the figure, influence the four main components of the framework, as well as each other (represented as broken lines). For example, the level of trust between agents will influence one agent's propensity to become dependent on the other, say for specific tasks or resources, and the level of distrust can lead to the addition of monitoring tasks to the operational plans. These monitoring tasks may increase or decrease the level of distrust felt by the agent.

Gans et al.'s method for modelling trust is different from Yu and Liu (2001)'s approach to describe trust relationships in i*. They propose a purely qualitative approach using softgoals with corresponding contributions. Also, Castelfranchi and Falcone (2001) formalize aspects of the mental state underlying trust using a multi-modal logic.

3   THE CASE STUDY

The goal of this case study was to investigate trust relationships between wards along a clinical pathway with the aid of the TCD framework described in section 2. The study was commissioned by Southern Health, a large metropolitan health service in South Eastern Melbourne, Victoria, Australia. Southern Health provides public hospital services, aged inpatient, community and home care services, and inpatient and community mental health services across an area in excess of 2,800 square kilometres with a population of over 700,000 people (see http://www.southernhealth.org.au/). Southern Health services are provided through five major hospitals and nine community health services centres. Two clinical services directors together with operations directors at each location manage the different services. Each director reports to the chief executive, who reports in turn to the hospital board. Thus, Southern Health can be classified as a (distributed) organization rather than a network of independent partners (see section 2). Our study involved the investigation of stroke patient transfers between an acute ward and a rehabilitation ward located on different sites. A mix of medical and allied health staff are involved in the transfers. These people report to different program managers, although ultimately the management responsibility for both the acute and sub-acute patients lies with the head of the Neurology program.

Stroke is the third highest cause of death, and the leading cause of chronic disability in adults in Australia (see Pollack and Disler (2002)). In our investigation we focused on the handover process of stroke patients from the acute ward (AW) to a specialized rehabilitation unit (RW). This unit is the major stroke rehabilitation facility. Stroke patient rehabilitation is a scarce resource needing a coordinated, multi-disciplinary team approach (Pollack and Disler (2002) give an overview of the different roles and stakeholders in stroke patient rehabilitation), so there is a significant amount of cooperation required within a ward, and between wards such as AW and RW. In our case study, AW and RW are physically located in two different hospitals, separated by a 30-minute drive. Patel et al. (2000) claim that, given that face-to-face communication is an important part of developing and maintaining a shared understanding of team goals and maintaining trust, geographical separation is a potential obsta-

cle to implementing good team processes. Consequently, we were interested in finding out whether the two wards managed to see each other as a team working together towards the shared goal of caring for the patient, or whether there were significant misconceptions about the other ward's work. As Suchman (1995) notes, "work has a tendency to disappear at a distance, such that the further removed we are from the work of others, the more simplified, often stereotyped, our view of their work becomes".
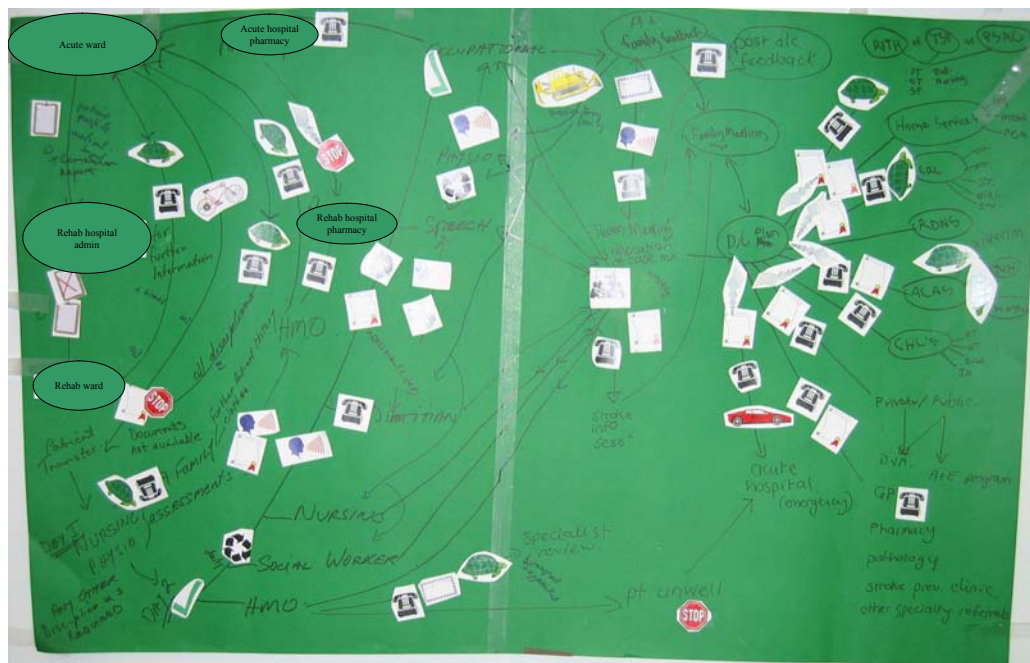

