Enterprise Ontology based Application Portfolio Rationalization at Rijkswaterstaat

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Abstract. At Rijkswaterstaat, under direct steering of its CFO and CIO, a large-scale application portfolio rationalization program is taking place. The Enterprise Architecture Rijkswaterstaat team, responsible to guard integrated business-ICT steering, shaped this program using part of an Enterprise Ontology as a stable description of the business. By connecting transactions from the DEMO Construction Model for Road Traffic Management directly to applications, we were able to detect duplications and similarities between applications originating from several regions but supporting the same business. With comparitively low investments, this led to a well underpinned phasing out proposal of 49% of all applications and also to a positive attitude-change towards the application portfolio rationalization program. In the future the DEMO Construction Model can play a key role in the ongoing clarification of responsibilities in the several Rijkswaterstaat regions.

1 Introduction

The Dutch governmental agency Rijkswaterstaat (RWS) wants to constantly rationalize and improve its application portfolio. Such improvements should be steered by the business benefits it can deliver to its stakeholders. To have a clear insight in that, we need to know what applications are supporting what part of the organization. Now at the same time the RWS organization is regularly changing, with a re-assigning of responsibilities as a consequence. Therefore we wanted to underpin our proposal for application portfolio rationalization by basing itself upon a stable model of the business.

An Enterprise Ontology according to Dietz (2006) claims to model the essence of a business, without making any assumptions about its realization and implementation. How does such an Enterprise Ontology look like in real-life? What are its practical benefits? How do we arrive at such an Enterprise Ontology? What is its *Return On Modeling Effort* (ROME)?

In this paper we will demonstrate the making, the result and the practical use of one of the ontological models, namely the DEMO Construction Model (CM), at RWS. First we will introduce the context, an application portfolio rationalization program for the area of Road Traffic Management at RWS. Then we will explain the method applied, with its key elements of drafting a CM, connecting it to applications from the application portfolio and detecting opportunities for rationalization. We subsequently show the results, from the CM via its cross-references with the application portfolio to an underpinned and supported phasing out proposal of 49% of all applications, including a positive attitude-change towards the application portfolio rationalization program. Finally we reflect on the method applied and its results: which value of the CM has been demonstrated and which value can be expected in the future, e.g. in the ongoing uniformization of processes in the several regional departments of RWS.

2 Context of the case

2.1 Rijkswaterstaat: an organization in transformation

Rijkswaterstaat (RWS), the Directorate-General for Public Works and Water Management, is the executive branch of the Dutch Ministry of Transport, Public Works and Water Management. Under the command of a departmental Minister and State Secretary, RWS develops and maintains the Netherlands' main infrastructure networks. Next to that, it manages traffic on roads and waterways and it manages waterquantity and –quality. RWS aims to prevent flooding, to ensure sufficient and clean water, to ensure safe and unimpeded movement on roads and waterways, and to provide reliable information in a user friendly format. In 2004, RWS had an annual expenditure of approximately € 4 billion, a number of staff of approximately 10.500, 17 departments and 160 offices in the Netherlands.

In the same year, RWS formulated an ambitious plan to change from an engineer's organization to a public demand driven organization. This transformation plan concentrated on 4 spearheads, namely (1) organizational unity – *one single Rijkswaterstaat*, (2) network management – *user oriented*, (3) good internal management – *order in the own organization,* and (4) professional client for private sector – *private sector as first option*. For instance, by taking the perspective of a road user, stimulus was given to provide traffic information on the level of the network instead of on the level of the region; therefore the collaboration with national and international network partners should be intensified. Also RWS wanted to change focus from network construction to network usage. By improving traffic management and traffic information providing, it should be possible to extend infrastructure only as last resort. In order to achieve *more with less*, and *order in the organization*, RWS decided to move to a more centralized organization. Centralization should occur in business decision making, in IT decision making and in the IT Service Organization.

One year before, RWS started the Enterprise Architecture Rijkswaterstaat (EAR) program. This program aims to be a central point for the numerous initiatives fulfilling the RWS ambition. It is used for diagnostic reasons, e.g. establishing impact of change, and for supporting decision-making, primarily in the ambition *order in the own organization* and secondary in the ambition *private sector as first option*. EAR wants the content of its Integrated Architecture Framework (IAF) (Goedvolk et al 1999, Op 't Land 2004) to gradually be built and validated by letting EAR participate in RWS's main change programs. Because of its broker role between information demand and information provision in RWS, EAR is steered from two sides; the business and information part is steered by the CFO/CIO, the ICT part is steered by the director Corporate IT.

2.2 The Application Portfolio Rationalization program

One of RWS's initiatives to achieve *more with less* and bring *order in the own organization* was the creation of one IT service organization in RWS. This IT service organization, Directorate Corporate IT (DCIT) became responsible for all the applications and technology infrastructure in RWS, a task which used to be managed by 17 different business units. The inheritance of this new IT Service Organization was initially estimated at 8000 applications. The CFO gave his top priority to decreasing this inheritance before transfering it to DCIT and issued a major application reduction: *re-*

duce the application portfolio by 90% in 4 years. The expected benefits are (1) cost savings by removing duplication of IT functionality, (2) increased uniformity in processes and IT – thus decreasing risk, (3) simplification in application manageability, and (4) easing of future developments. Especially the last benefit, easing of future developments e.g., corridor management, should build on one solution instead of many solutions – this is impossible with non uniform processes and applications.

