Chapter 5

A business process study of human collaboration

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A collaboration process study with application of agent interaction and behaviour diagrams.
Abstract

The contemporary workplace is characterized by all kinds of (synchronous and asynchronous) human interactions both within and across organizations like meetings, discussions, consultations, conversations etc. Although such interactions are an essential part of a modern organization’s business activity, current business process research focuses mainly on the sequence of activities or tasks within a process (i.e. workflow processes), and not on human interactions. This chapter presents an application of an interaction-centric business process modelling language named TALL for human collaboration processes (HCPs). For the illustration and evaluation of the language, a case study of a real-life HCP is presented. The case study concerns the collaborative work of a Dutch municipality with regard to young persons who drop out from school. Shortcomings of existing graphical workflow-based process modelling languages in their ability to model HCPs are elicited. In the case study, the TALL modelling language is shown to address these shortcomings. The main strengths of the language are (1) the rich graphical representation of human interactions, their composition and routing relations, and their participants (i.e. agents) in an interaction diagram with a tree layout, and (2) the explicit recognition and specification of the local behaviours of the agents who are assigned to play the roles in a given interaction. Evaluation results are discussed. These results comprise practical insights for the municipality and theoretical insights that stem from the application of the language.
5.1. Introduction

Within organizations, many business processes are defined in workflows, such as order handling. A workflow definition specifies which tasks in a process need to be executed and in what order (van der Aalst, 1998). Such a specification is usually implemented in the form of a model in a software system (i.e. workflow application). In this way, the model can be applied to a multitude of similar cases (e.g. multiple orders follow the same process structure in an order handling process). Alternatively, the model can be implemented in a set of organizational protocols. In both cases, the goal of workflow modelling is to increase process efficiency. Conventional graphical workflow-based process modelling languages include, amongst others, BPMN (White, 2004), WS-BPEL (OASIS, 2007), Petri nets (Desel, 2005), UML activity diagrams (Dumas & ter Hofstede, 2001; Eshuis, 2002), EPCs (Scheer, Thomas, & Adam, 2005), and IDEF0 (Mayer, Painter, & deWitte, 1992). The essence of workflow-based languages is similar; they create structured, well-defined process models in which the collection of tasks or activities in the business process and their ordering constraints are formalized in a task execution sequence (Wang & Wang, 2006).

In the last decade, organizational structures with a more collaborative nature have emerged like the knowledge organization, horizontal organization, networked organization, and virtual organization. A common characteristic of these organizations is that human work is executed across internal (e.g. team, departmental) and external (e.g. organizational) boundaries (Stanford, 2005). In these organizations, humans cooperate through (informal) interactions. Cooperation is required to leverage each other’s expertise, experience and resources, and to reach individual and joint business goals. Typical examples of human interactions are meetings, consultations, discussions, or conversations. These interactions occur either synchronous (e.g. face-to-face) or asynchronous (e.g. via e-mail, telephone), and are seldom isolated since humans are usually engaged in several related and intermittent interactions to reach their goals. Since such interactions consume a lot of time in daily work practice, it is remarkable that business modelling tools, in particular process modelling languages, focus primarily on the specification of workflow processes. This research takes the position that human interactions should be managed as a business process. In literature, such processes are designated as knowledge-intensive processes, case management processes, complex and dynamic processes, ad-hoc and informal
processes etc. In this research, these processes are named human collaboration processes (HCPs). A HCP consists of a process structure of (several forms of) workplace interactions between humans who may each play different roles. In a HCP, there is a need for communication and collaboration between workers (Stohr & Zhao, 2001). Collaboration instead of task sequence determines the nature of the business activity (Harrison-Broninski, 2005).

The workflow-based languages have their main purpose to ‘program’ workflows as task sequences. Therefore, new graphical process modelling tools are required to represent HCPs. This research adopts an interaction-centric business process modelling language named TALL (Stuit & Szirbik, 2007; Stuit & Szirbik, 2009; Stuit & Wortmann, 2010) for the graphical representation of HCPs. The language is process-oriented but based on agent-oriented concepts and notations (i.e. interactions, behaviours, agents, and roles).

This chapter adopts a design science research approach because of its focus on problem solving through the application of novel artefacts, and the evaluation of their effectiveness and practical utility using empirical methods (Hevner, March, Park, & Ram, 2004). The empirical method used in this chapter is a case study of a real-life HCP at a Dutch municipality. The general methodology for design research as described by (Vaishnavi & Kuechler Jr., 2008) is followed.