Figure 2: Informal Process Diagram

Because our focus was on the trust, confidence, and distrust relationships between wards AW and RW, we wanted to capture the stakeholders' *perceptions* of the handover process. In this context, the stakeholders are the wards; specifically, the health professionals in the acute ward who prepare patients for discharge to the sub-acute area and those in the rehabilitation ward who carry out the patient admission procedures. Stakeholder perceptions are an important indicator of the performance of the transfer processes; in particular, the perceptions in one ward can identify failures in the process not evident to the other ward. We followed the method described by Kethers (2002) to obtain the process information for the "a priori goal and capability analysis" postulated by Gans et al. (2003). The main advantage of this method is the strong semantic model underlying the captured data, which allows formal mapping of the data into different perspectives on the investigated process. After an initial meeting with the Nursing Director and members of the Allied Health Rehabilitation and Aged Services Program, we conducted two focus group meetings, each with a team from one ward, to capture that ward's view[1] of the interactions within the ward and with external units, including the other ward. In these meetings, the group developed informal process diagrams (see Figure 2 for an example) that focus on the interactions and information flows within and between the two wards. Information flows between agents are captured as arrows between ovals representing sender and receiver of the information. Graphical symbols are used to represent the media for information flows (for example, phone, formal document, or meeting), and the recipient's perception of the quality of the information flow (e.g., a tortoise for "too slow", or a stop sign for "does not occur at all"). A more detailed description of the different graphical symbols is given by Kethers (2002). During one of the focus group meetings, we became aware of the role of the Rehabilitation Liaison Officer (RLO) who acts as an interface between the wards, so we conducted an additional interview with her.

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[1] Note that the ward's view expressed in the process diagrams is not a given, but evolves as the result of much discussion during the focus group meeting, as different staff members discuss their different views of what is happening.

4 APPLICATION OF THE TCD FRAMEWORK

Based on the informal process diagrams, meeting notes, and additional information collected, we developed the different perspectives on the process shown in Figure 1. As a first step, we develop two *strategic dependency (SD)* models (see Yu (1995)), one for each ward's perspective concerning the patient transfer process. In a second step we refine our models to *strategic rationale (SR)* models in order to regard the actors' internal actions as well as their interactions. To identify trust, confidence, and distrust issues in a third step, we then analyze the different diagrams by regarding the different stakeholders' (the two wards' and the RLO's) perceptions of the process, identifying conflicting views of what is really happening in the scenario, tracking the effects on trust relationships between the wards, and recognizing the effects of these relationships on the process.