Several application portfolio rationalization strategies were considered. For the long term application guidelines should be developed and enforced, favoring Commercial Off-The-Shelf (COTS) standard application packages and Service Oriented Architecture. On the short term duplicate application solutions in the existing application portfolio should be detected quickly, ensuring that business functionality was implemented only once and uniformly. With this aim, a large program was started to reduce the RWS application portfolio. In it, the match between business and IT would have to be scrutinized, and it had to be made explicit which applications supported which parts of the business. This had to be done in an organization where several rationalization processes were running in parallel, including the business process reengineering project Uniformizing Primary Processes (UPP). A final result from UPP was not to be expected before the application portfolio rationalization program would need a single unified description of the RWS business; which itself was constantly changing.

As a first step in this application portfolio rationalization program, we divided the application portfolio in chunks we could manage. For that division we used the criteria (1) follow the main processes / services of RWS, (2) the interaction of applications between chunks should be low, and (3) the chunk should fit in the responsibility of one coordination director. In this way we formed a number of rationalization projects. The first rationalization project, focussing on network and traffic management on water & integrated water systems, was a pathfinder for all other rationalization projects. It resulted in a reduction of 85% of all applications in this area and also in a standard process to consolidate all other applications.

We will now focus on the application rationalization for Traffic management on the Highways (*Road Traffic Management*). This business area deals with operational traffic management, incident management and the provision of traffic information. The work was done in 5 regional Traffic Management Centers (TMCs), one national TMC, and one Traffic Management Expert organization. In this area there are – as turned out later – approximately 130 applications e.g., traffic control systems, traffic control centers, Dynamic Route Information Panel's, Entry Point Dosing devices and information systems for incident management and route information.

3 From models & cross-references to advice: the applied method

To arrive at an application portfolio rationalization proposal for Road Traffic Management, we followed a method. In describing the method applied, we will follow a slightly adapted version of the so-called *5 Ways* of Seligman et al (1989) (see Fig. 1):

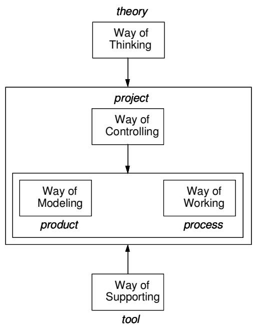

Fig. 1 The *5 Ways* (after Seligman et al 1989)

1. Way of Thinking (WoT): the *theory* about the kind of object systems that the method addresses; it provides the basis for integrating the other 'ways';
2. the Way of Modeling (WoM): the distinct *products* (aspect or partial models) that together constitute the complete model of the object system, as well as the applicable representation techniques (diagrams, tables, decomposition, etc.);
3. Way of Working (WoW): the *process* (procedures etc.) of developing the models, as well as the set of techniques (analysis, interview, etc.) for acquiring the knowledge about the object system that is needed for making the models;
4. Way of Controlling (WoC): the organization and the control of the *project* in which the methodology is applied; it regards both WoM and WoW;
5. Way of Supporting (WoS): the set of (software) *tools* that can be used to support the people who apply the method.

3.1 The Way of Thinking and the Way of Modeling

We wanted to enable the RWS business in selecting the "right" applications from the application portfolio and also to spot opportunities for better application support. To understand the concepts which play a role in application portfolio rationalization, we started by positioning them in the Integated Archi-

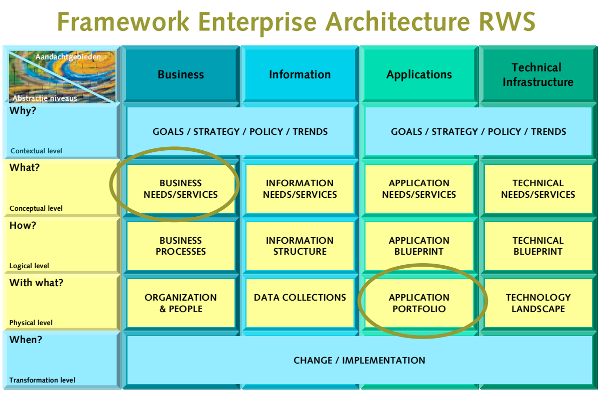

Fig. 2 Concepts for application rationalization in IAF

tecture Framework (IAF), as applied and adapted at Rijkswaterstaat (Fig. 2). IAF is used as an ordering framework for EAR deliverables and its interrelations, like business function models, business object models, process models, Information models, data models, ISO standards, IEEE standards, and so on. One of the deliverables is the *application portfolio*, residing in the column Application at the Physical Level. Another key-deliverable is the DEMO Construction Model (CM), positioned in IAF in column Business and row Conceptual Level.

We will now briefly introduce the required concepts of the DEMO Construction Model (CM), using Fig. 3. A CM expresses the coherence (chain/network) of business services, delivered by actors to other actors within a defined scope by executing transactions. E.g. actor A01 executes transaction T01, which delivers a business service to actor A00. Actor A00 is called the *initiator* and actor A01 the *executor* of transaction T01. The execution of transaction T01 results in a new fact in reality. Another actor A07, for its responsibility in executing transaction T07, needs information about those facts from transaction T01; this *information link* between actor A07 and (the fact bank of) transaction T01 is indicated by a dashed line. In the fact bank of T01 we find both the production facts and the coordination facts (like status “requested”, “promised”, “stated”, “accepted”) of transaction T01.

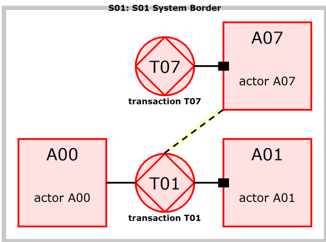

Fig. 3 Typical DEMO Construction Model

From DEMO-theory we also use the *distinction axiom*, which discerns three distinct abilities and corresponding actions of actors. Those distinct actions, which also can be made visible in the CM, are:

1. ontological or business actions (red-colored in the CM) bring about new original things, directly or indirectly in communication, e.g. engaging into commitments, taking decisions;
2. infological actions (green-colored in the CM) concern the content and meaning aspects of communication and information, like sharing of thoughts, remembering and recalling of knowledge and reasoning;
3. datalogical actions (blue-colored in the CM) concern the form aspects of communication and information, like syntax of sentences, the coding and decoding of messages, and the storing and transmission of data and documents.