In the Problem Awareness phase, the problems are identified. Based on an analysis of business process literature, modelling shortcomings of existing graphical workflow-based process modelling languages in their ability to represent HCPs are identified. These shortcomings form the theoretical problem. It is important to mention that these shortcomings do not mean that the workflow-based languages are flawed, only that they have their main utility in the specification of workflows. Section 5.2 presents the shortcomings, supported by related works. Next, Section 5.3 introduces the process diagrams in the TALL modelling language, which consist of interaction and behaviour diagrams, as a potential solution for the problem (Suggestion phase). Section 5.4 first introduces the case study and the organizational problem. Second, it presents an instantiation (read: application), an artefact of design science research (Hevner, March, Park, & Ram, 2004), of the TALL diagrams in the case study (Development phase). The goal is to make human interaction and behaviour in the HCP under study explicit via diagrams so that it becomes amenable to process analysis and improvement. Section 5.5 reports on the practical results (i.e. HCP improvement options) to show that the organizational problem has been addressed whereas Section 5.6 offers a
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discussion to show that the theoretical problem has been addressed (Evaluation phase). Finally, Section 5.7 gives conclusions together with future work (Conclusion phase).

5.2. Modelling Shortcomings

5.2.1. The interaction shortcoming

Existing graphical workflow-based process modelling languages have shortcomings in their ability to model a HCP’s interaction structure. In these languages, the graphical representation of interactions is either weak or not addressed at all. When interactions are modelled, they are modelled as part of the workflow – as mere ‘connected’ individual communicative activities that are mixed with the specification of non-communicative activities. In most cases, the roles or actors are differentiated using explicit boundaries or swimlanes (e.g. UML activity diagrams). In the case of a (peer-to-peer) interaction between two actors, message or flow arrows are used to connect the communicative activities in two adjacent swimlanes. In the case of an interaction between three or more actors, the communicative activity needs to be repeated on each swimlane and all activities need to be connected. This introduces unnecessary redundancy. In (De Backer, Snoeck, Monsieur, Lemahieu, & Dedene, 2009), the authors confirm that, when modelling collaboration, an increasing amount of “coordination overhead” is introduced as the number of participants increase. In the case of multiple interactions, with relations to each other, between different sets of actors, the model becomes difficult to read. Certain interactions may be part of other interactions, certain interactions may have to be completed before others, certain interactions may run in parallel with other interactions, or certain interactions may have to be repeated. Li, Hosking, and Grundy (2007) write that cobweb and labyrinth problems appear quickly when workflow-based models are used to create very complex diagrams or to model many cross-diagram relations. Workflow-based languages adopt box-and-line style diagrams, also called flowchart or graph-based notations. Hommes (2004) explains that these do not work well for large diagrams where users have to model interactions between a wide range of actors. Workflow-based languages are appropriate for modelling business processes that display complex activity or task flows (i.e. workflow processes) but are less appropriate for modelling business processes that involve the interaction of a multitude of actors (i.e. HCPs) (Barjis, 2007; De Backer, Snoeck, Monsieur, Lemahieu, & Dedene, 2009; Hommes, 2004; Melão & Pidd, 2000; Ryu &
Yücesan, 2007). With an increasing number of participants and interactions, it is difficult to read in a workflow-based process model where interaction takes place and between whom. Moreover, it is not represented how an interaction is related to other interactions as part of the HCP.

The advent of web service technology puts more emphasis on collaboration and has given rise to new modelling techniques. In choreography models (Pelz, 2003), interaction between business entities is modelled by describing the sending and receiving of messages in a way similar to interaction protocols (Odell, Van Dyke Parunak, & Bauer, 2001). First, choreography models are most useful when a high level of automation is the primary goal. In this situation, there need to be unambiguous models that specify in detail the nature of the collaboration between business partners (Weske, 2007). Thus, choreography models are implementation-driven instead of human-driven. The realistic capture of actual human work practice is less important. Second, a choreography model or interaction protocol does not reveal how an interaction is related to other interactions as part of a business process. This means that the complexity of a HCP’s interaction structure remains implicit. De Backer, Snoeck, Monsieur, Lemahieu, and Dedene (2009) confirm that, although useful for implementation and enactment, these message-oriented approaches are essentially binary (peer-to-peer) and not capable of modelling complex collaboration relations in a business process.