The SD model (a detailed description is given in Yu (1995)) describes the network of relationships among agents (nodes) by specifying dependencies (links) between them. A dependency relationship enables the depender to do things that she would otherwise not be able to, but also makes her vulnerable if the dependee does not fulfil the dependencies. The model offers four dependency types: goal, task, resource, and softgoal dependencies, which differ according to the degree of freedom they leave for the dependee.
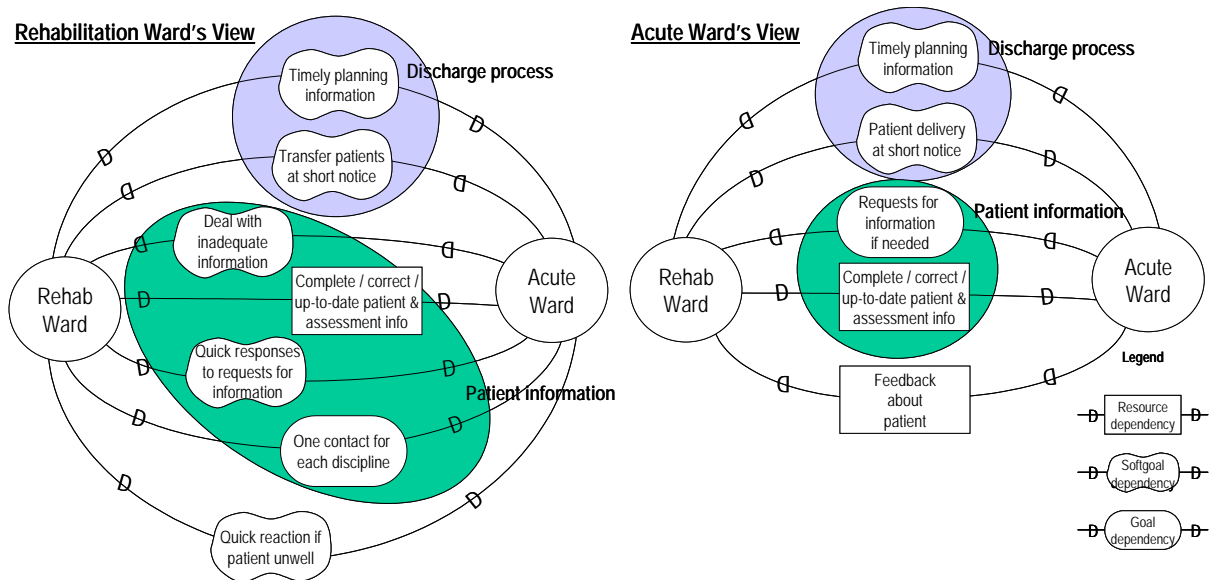

Figure 3: Strategic Dependency Diagrams

The SD models shown in Figure 3 are structured as follows: The circles show the two wards, the arcs show what one ward wants or needs from the other ward. The directions of the 'D's on the arcs show the direction of a dependency. For example, the lowermost arc in the left half of Figure 3 (RW's view) shows that RW depends on AW for a quick reaction if a patient is unwell. Rectangles represent a resource, such as a piece of information, for example "Feedback about patient" as shown in Figure 3 (AW's view). Boxes with rounded edges represent goals that can be measured, for example in Figure 3 (RW's view), the need expressed by RW for "one contact person for each discipline" at AW. The irregular shapes represent so-called "soft goals" – goals that are subjective and cannot be precisely measured, for example RW's requirement for a "quick reaction if patient unwell" from AW. In this case, does 'quick' mean 5 minutes or 2 hours?

The SD models show that each ward attributes different and sometimes very stereotyped goals and intentions to the other, even though the main goal for both wards should be (and is!) the welfare of the patient. As an example taken from Figure 3, for the patient transfer process, RW sees AW as trying to move patients out as fast as possible (RW's view, softgoal: "Transfer patients at short notice"), whereas AW sees RW as expecting patients to be handed over at very short notice (AW's view soft-