The CM is independent of any organizational implementation, therefore we considered it a good instrument to describe the RWS business, especially when its organizational implementation was still moving on the scale from regionalized to decentralized. From the three actions mentioned in the distinction axiom, in our CM's we will focus on the business aspect, though now and then we will show a part of the infological aspect.

In order to find candidate applications for rationalization we wanted to relate the current application portfolio to the CM. We assumed we could thus find application portfolio rationalization opportunities (a) in applications that did not support any transaction or actor, (b) in duplicate applications with similar functionality supporting the same transaction and (c) in applications that had overlap in functionality because each supported some of the same and some different transactions.

Now IAF assumes always direct relationships between architectural deliverables in adjacent cells. As the mapping on IAF in Fig. 2 shows however, the CM and the existing application portfolio model are separated by the Information column, and they are in different rows as well. Therefore, should we be working in a green field, we would derive information needs as well as information creation from the RWS business as described by the CM, progress into abstract application services which would then evolve into concrete applications serving concrete datastores. For our goal of supporting the application portfolio rationalization this was deemed a too time consuming approach, and unnecessarily complex in order to achieve the desired results. Instead, we decided to directly model each application as supporting elements in the CM.

We hypothesised applications had three options to support the business, as expressed in the CM (Fig. 4):

1. an application is supporting an *actor* in all of its responsibilities; e.g., a portal for the actor Financial Administrator;
2. an application is supporting (the execution of) a *transaction*; e.g., the payment of invoices;
3. an application supports the *information link*, representing inspection of facts in a transaction by an actor; e.g., to inform the Financial Administrator about the fact „Infraprovider has accepted work of contractor".

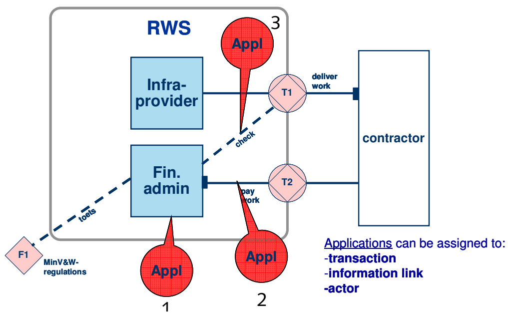

Fig. 4 **Applications supporting several CM-elements**

To decide which of the three options was most fruitful for our purpose, a validation should be executed as part of our way of working.

3.2 The Way of Working

We designed our way of working as consisting of the following steps, which will be described hereafter:

1. build and validate a DEMO Construction Model (CM);
2. create an application portfolio inventory;
3. connect applications to CM-elements, including validation;
4. order, select and prioritize rationalization of applications;
5. define next steps.

Ad 1: Build and validate a DEMO Construction Model

As a starting point we studied policy-oriented documents of RWS. We looked for statements about vision, strategy and the way of working in the primary processes of our domain. At RWS level, we used the business plan, handbooks and process models. For example, in the domain of Traffic Management we used the method “Area-oriented utilization”. That method describes how to produce a balanced and underpinned mix of traffic and infrastructural measures, deriving this from transport needs and traffic requirements within safety and livability constraints. As a test for completeness, we also used the organization handbook, including the organigram, and function profiles.

Using this, a first version of the DEMO Construction Model was drafted, showing at first only actors, transactions and their coherence. Wherever it was immediately clear that an actor needed certain information, we drafted the information links as well, so gradually a more complete DEMO Construction Model came into being. We say "more complete", because we did not perform a real completeness check for the information links by using DEMO’s Process, Action and State Model.

We restricted ourselves initially to primary transactions. So e.g. the Asset Management (control & maintenance) for Traffic Management means would stay out of scope, because Asset Management as a whole was part of another domain to be analyzed for application portfolio rationalization.

Ad 2: Create an application portfolio inventory

It was decided early on that no separate large scale effort would be started to create an application inventory specific to the purpose of rationalization. The existing lists from different parts of the organization would have to suffice as a starting point, to be extended and detailed during the rationalization process itself. An extensive application portfolio list (containing over 2000 applications RWS wide) that had been made to support the creation of the RWS centralized IT Service Organization would serve as the starting point. As a consequence the properties known of each application were a given, and primarily focused on a functional description and identifying the using and supporting organization units.

Specific to the domain of road traffic management there had previously been made a separate effort to describe the main applications in more detail, and model a course data flow description. Further, a visit to each of the Traffic Management Centers did enhance the usage data for the application portfolio, as well as add some extra entries to the application list. This knowledge was all integrated in the application architectural model.

The complete RWS application portfolio was categorized into domain specific applications, and those that were used in more than one business domain. The latter were generic applications such as word processing tools and project management tools. In the described rationalization of road traffic management applications only domain specific applications were considered, except for the area of traffic management systems management that is closely related to generic IT management.

Ad 3: Connect applications to CM-elements, including validation

One part of the Way of Thinking and the Way of Modeling – namely the method of connecting applications directly to the CM-elements actor, transaction or information link – needed validation to ensure satisfactory results. This validation was done for a different business domain in a time-boxed effort to relate all applications (590) and transactions (133), taking max. 10 minutes per application. The result was that about 80% of all applications could be mapped onto a transaction; the other 20% could not be mapped based on what could be learned about an application in its given timebox. From this we concluded that the approach was efficient and delivered its results well enough, and also that all well known applications could be related to a transaction. By choosing not to relate applications to information links or actors some subtlety may be lost, but it was felt that essential information was retained. The advantage of using a single method of relating applications to transactions was that the grouping of applications into clusters serving distinct parts of the business was unique. We did, however, make a distinction between applications that supported the production part of the transaction and those that implement storage and retrieval of information in the associated fact bank.