5.2.2. The local view shortcoming

In graphical workflow-based process modelling languages, the process is defined independently from the actors. The process model reflects the generic perspective of the process designer who aims to increase process standardization and efficiency. Such a model is referred to as a centralistic model since it is created from a central observer view. In a HCP, the knowledge, expertise, and experience of the humans are quite distinct and different. The humans have their own local (i.e. personal, individual) view or perception of the process. The disadvantage of a centralistic model is that local process views are lost at the choice of the process designer since they are squeezed into a single model. In other words, in a centralistic model local views are not explicitly captured and modelled. Liu, Li, and Zhao (2009) mention that such a (centralistic) approach neutralizes the diversity of participants in terms of perception scopes. King and Johnson (2006) add that a standardization approach has the danger to stifle local process variety through a one-size-fits-it-all solution. In this chapter, the terms process variety and diversity are used interchangeably to refer to the multifariousness of a HCP in
terms of local process views. The monolithic nature of centralistic models strengthens the interaction shortcoming since centralistic models tend to get large and unreadable with increasing numbers of participants and interactions. Another shortcoming arises out of the centralistic nature of existing workflow-based process models. **The (communicative) activities of different actors are not allowed to conflict.** Current modelling frameworks do not acknowledge the complex, situated, adaptive nature of human behaviour, and provide 'aerial’ representations that ignore the process required to align the different and inconsistent views that human agents frequently have of the organization (Zacarias, Pinto, Magelhães, & Tribolet, 2009). The neutralization of local process views may make humans feel that their views are not adequately modelled. Taking into account the local views of the agents has the potential to minimize the gap between the actual process and the modelled process by capturing real-world nuances, diversity, and intricacies. This provides a richer basis for a process analysis and improvement effort. Moreover, the process can flow in a different way than if it were centrally modelled.

### 5.3. The TALL Modelling Language

In the TALL modelling language (Stuit & Szirbik, 2007; Stuit & Szirbik, 2009), the organizational context in which a HCP occurs is seen as a multi-agent environment in which different agents behave in interactions to coordinate their work. The language’s main modelling concepts are agents, roles, interactions, and behaviours.

The language separates between two levels of linked process representation. On a high level, the set of interactions that forms the HCP is structured in the Interaction Structure (IS) diagram. Interactions are depicted as flattened hexagons and are related to other interactions through composition (one interaction being part of another) and routing (one interaction must be completed before, in parallel with, or instead of another interaction). The routing relations supported in the IS diagram are sequential routing (SEQ), parallel routing (PAR), and exclusive choice (XOR). Formally, the IS diagram is a tree with a single root interaction. Figure 5-1 shows a simple example of the interactions in a 2-Day Workshop in which the first day consists of Paper Presentations and the second day ends with a Best Paper Ceremony. The Paper Presentations interaction could be decomposed further to represent all individual presentations. Child interactions are linked to their parent interaction by a routing symbol that indicates the process flow of sibling interactions. A parent interaction completes if all its children complete according to
the specified routing relation. Thus, by convention, completion or composition is read bottom-up while routing between sibling interactions is read from left to right. Decision rules can be attached to the three routing types to enable rule-based execution of a set of sibling interactions. Graphically, a (non-empty) decision rule set is depicted by attaching a subscripted letter \( d \) to the routing type. In effect, decision rules allow the specification of optional and repetitive interactions.

Figure 5-1. Agent interaction and behaviour modelling in TALL.

For each elementary interaction (i.e. interactions without children), it is indicated which roles are involved. Roles are depicted as ellipses and are attached to the lines outgoing the hexagon (see Figure 5-1). In TALL, an interaction does not exist without at least two roles being bound to it (Stuit & Szirbik, 2007; Stuit, Szirbik, & Wortmann, 2007b; Stuit & Szirbik, 2009). An initiator role either starts or leads an interaction, and can be recognized by the role-interaction connector with a filled arrowhead (see Figure 5-1). A role is directly linked to an interaction and is an independent object separate from the agent(s) that is(are) assigned to play a specific role. Roles serve as placeholders for the agents and can be thought of as generic participant types. The roles in an interaction also represent division of responsibility within the process.