goal: "Patient delivery at short notice"); sometimes, we were told, in as little as three hours. Because the discharge documentation that has to accompany the patient has to be compiled by different staff members, by the pharmacy, etc., this extreme time pressure can lead to a lack of coordination in the collection of discharge documents. As a result, incomplete or outdated information can be transmitted from the acute to the rehabilitation ward (RW's view, resource: "Complete / correct / up-to-date patient & assessment info").
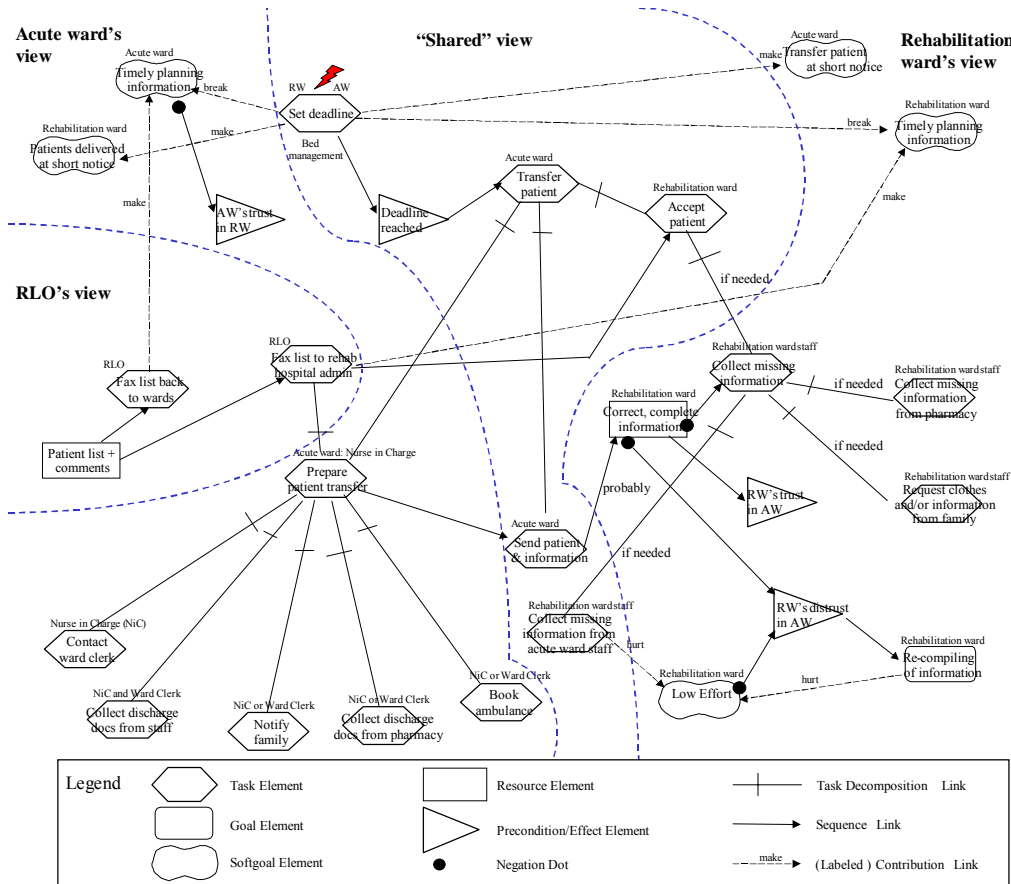

Figure 4: Combined extended SR model – patient transfer between wards

Based on the dependency diagrams, and the additional information obtained in the focus group meetings and interviews, we developed extended SR models[2] as described by Gans et al. (2003) for AW, RW, and the RLO. SR diagrams (see Yu (1995)) describe the intentional relationships that are internal to actors, so that they can be reasoned about. Nodes of the model represent goals, tasks, resources, and softgoals, respectively, while links represent either means-ends links, or task decomposition links. The original SR models contain only strategically relevant elements, hence, Gans et al. extended them for operational use. For example, in Figure 4, the task "Transfer patient" is decomposed into five subtasks which are timely ordered. Negation dots, e.g., at the resource "Correct, complete information", stand for a missing resource or the logical negation of a precondition, goal, or softgoal. Contribution links are labelled according to their effects on softgoals (make, break, help, hurt) and finally only if the "Deadline reached" precondition holds the "Transfer patient" task can be initiated.

Relevant excerpts from the three different views of the patient transfer process as held by AW, RW, and the RLO, respectively, are integrated into a combined SR model shown in Figure 4. Interestingly, as can be seen in Figure 4 and was stated by the RLO in the interview, AW should know in advance which patients will need to be handed over within the next few days, since a list of those patients is

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[2] We developed separate extended strategic rationale models for RW, AW, and RLO, which we used as basis for the combined trust models shown in Figure 4.

faxed to the wards. Thus, AW should be able to compile the discharge documentation with sufficient prior warning. In addition, the patients' complete medical record is sent, together with the discharge documents, to the rehabilitation hospital's administration, where it would be available to RW staff for a few days before admission. Also, given that the rehabilitation hospital administration receives the list of patients, RW does – at least in theory – have access to timely planning information, as well.