As far as the level of detail was concerned, we needed to have clusters of applications around transactions that had similar functionality, without strictly defining what that was. Our aim was to have manageable cluster sizes between 3 and 10 applications. This range was in part based on the expected amount of duplicate IT functionality between the 18 directorates and 5 Traffic Management Centers (TMCs). The transactions whose number of connected applications exceeded this range were more detailed until the right order size of connected applications was reached.

Ad 4: Order, select and prioritize rationalization of applications

At this stage we had a matrix of transactions supported by multiple applications, and applications that supported multiple transactions. In order to create workable application domains suitable for integrated discussion we had to assign each application to a single unique domain. This meant that in more than a few cases we had to define the "primary functionality" or "primary supported transaction" of an application and use that to classify the application. We also let ourselves be inspired by existing ideas about the structure of the application landscape.

For each application domain a team of experts would classify applications as either:

- Out of Scope, for applications that are embedded in a physical object such as a bridge or tunnel, that are specific to a certain device or reference CD-ROMs where data and application are tightly connected;
- Application will remain;
- Application will be phased out (either completely, or replaced by one or more of the remaining applications);
- Further research is necessary for this application, if the available time was not sufficient to reach a clear conclusion or if there were still ongoing developments that were of obvious influence on the decision.

In order to reach a decision per application and ranking between applications, some criteria were set beforehand for all domains and others were defined ad hoc per domain. Application use was important, because unification was a primary goal. Applications that were in use only by one or two TMCs or directorates would disappear, unless they supported a transaction unique to that TMC or were new and of such value that they needed to be rolled out company wide. Also, applications that were already centrally supplied and supported were prioritized over those that were locally built and maintained. Finally, newer applications (and running developments) would be favored over old – either because the old application was already meant to be replaced by the new one, or because new developments would be technologically better suited for centralized hosting, and should be a good match to today's and tomorrow's business requirements.

Ad 5: Define next steps

The process described above should lead to a recommendation to the RWS board of directors. It was acknowledged that while this advice gave direction, many details still would be needed to be ironed out afterwards.

First the applications for which further research was deemed necessary should be decided upon. Secondly, there should be checks on whether the termination of applications would lead to unacceptable loss in functionality or data. Finally, during the implementation phase required functionality should be implemented in the remaining applications, and connections between applications should be rerouted.

3.3 The Way of Controlling

In the first phase of the project, the focus was on building corporate knowledge about the business, information exchange and applications for Traffic Management. The main Way of Controlling this process was bottom-up. A part of the EAR team, the *Dry domain team*, was assigned to cover the "Dry Areas", including Road Traffic Management. During about half a year, gradually models for business and information were built and the inventory of the application portfolio was brought up-to-date. The business and information models were built by architects from the Dry domain team and regularly validated by business experts and business management, e.g. from the national and regional traffic control centers. The inventory of the application portfolio was updated for Road Traffic Management by architects of the Dry domain team and validated by ICT-experts from the Specialist Department "Traffic Research Center" and the national and regional traffic control centers.

In the second phase of the project, the focus was on decision making for application portfolio rationalization for Traffic Management. That process was controlled mainly top-down while actively pursuing involvement and support. In each of four consecutive months a workshop was conducted with a broad representation for the Traffic Management field: a mix between management and operations, business- and ICT-experts, line and staff people, central staff and regional staff. Right from the beginning it was made clear that the result should be a proposal for application portfolio rationalization, to be presented by the coordinating director for Traffic Management towards the Board of Directors of RWS. Between the monthly workshops, dedicated working groups sorted out issues in specialized application areas and fed back their results in the monthly workshops. For this part of the project, Corporate Staff RWS took over-all process responsibility. The Dry domain team collected the results of the workshops and working groups, and analyzed the several proposals for application portfolio rationalization on mutual coherence and impact of change for business and information.

3.4 The Way of Supporting

Support of this process by (software) tools was as follows. Already in 2004 RWS made the strategic decision to gradually collect meta-data to enable better decision-making about ICT-investments. For this purpose the Architecture-tool Metis[1] was selected and implemented. During the Application Portfolio Rationalization-program, all results were recorded systematically and in coherence in Metis. Of course we needed to record our CM with its actors and transactions. But also we needed other meta-data, e.g. about the organization ("who is fulfilling what actor-role") and the applications (including "which application is supporting what transaction"). In this way, we could perform impact-of-change analysis relatively easy.

Initially we also used Essmod[2]. With Essmod we could easily build CMs, make large and nice (A0) visualizations and create documentation. Later on, we customized Metis to let it produce comparable visualizations and documentation, which then could embed information about e.g. applications and functionary types too.

To enable our communication with all stakeholders, we had to choose our visualizations carefully. Just to give a few examples:

- the actor "road user" uses a result from RWS's primary business, namely a constructed road; however, at this moment that actor has no direct transaction-relationship (request – promise – state – accept etc.) with RWS, though this could change in the future with the introduction of road-pricing; to avoid irrelevant discussions, we nevertheless added this actor in several visualizations;
- for several discussions it appeared to work better to use several layerings, e.g. primary processes – control – secondary processes or strategic – tactical – operational; the content of the CM did not change, but its manageability and ease of use increased;
- to simplify validation of the CM, we linked its actors to *functionary types* like "road inspector"; a RWS-staff thus could easier verify

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[1] METIS™ is supplied by Troux Technologies, www.troux.com

[2] Essmod or Essential Business Modeller (EBM) is supplied by Essmod Company, www.essmod.com

whether e.g. a road inspector indeed cooperates with the incident manager and uses the indicated information about meteo and road quality.