The elementary interactions are completed by the coordinated execution of the local behaviours performed by the agents playing the involved roles. Agents are depicted as rounded rectangles and are assigned to play roles as in Figure 5-1. The circle icon represents human agents. Figure 5-1 shows two human agents that are assigned to play the roles of Presenter and Chairman. No audience members are
depicted. In the IS diagram, agent behaviours are depicted as chevron symbols (i.e. arrow rectangles) that appear at the tail of the agent-role connector (see Figure 5-1). Each chevron is owned by the adjacent agent and is a compact representation of an Agent Behaviour (AB) diagram that details the (intended) behaviour of the owner agent for that specific interaction. Thus, on a lower level of modelling, a set of AB diagrams specifies the individual local behaviours of the agents assigned to the roles of a given interaction in the IS diagram. Although an agent may have a knowledge base of applicable behaviours, from a modelling perspective, only the behaviour that is selected for usage or analysis is depicted in the IS diagram. An AB diagram is a swimlane that specifies the internal states of the owner agent, and the communicative and non-communicative activities that cause it to change states. AB diagrams are based on the Behaviour net formalism (Meyer & Szirbik, 2007a), an extension of the coloured Petri net formalism with the message place type. The messages sent and received by the agent are modelled explicitly as message places. Message places allow the process flow to alternate between different agent behaviours in an interaction. Section 5.4.4 shows some examples of AB diagrams from the municipality case study.

AB diagrams allow to represent beliefs about the contribution expected (i.e. expected behaviours) from other agents in the same interaction. Such AB diagrams are named interaction beliefs in TALL. They allow an expected interaction to be modelled from the viewpoint of one agent: the left-most swimlane depicts the behaviour of the owner agent and the other agents are regarded as message senders or receivers. Other (non agent-oriented) process modelling techniques do not consider that an actor can have explicit process beliefs. The interaction belief concept is explained in more detail in (Stuit, Szirbik, & de Snoo, 2007). A software tool, named the Visual Editor, supports the TALL modelling language. It allows the user to build and manipulate TALL diagrams and is freely available from the software section on http://www.agentlab.nl/.

5.4. Case Study

5.4.1. Case description

In the Netherlands, national legislation enforces compulsory education for each young person until their 16th birthday. This is extended up to the 18th birthday when the young person did not yet obtain a so-called start qualification, which is a school diploma with a certain educational level that qualifies as a job qualification. The execution of the Law for Compulsory Education (LCE) is organized de-
centrally by municipalities. The LCE requires Dutch municipalities to check and enforce the school attendance of the school age youth (age 5-18) in their residential area. Since 2002, the Dutch government also pursues to help dropouts in the age group 18-23 without a start qualification to obtain such a qualification. However, young persons in this age group cannot be forced since the LCE does only apply to the 5-18 year olds. Municipalities must maintain a database in which school (un)enrolments (age 5-23) and data about school absenteeism (age 5-18) are registered as part of a Student Administration system. Educational institutions (e.g. primary and secondary schools, vocational/professional schools) have a legal obligation to report school absenteeism and school (un)enrolments to the municipality where the young person resides. For the dropouts of age 18-23, municipalities also receive reports about social security benefits from social service institutions and job data from employment offices. In Oldambt, the case study municipality, the cluster Student Affairs (cluster SA) in the department of Welfare and Neighbourhood Management is responsible for the above work. The primary goal of the cluster SA is the reduction of school absenteeism and the number of dropouts. The (collaborative) work concerned with all facets of the student affairs in the cluster SA forms the scope of the HCP in this case study.

5.4.2. Agents and roles

Eight full-time employees, who play five different roles, work in the cluster SA. There are two school attendance officers. The primary task of the school attendance officer is the enforcement of the LCE. The school attendance officer deals with absolute (no school enrolment), relative (truancy), and luxury (holiday leave without permission) school absenteeism, and is responsible for (re)directing dropouts (5-18) back to the formal education system. Because of the LCE, the school attendance officer has several means of coercion (e.g. official warnings, summons). There is one prevention officer who focuses on the 18-23 year olds. The primary goal of the prevention officer is to have all dropouts in this age group without a start qualification on the radar, and to pro-actively approach them to motivate and help them to obtain a start qualification. The school attendance and prevention officers also have a care task in the case of family issues or socio-emotional problems. To find solutions to problems, they collaborate with several partners: educational institutions, care institutions, the police, the public

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27 The municipality of Oldambt is a relatively big Dutch municipality in the eastern part of the northern province Groningen.
prosecution office, (youth) welfare work, the child abuse office, employment offices, social welfare institutions, the child welfare council, the schools inspectorate, the labour inspectorate etc. The abundance of interactions with these external partners is one of the causes of the organizational problem (see Section 5.4.3). Interaction with young persons and their parents/caretakers usually occurs through telephone, e-mail, house visits, conversations at the town hall etc. There are three administrative employees. Two of them support the school attendance officers and one supports the prevention officer. Their primary tasks include filing activities, entering school (un)enrolments and school absenteeism reports in the Student Administration system, dealing with less serious cases of school absenteeism, and taking care of the correspondence with young persons, parents/caretakers and schools. There is one employee who takes care of applications for student transport coming from parents/caretakers. Student transport is requested in the case of absence of suitable education nearby (e.g. because of religious conviction or a serious disability of a young person). Finally, the senior manager student affairs sets out the policy of the cluster SA and coordinates the collaborative work of all employees.