The conflicts which were identified on the strategic dependency and strategic rationale diagram level, of course, affect the trust relationships. First of all, the models reveal that there was little direct and positive interaction between AW and RW, and there were no trust-building or relationship-building activities planned into the process. Information flowed from AW to RW, but there was almost no information flowing back from RW to AW. In particular, although AW mentioned that they would like to hear about "their" patients' progress in the rehabilitation ward (see the "Feedback about patient" resource dependency in Figure 3), there is no communication of patient status information from RW to AW unless something untoward happens to the patient, when RW expects (and gets) a quick reaction from AW. This is not conducive to establishing trustful relationships between the wards. In contrast to this, the physical proximity of team members within each ward (including, in the case of AW, the location of the RLO in the same building) leads to good relationships, trust, and understanding, resulting in extremely good (ad-hoc) communication and cooperation.

A main source of distrust in the patient transfer process results from the accompanying patient information documents. There are conflicting ideas about who is actually responsible for ensuring that the patient information is complete (cf. Figure 3). RW staff members consider it their right to receive complete, correct, and up-to-date information; chasing up what is missing takes up a large amount of time. AW on the other hand holds the opinion that RW should be able to cope with the information they get, and that it is RW's responsibility to request additional information if it is required. This difference in expectations creates resentment and increases distrust on both sides. For RW, this distrust means that the information coming from AW is often not trusted, even when apparently correct patient information is provided. Instead, RW duplicates AW's work by compiling the information again. As another example RW sometimes considers some of the patients that AW sends them unsuitable. However, RW does not seem to discuss these cases with AW, and no mention was made of the RLO at all during the focus group meeting. Thus, the RLO was not "used" as effectively by RW as by AW, and RW's distrust in AW increases.

Confidence is a less important issue here, because the metropolitan health service is a stable organization with less choice for the agents involved, and more rules and constraints than the social networks described by Gans et al. (2003). However, due to dis-confidence, by which we mean dissatisfaction with these rules and constraints, agents sometimes circumvent those rules and processes that are seen as producing the wrong results. For example (not shown here due to space limitations), AW therapists sometimes disagree with the patient assessments made by a doctor and the RLO. The therapists feel that they know the patient better, due to their long-term observation, than a doctor could from a short visit, especially if the patient has a bad day. In these cases, the therapists often use the strong relationship they have with the RLO to voice their concerns and initiate a reassessment at short notice, which is not intended to happen in the clinical process.

5   EVALUATION AND CONCLUSION

In this evaluation of the applicability of the TCD modelling approach, we applied the framework in a more organizational setting than described by Gans et al. (2003). This means that there are more rules, constraints, and procedures than in a typical social network. This in turn leads to less freedom for the agents (individuals or wards) to change their work processes, for example by changing their delegation behaviour, according to their level of trust, confidence, or distrust in the other agents. In addition, the delegation processes were predetermined due to lack of alternatives, as well, so they did not provide many insights, either. From this it follows that we do not need to apply the more dynamic perspectives

from the TCD framework, namely plans and speech acts. In this case study, SD and extended SR diagrams are sufficient to extract information on the trust relationships between the wards.

The data capture method we employed focused on recording the different parties' perceptions of the patient handover process, which we later found very useful in understanding the trust and distrust relationships between the people involved. The information flow diagrams (Figure 2) indicated not just the different agents' activities, but also, for example, where information was perceived as being too late, or of too low quality. The SD and SR diagrams (Figure 3 and Figure 4) resulting from the initial process diagrams, together with our meeting notes, indicated (real and perceived) conflicting goals and expectations that were not met. These lead to manifestations of distrust, which in turn lead to re-work, e.g. recompilation of information by RW, and dis-confidence, e.g. when AW staff exploit their good relationship with the RLO to circumvent the defined patient assessment process. Thus, generally, we found the TCD framework to be applicable also in this more organizational setting.

We believe that understanding and evaluating trust relationships is crucial to supporting people's work processes. While many aspects of this problem are still open research questions, we hope that our case study has provided some validation of the TCD framework as one methodology for investigating trust relationships in both organizational and network settings.

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