4 Case-results: from models to rationalization advice

4.1 DEMO Construction Model for Road Traffic Management

We will now explain the CM for Road Traffic Management, sometimes also called Dry Traffic Management. In this explanation we will use *italic* for the names of actors and transaction, as they are used in the CM diagrams in Fig. 5 and Fig. 6. The first time we mention an actor or transaction, we will include between brackets its code used in the CM diagrams.

In our over-all CM (Fig. 5), we emphasized the coherence of the Dry Sector of RWS. For this Dry Sector, the *Director Dry Network (S001)* is integrally responsible for the Dry Infrastructure itself and its utilization. The *Infraprovider (S002)* will provide – by building and maintaining – the right infrastructure in the right location, time and quality. The *Traffic Manager (S003)* delivers *optimal utilization of existing and usable infrastructure (T023). Advice and Support (S004)* supports the *Director Dry Network* with *advice on traffic- and infra-measures (T090).*

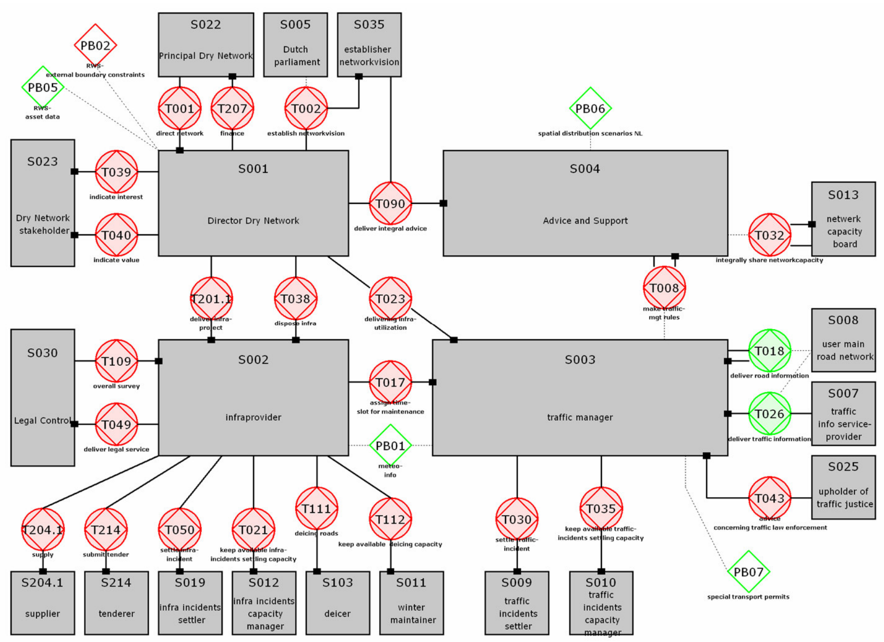

Fig. 5 DEMO CM (v0.43) for Dry Sector of RWS

Very typical for a public institution is the role of the user of the products. RWS delivers infrastructure and services but, unlike in a commercial environment, no direct classic request-reply relationship between user and supplier exists. Indeed, the cycle of request-reply starts all the way from voter to the *Dutch Parliament (S022)* to political choices, which leads to issuing laws and regulations by the Ministry and its *Principal Dry Network (S022)*. RWS as agency of the Ministry executes those laws and regulations, in which they are controlled by the *Dutch parliament*. The interests of real users of the Dry Network are looked after by *Stakeholder Dry Network (S023)*, like the municipal road maintenance authority, neighborhood group or car interest group. And the day-to-day *user*s *of the main road network (S008)* get access to *traffic- infra- and travel-information (T026, T018)*, as delivered to *Traffic Information Service Providers (S007)*. So in the end, the end-user of RWS-products mainly has an information-relationship with RWS; his requests are translated and prioritized by a chain of political representation, legislation, lobby mechanisms and official commands.

When we follow the chain of services, we see the *Infraprovider* delivering infra projects – which create new infrastructure, like roads, tunnels and rush-hour strips – and also disposing that infrastructure – keeping it usable – to the *Director Dry Network.* The real designing, building and maintaining of this infrastructure is done by *suppliers (S204.1)*, who first *submit a tender* (T214). A special example of this maintenance is executed by the *deicer (T111)*, when he scatters salt on icy roads. The capacity for that is reserved at beforehand by the *winter maintainer (S011).* Exactly the same pattern we see back for the *infra-incident settler (S019)*, e.g. repairing potholes, whose capacity has been reserved by the *infra-incidents capacity manager (S012)*. The execution of the work of the *Infraprovider* is restricted within legal boundaries, monitored by *Legal Control (S030)* by means of granting permits, e.g. for the well-point drainage required for road-construction.