5.4.3. Organizational problem

The cluster SA is dealing with a large coordination complexity in the execution of the student affairs for several reasons. The first reason is the general problem situation in this part of the Netherlands (higher than average levels of poverty, population exodus, brain drain etc.) and all social issues that stem from it. The second reason is the resulting increase in the number of dropouts and school absenteeism. The third reason is the recent merger (April 2009) of three municipalities into the municipality Oldambt. Consequently, the cluster SA is now responsible for the young persons in a larger residential area. The fourth reason is the government policy towards the extension to the age of 23. Finally, there is the ever-increasing pressure of new national regulation. These factors contribute to a complex mix of numerous interactions and their interrelations:

- Local, communal meetings are visited three times by the SA employees due to the recent merger, in particular by the school attendance and prevention officers;
- Regional, inter-communal meetings increased in number since the government enforced the creation of regional networks of collaboration in which preventive policy gets priority over curative policy;
• Interactions with external partners, young persons, and their parent/caretakers increased in number because of the higher amount of young persons with problems. Each young person is considered a unique case so interaction and information-exchange is of utmost importance;

• The senior manager has increased the number of intra-departmental interactions (i.e. work meetings) to improve knowledge-exchange and collaboration between the employees who originate from the three pre-merger municipalities.

Although all employees pursue a common business goal and share a passion for their work, different views on the work processes exist. This is partly caused by the fact that the employees originate from three different municipalities. Traditionally, Dutch municipalities have had much autonomy in the definition and execution of their business processes. Therefore, the operational process views of the employees from different municipalities differ. In addition, the existence of different process views is caused by the fact that most of the employees operate in specific focus areas, each with their own expertise and experience. For example, the school attendance and prevention officers have professional autonomy. This means they have the ability to make their own decisions without having to account to others beforehand (WCPT, 2003). This implies that the administrative employees supporting them also have specific focus areas.

The core of the organizational problem is that nobody knows exactly what everyone is doing, that is, there is no clear view of the overall HCP in which the colleagues are engaged. The municipality attempted to solve this problem about a year ago when they hired a consultancy company to model their operational work processes (including the work of the cluster SA). The consultancy company studied documentation and performed interviews with one representative of each job title/role. The result was a report with process models and descriptions of the current situation. In the initial phase of the current case study, the senior manager communicated that the consultancy report was a poor basis for a process analysis and improvement effort since it did not provide insight into actual human work practice.

5.4.4. Interaction and behaviour modelling

The TALL modelling activity at the municipality consisted of two sequential phases. The first phase started with the creation of a preliminary IS diagram based on an in-depth study of municipality documentation with regard to student affairs.
However, written documents are not sufficient to provide a complete and accurate picture of actual human interactions. For this, the valuable input of the subject matter experts (i.e. process participants) is required. Therefore, a model-based workshop was hosted and chaired by the researcher to validate the IS diagram with the eight employees. In a model-based workshop, models are built interactively with subject matter experts who talk about the process and a modeller/facilitator who changes models on the fly (Bridgeland & Zahavi, 2009).

The workshop spanned one entire morning and lasted about 4 hours. During the workshop, the researcher started with an explanation of the TALL modelling notations using the preliminary IS diagram. Next, the author facilitated a focused walkthrough discussion of the HCP using the preliminary IS diagram. During the discussion, the employees were asked to improve the preliminary IS diagram. The researcher processed live the feedback of the participants (i.e. extensions, refinements, deletions) in the TALL Visual Editor. This lead to several new interactions, improvements to the role assignment of interactions, changes to the classification and placement (composition) of interactions (composition), and changes to the routing of interactions. In this way, the workshop allowed for immediate face validation of the IS diagram. Face validation is asking the reality owners or subject matter experts whether the models accurately reflect reality (Sargent, 2007). It is a form of qualitative assessment, which involves human judgment or expert opinion, to review if a model meets user expectations (Illgen & Gledhill, 2001; Pace, 2004). Figure 5-2 shows a fragment of the IS diagram output from the model-based workshop. The complete model is not included but can be downloaded with the TALL Visual Editor.