Let's now turn to the *Traffic Manager* and his immediate context. *Traffic Manager* has to tune the use of the roads with the maintenance-needs of the *Infraprovider*. During his maintenance-planning the *Infraprovider* requests *a timeslot for maintenance (T017)* from the *Traffic Manager*. When the *Infraprovider*, at that moment e.g. represented by a road constructor, actually needs to maintain a section of road, the *Traffic Manager* has to release the infrastructure for that, blocking the road-section for traffic by crossing off the Dynamic Route Information Panel (DRIP). When a traffic incident occurs, this will be settled by *traffic incident settler (S009)*, generally an ad hoc cooperative of a/o police, fire brigade, medics, cleaner and salvagers. For the parties involved in that, capacity needs to be reserved by the *traffic incidents capacity manager (S010)* (by the way, on purpose we chose the plural *incidents*, to make the responsibility for cross-incident coordination explicit). This sometimes includes also agreements on financial compensation with commercial parties, e.g. the salvage company. Because of his practical knowledge where traffic offenses tend to occur, *Traffic Manager* from time to time *advises on traffic law enforcement (T043)*. The operations of *Traffic Manager* are directed by *traffic management rules (T008)*, as formulated by *Advice and Support*, and supported by access to external information, like *meteo information (PB01)* and *granted permits for special transport (PB07).*

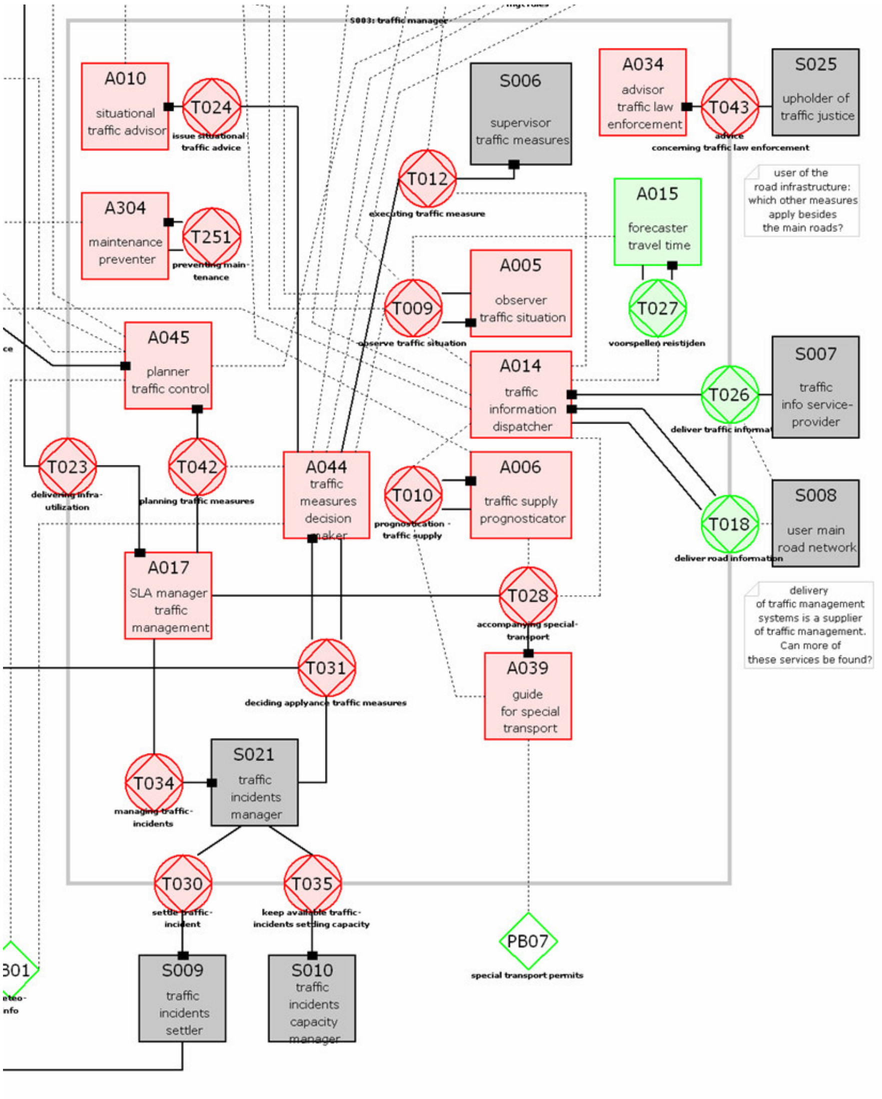

Fig. 6 DEMO CM (v0.43) for Road Traffic Management RWS (part)

Zooming in on Traffic Manager, the CM in Fig. 6 shows *SLA manager traffic manager (A017)* as central responsibility. To deliver his requested *infra-utilization*, the *traffic control has to be planned (T042)*, *traffic incidents have to be managed (T034)* and *special transports have to be accompanied (T028)*. In this area also the *traffic situation is observed (T009),* e.g., by road inspectors, but also by citizens informing the RWS helpdesk. Based on that and also a/o on the *traffic measures executed (T012)*, on *forecasted travel times (T027)*, on *prognosticized traffic supply (T010)*, both *traffic and road information* is delivered by *traffic information dispatcher (A014)*. *Traffic measures decision maker (A044)* decides on applying traffic measures, a/o based on requests by *Infraprovider* and *traffic incident manager (S021)*. In his decisions he is also influenced by the *traffic control planning, situational traffic advice (T024)*, *network capacity sharing agreements (T032)* and of course also by the *meteo information* and the *traffic management rules* we saw earlier.

4.2 Connecting DEMO Transactions to the Application Portfolio

The domain at hand contained a total of 134 applications, separated into 14 application domains plus a category "unknown" for those (4) applications that were mentioned but whose function or even existence could not be confirmed. One domain, applications aggregating data for the purpose of management policy making (including software for model predictions), was excluded because it required a different workshop audience than was available.

While the total number of applications in the traffic management domain does not seem large compared to the complete RWS application portfolio, it is a domain of high complexity. RWS' history of being (one of?) the first European highway agency to apply traffic management automation has led to many legacy applications, in a high degree of entanglement and with many interdependencies. Also, the creation of five autonomous traffic management Centers in the mid '90s made that since then diverse application landscapes have emerged. Another complicating factor is that many applications were developed as stovepipes, having a strong interdependency from the operator's desk to the specific hardware at or near the highways.

All applications considered could be linked to at least one transaction; therefore no IT without purpose was detected. The 14 application domains could further be clustered along the lines of the top-level primary processes of RWS traffic management: Operational Traffic Management (89 applications), Traffic Information Providing (16 applications) and Incident Management (7 applications). The business process Road Maintenance Planning (8 applications) was added to provide for those applications that facilitated the coordination between Infraprovider and Traffic Manager. Finally, applications aiding in systems (configuration) management (18 applications) were put in a separate domain.

We found that when we directly related applications to transactions, it was necessary to distinguish between applications that were supporting the actual production (the performing of traffic management acts) and those that were supporting the infological and datalogical aspects of the transaction (deriving or storing of data). In order to be able to map all applications a few infological transactions were added to the construction model (the green transactions in Fig. 5 and Fig. 6), which we primarily intended to be ontological only. This distinction enabled us to recognize that a system called Traffic Management Data Layer supports the datalogical aspects of a number of transactions.

A theoretical issue did remain, however, with an application aimed at creating an integrated control interface at the traffic operators desk. This too would support a number of (ontological) transactions, by means of front-end integration. Back-end functional units would however each still be attributed to a single transaction. Since all people involved in the rationalization project were familiar with the application, this was easily recognized and did not pose any practical problems.

The distinction between ontological on one hand and info- and datalogical on the other was deemed sufficient to create clusters of similar applications. No need arose to identify applications in support of the coordination. One could wonder why not: specific applications for coordination, e.g. , supporting a request, could be expected. Is there a specific reason in this domain or in the specific contents of our current application portfolio?

Applications from the systems (configuration) management domain could not be directly related to the construction model of traffic management. These applications should be considered to be supporting to the business of the IT service management (which was not modeled).

We found that applications in the meteorological area were all used to inspect a fact bank external to RWS. Each of the applications involved is actually supplied by the meteorological institute that supplies the data.

To gain further insight in the application portfolio, we performed several analyses, like (1) how many applications are supporting a given transaction (2) how many transactions are supporting a given application, and (3) in how many Traffic Management Centers an application is in use. For a part of the application portfolio, we give an impression of the answers we found. Fig. 8 answers question 1: apparently most applications support 1 or 2 transactions; one application supports all (14) transactions. From Fig. 9 we see, answering question 2, that the majority of transactions is supported by at most 3 applications; one transaction is supported by 20 applications. Fig. 7 shows the answers on question 3; apparently 32 applications are in use at just one TMC, meaning either that functionality is not automated in other TMCs or that functionality is duplicated in other appliations; 12 applications were used in 2 TMCs, in part because – as appeared – bridges and tunnels only exist in 2 out of 5 regions; 10 applications are in use in all TMCs. This all helped to focus our attention towards duplication of application functionality and to arrive at an underpinned rationalization advice.

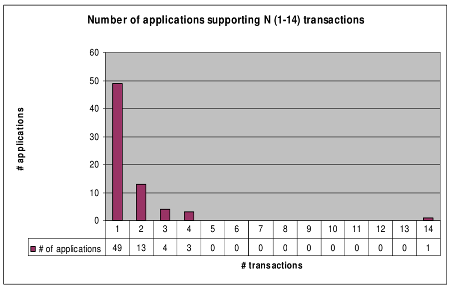

Fig. 8 (1) Application support per transaction

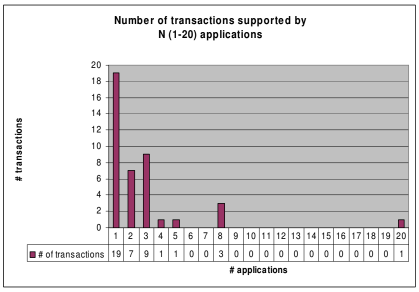

Fig. 9 (2) # transaction supported by applications

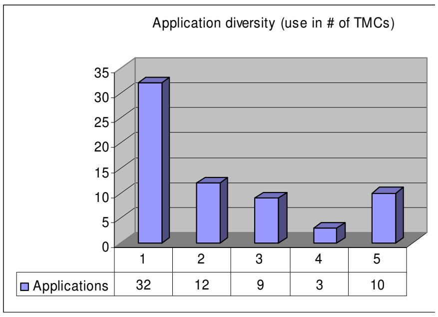

Fig. 7 (3) Application diversity per TMC

4.3 The Rationalization Advice

As a first result to the Board of Directors it was mentioned that for the domain of Road Traffic Management we now have a well structured insight in which applications are used by what departments and TMCs and how this corresponds to other applications, processes and information exchange. Based on that, two important proposals were made, namely (1) on application portfolio rationalization and (2) on technical uniformization of the TMCs.

For application portfolio rationalization, it appeared (Fig. 10) that 49% of the applications could be phased out, 37% is useful and necessary for good Traffic Management and 14% needed further investigation before taking a final decision. For instance, after discovering that for Meteo 4 comparable meteo-systems were used in the several regions, one solution was selected. Even across the borders of Road Traffic Management applications appeared to be "shareable", e.g., the application for Incident Management originating from Wet Traffic Management will now be used for Road Traffic Management as well.