The IS diagram served as input for the behaviour modelling phase. In this phase, data collection was done through semi-structured interviews. The researcher interviewed all employees for 1-2 hours in their offices. During the interviews, the employees were asked, for each interaction in which they are involved, to describe their actual behaviours (i.e. activities and their order), the message exchange points with the other interaction participants, and the expected behaviours’ of the other participants. Moreover, the employees were explicitly asked and stimulated to discuss these behaviours from their own personal view and experience. Audio was recorded with a voice recorder. Since there was limited time during the interviews, the researcher formalized the collected local domain knowledge in AB diagrams in his own time. The behaviour modelling phase resulted in 26 AB diagrams for different interactions in the IS diagram. To validate these AB diagrams, each
employee was then sent their own set of AB diagrams together with a legend explaining the modelling notations. Based on the feedback received, the researcher made corrections to the AB diagrams.

Figure 5-2. Fragment of the IS diagram for the cluster Student Affairs.
In the bottom left part of Figure 5-2, the two school attendance officers and their local behaviours are assigned to the roles of the *School Enrolment Exemption* interaction. Figure 5-3 and Figure 5-4 show the two corresponding AB diagrams. For privacy reasons, the names of the employees have been disguised.

![AB diagram](image)

**Figure 5-3.** The local behaviour of the first school attendance officer.

Although the AB diagrams in Figure 5-3 and Figure 5-4 have been simplified to take into account a non-disclosure agreement, the key aspects of the behaviours are still present. Both diagrams are *interaction beliefs* since they show beliefs about the expected behaviours of the other agents in the interaction. Thus, these AB diagrams are represented as multi-swimlaned Behaviour nets including message exchange points (i.e. both have three swimlanes). In each swimlane, incoming messages are indicated on the left and outgoing messages are indicated on the right. These messages can be matched to the incoming and outgoing messages of the other swimlanes using the message labels that act as type names (Meyer & Szirbik, 2007a). In a workflow-based process modelling language, a single generic
behaviour would be specified for the role of the school attendance officer in this interaction. In other words, the two individual behaviours of the two agents who play the role of school attendance officer would not be modelled separately. This means differences between behaviours are not explicitly modelled. The explicit capture and modelling of the local behaviours with TALL retains process diversity, that is, the two AB diagrams show differences in the behaviours of the two school attendance officers. This allows these differences to be analysed (see Section 5.5).

Figure 5-4. The local behaviour of the second school attendance officer.
5.5. Practical Results

The IS diagram gives the cluster SA a clear overview of the (number of) interactions, their composition and routing relations, and their (initiator) roles. In particular, the composition (i.e. classification) of interactions in preventive and curative interactions, communal and inter-communal meetings, and internal and external meetings provides insight into the number of interactions of each class. The following list presents examples of some specific actionable insights:

- The IS diagram reveals that the school attendance officers are involved in a relatively high number of preventive consultations with external partners. The senior manager decided to merge some of these consultations. This reduces the number of consultations and allows partners to leverage each other’s expertise;

- The IS diagram reveals that the school attendance and prevention officers are involved in a relatively high number of external work meetings. Work meetings do not focus on cases (i.e. young persons) but on higher-level issues (e.g. policy, professional-related issues). The senior manager decided to attend these work meetings personally rather than delegating this work to subordinates, allowing the school attendance and prevention officers to focus on the case load;

- The school attendance and prevention officers are not consistently involved in the school cooperation networks that are centred in large secondary schools. Since such students from multiple municipalities enrol in these secondary schools, multiple school attendance and prevention officers are involved in these cooperation networks. The senior manager decided that clear agreements about participation and information-exchange between the different municipalities need to be made;

- There is a clear division and sequence between the interactions of the school attendance officers and their administrative employees. The preparatory interactions of the administrative employees occur before the interactions of the school attendance officers. Such a division and sequence does not exist between the prevention officer and its administrative employee, which makes the responsibilities unclear. The senior manager decided to clarify the job descriptions for the work concerned with the 18-23 year olds.

The cluster SA confirmed that the IS diagram breaks the previous opacity of the HCP through an effective representation of its human interaction structure. The
insights obtained from the IS diagram helped to prioritize and evaluate interactions, enabling more effective resource assignment and case management.

The AB diagrams of the eight employees were compared and analysed to identify deficiencies and to discover innovations. Differences were found in the behaviours of the employees in certain interactions. Some examples of innovations are:

- School (Un)Enrolment interaction: the administrative employee working for one of the school attendance officers tries to retrieve any missing information on a school enrolment with the school through telephone. The administrative employee working for the other school attendance officer does not perform this activity, which increases the workload of the school attendance officer;

- School Enrolment Exemption interaction: one of the school attendance officers always has a face-to-face conversation with the young person and his/her parent/caretakers before an exemption is granted. The goal is to warn and inform them about the consequences or impact of an exemption. In many cases, this motivates parents/caretakers to consider (previously unknown) options for alternative schooling. This activity is not executed by the other school attendance officer, which can impede the development of the given young person;

- 18-23 Dropout interaction: The prevention officer communicates with young persons in the age group 18-23 mainly by e-mail. This increases the response rate, as compared with paper mail. Other officers and employees can do the same.

Some examples of deficiencies are:

- Relative School Absenteeism interaction: the school attendance officers do not close the absenteeism reports in the Student Administration system when they finish a case. It is important for case management to close all cases immediately;

- Student Transport interaction: the employee student transport receives a call from the transport company when a young person has not been travelling a while. This care signal should be reported to the school attendance officer since it could indicate a social problem;

- In all interactions with external partners or young persons, the school attendance and prevention officers make many handwritten notes. These are not entered in the Student Administration system. It is important to
register all relevant data about young persons to be able to make informed decisions.

Based on the behaviour analysis, the cluster SA gained insight into the diversity of (local) behaviours of its employees in the modelled interactions. The senior manager decided to standardize the innovations and take out the deficiencies to increase the efficiency of the HCP.

5.6. Discussion

*The interaction shortcoming*

A real-life HCP, like the one studied in the municipality case study, consists of hundreds of tasks performed by numerous actors and has a complex interaction structure. The studied HCP is not an atypical HCP in the sense that one can expect to encounter similar organizational problems in other HCPs. The complexity of HCPs often grows to the extent that no one has a clear overview of the process. This is also the core of the organizational problem at the cluster SA.

A common approach to reduce the complexity of a process and provide structure to a model is to introduce modularity in the process definition. A good overview of modularity in process models is provided by (Reijers & Mendling, 2008). The authors explain that most popular process modelling techniques support modularity through the sub process concept. This concept uses *task refinement* to achieve modularity, that is, tasks can be detailed through sub processes on a lower level. In this way, task refinement enables the hierarchical structuring of complex business processes. The main advantages attributed to task refinement are enhanced understanding, ease of reuse, and scalability. Although task refinement reduces the complexity of a process through decomposition of tasks, the focus remains on task specification. Therefore, this approach does not address the interaction shortcoming. Another approach, not based on task refinement, is the work on *proclets* (Mans, Russell, van der Aalst, Bakker, Moleman, & Jaspers, 2010; van der Aalst, Barthelmess, Ellis, & Wainer, 2001), which partitions complex workflows into interacting lightweight workflows. Although this approach promotes interactions to first-class citizens, interaction is specified through message exchange. It has the same disadvantages as choreography models and interaction protocols discussed in Section 5.2.1. The interaction structure remains implicit and the focus is on the modelling of prescribed rather than actual collaboration. Therefore, the interaction shortcoming is not addressed in this approach either.
In the TALL modelling language, the complexity of a HCP is addressed in the IS diagram where interaction is the primary unit of representation and analysis. The IS diagram separates the interaction specification from the task or activity specification. The interactions, the relations between interactions, and the participants for each interaction (i.e. agents and roles) are modelled on a higher level in a tree layout. This addresses the interaction shortcoming. The tree layout is not a diagrammatic convention but part of the formal syntax and semantics of the IS diagram (Stuit & Szirbik, 2009). Li, Hosking, and Grundy (2007) argue that trees are familiar abstractions for business modellers to manage complex relations because they support navigation, elision, and automatic layout in ways difficult to achieve with the workflow-based box-and-line representations. With TALL, the process designer can at first focus on the interactions in the HCP without being concerned with the tasks or activities (read: behaviours) of the agents. This allows a complex HCP to be made simpler. Effectively, the interactions in the IS diagram break the process in smaller related topics. This feature has been successfully applied in the municipality case study, and the IS diagram has shown to overcome the organizational problem with several desirable process insights. Moreover, the behaviour capture through interviews has been shown to benefit from this feature. The interactions in the IS diagram provided a starting point for the local agent behaviour specification. Overall, the two-phase modelling activity results in a clear separation between a HCP’s interaction structure and the behaviours exhibited by the agents to perform the interactions.

The local view shortcoming

Section 5.2.2 argues that existing graphical workflow-based process modelling languages do not capture and model explicitly the local behaviours (i.e. the operational process views) of the agents or actors. Several business process approaches reduce the complexity of a process model by the specification of multiple abstraction levels (e.g. public vs. private, business vs. technical) or views (e.g. data, resources, control flow, security). In literature, the latter are also referred to as process layers, aspects, or dimensions, which may be better designations to separate them clearly from the process views owned by individual actors or agents. Both dimensions and abstraction levels simplify a process definition through a separation of concerns (De Backer, Snoeck, Monsieur, Lemahieu, & Dedene, 2009) but do not capture and model process views as discussed in this chapter. Therefore, they do not address the local view shortcoming.
In TALL, an AB diagram reflects the individual operational process view of the owner agent in a given interaction. It is at this level that local process variety or diversity occurs. King and Johnson (2006) confirm that traditional process modelling languages do not express process variety well. Through the AB diagrams, TALL allows to explore process diversity in the local behaviours of the agents. The practical results in Section 5.5 show that analysis of the AB diagrams identified several innovations and deficiencies on the behavioural level. The modeller can compare AB diagrams in their local interaction context. In other words, the modeller does not have to cross-analyse all AB diagrams but can focus on those AB diagrams that complete a certain interaction or play a certain role. This reduces the cognitive effort for the process analyst. In this way, the interaction construct serves as a container for the behaviours within it, providing good local context, and a good overview of all roles involved.

Section 5.2.2 also argues that in existing graphical workflow-based process modelling languages the (communicative) activities of different actors are not allowed to conflict. In contrast, the AB diagrams in a given interaction are allowed to conflict at design time. However, based on the local behaviour of an agent, there is no certainty that the behaviour(s) of the other agent(s) in the interaction are matching the behaviour of the agent. Meyer and Szirbik (2007a) discuss in more detail how non-aligned intended agent behaviours are dealt with at execution time. In the approaches that introduce modularity, the different modules are not allowed to conflict. The process designer makes the choice of what to do and when to do it in advance. Overall, through the AB diagrams, the TALL modelling languages overcome the local view shortcoming.

An interesting finding from the municipality case study is that the employees performed a very thorough validation of the AB diagrams, which resulted in diagrams that are more precise. The reason is the personal, individual nature of these diagrams, which contain the employees’ own names. This created a sense of ownership of the models among the process participants, and fuelled their interest and involvement. This finding corroborates the finding in (Zacarias, Pinto, Magelhães, & Tribolet, 2009): subjects pay more attention, perform more thorough analysis, and engage in more in-depth discussions with diagrams with their name that reflect their actual work practices than when they work with generic and role-based task diagrams.

The identified modelling shortcomings are not exhaustive since they are based on a literature study only. The shortcomings should be seen as a first step in the
identification of requirements for the proper graphical representation of HCPs. Other process modelling languages may exist that address some, all, or other modelling shortcomings. It is practically impossible to make an explicit comparison with all of them. Other research performed comparisons with several mainstream process modelling languages (Stuit & Szirbik, 2007). The main innovation of the TALL modelling language is the interaction-centricity of the language, which results from the agent-orientation. In the language, interaction is recognized as the core activity in collaborative organizational work and the starting point in the modelling effort. Moreover, the operational flow of the process is specified from each agent’s local viewpoint.

5.7. Conclusions

This chapter separates the interaction- and human-driven nature of HCPs from the task- and implementation-driven nature of workflow processes. Based on a study of relevant theory and research, modelling shortcomings of existing graphical workflow-based process modelling languages in their ability to represent human interactions and behaviours in a HCP are discussed. A case study application of a real-life HCP is presented to allow assessment of the effectiveness and utility of an interaction-centric business process modelling language. The application results demonstrate that the language effectively addresses the identified shortcomings and has practical utility. The specific properties of TALL generate desirable and actionable insights in the HCP after analysis of the modelled interaction structure and the modelled local behaviours of the agents that perform the interactions. The main contribution of this chapter is a practice of modelling and understanding a real-world collaboration.

Future work is directed towards the application of the TALL modelling language in other case studies to ensure utility among a wider range of HCPs. These future case studies are planned to include the application of workflow-based process modelling languages to demonstrate that these are less effective for the modelling of HCPs, as compared to TALL. This allows stronger claims of language effectiveness and suitability. Moreover, these studies enable empirical investigation and validation of the identified modelling shortcomings.