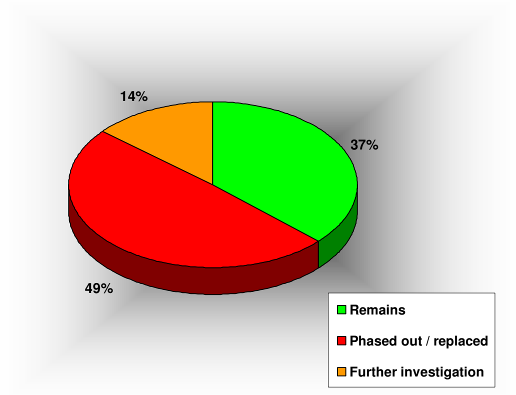

Fig. 10 Summary application reduction proposal

For the TMCs it was advised to replace all 5 existing – different – TMCs by a set of 5 uniform TMCs, uniform both in operating procedures and in ICT. This should strongly reduce the ICT-complexity for Traffic Management, also enabling growth and change to be built on one basis instead of 5, including *distance operation* – traffic operator physically working in one TMC, but operating (part of) a distant TMC. Such a uniform TMC should preferably reuse existing concepts, more a *TMC of tomorrow* than a *TMC of the future*.

Both advices were strongly supported by all parties involved.

4.4 The Return On Modeling Effort (ROME)

In phase 1, "building CM and cross-references to application portfolio", we started to create a generic CM for Road Traffic Management by looking at the regions of RWS that manage and monitor the traffic. RWS has 5 different regions managed by a TMC, and also a TMC on national level. We used the TMC's procedures and reports on traffic management as input on actors and transactions. To refine our view and obtain a stable CM, we spoke to 3 persons on average per TMC, in 4 TMCs each in a 2 hour workshop. In these workshops we refined the descriptions of actors and transactions. Then we could also validate, starting from a current application portfolio list, which applications are supporting the transactions. Using an updated model for the relationship between transactions and applications in the next interview, we were also able to validate the CM in ½ hour. In between, 2 consultants were maintaining the CM, the application portfolio data and the cross-references in Metis, which took roughly 10 mandays.

In phase 2, "decision making on the Application Portfolio for Road Traffic Mgt", 4 workshops with 30 experts were conducted, taking 4 hours for each workshop plus 1 day preparation per consultant. Between the workshops, the experts had to validate and complete the supplied lists, which took them roughly 1 day per expert. The consultants had to elaborate each workshop's results, which took each consultant say 4 hours for each of the 4 workshops, so 2 days per consultant. And also in this period, two consultants were maintaining the CM, the application portfolio data and the cross-references in Metis, which took roughly 10 mandays.

These investments, summarized in Fig. 11, resulted in a phasing out proposal of 49% of the application portfolio. The financial benefits are expected to be substantial, it will e.g. enable that for many applications only one expert is needed instead of 5 (namely currently one per region).

		DEMO-experts		other consultants		TrafficMgt-experts		total
Phase		#	# mandays	#	# mandays	#	# mandays	# mandays
1	building CM & cross-reference to appl-portfolio							
	initial CM and discussion (8 days)	2	16					16
	4 workshops ad 2 hours	2	2			3	3	5
	prepare 4 workshops ad 4 hours/DEMO-expert	2	4					4
	validation CM in 4 interviews ad 0,5 hour	2	0,5			3	0,75	1,25
	maintaining CM, appl-portfolio, X-ref in Metis			2	10			10
	subtotal mandays for Phase 1		22,5		10		3,75	36,25
2	decision making appl-portf Dry Traffic Mgt							
	preparation ad 1 day pp for 4 workshops			5	20			20
	4 workshops ad 4 hours			5	10	30	60	70
	complete & validate lists, 1 day per TM-expert					30	30	30
	elaborate workshops, 4*0,5 day per consultant			5	10			10
	maintaining CM, appl-portfolio, X-ref in Metis			2	10			10
	subtotal mandays for Phase 2		---		50		90	140
	Total mandays ApplPortfRation DryTrafficMgt		**22,5**		**60**		**93,75**	**176,25**
	as percentage of the total time spent		13%		34%		53%	100%

Fig. 11 Investments in Application Portfolio Rationalization Road Traffic Management

5 Conclusions

5.1 Conclusions at the level of this case

With a comparitively low investment, say 175 mandays during half a year, we were able to build a well underpinned application portfolio rationalization proposal, saving 49% of all approximately 130 applications in use by a total of 300 staff in 5 regions and at national level, in a way which was suppported by all parties involved. The fruit of that was not only cost savings, but even an improved use of existing application functionality – regions got access to each other's best practices. Existing knowledge available in the business organization could be used now, which also gave a broad buy in for the application portfolio rationalization program. The attitude towards the program became more positive; where in the beginning the program was seen as a "mission impossible", now many people are positive, seeing the considerable rationalization opportunities and results. It also positioned EAR and its models as strategic and tactical instrument for change in the RWS application portfolio.

In what respect did the method applied contribute to this, what was its added value?

First of all RWS now has a systematic overview and insight on business services and its support by the application portfolio. Using the DEMO CM as a basis, we were able to derive the *impact-of-change* of decisions concerning our application portfolio. This enables RWS to steer its improvement in a controlled way now and in the near future. We e.g. now know which application can be removed without disturbing the business.

Linking DEMO's Construction Model to the application portfolio turned out to be a good *diagnostic instrument for current application duplication*. It opened the opportunity to detect different but similar applications, supporting the same business tasks. For example, for traffic data 4 data collection chains exist, historically originating from different information needs. This issue now got pinpointed and discussed, using questions like (1) what are the underlying information needs in content and quality (e.g., reliability, availability, timeliness, accuracy), (2) to what extent do the several data collection chains needs comply with the quality criteria, and (3) to what extent are the 4 different data collection chains still all required. This instrument for detecting application duplication even worked across RWS's classic organizational divisions, like the distinction between the Wet and the Dry Area. For example, we detected sufficient similarities in

Incident Management for the Wet and the Dry Areas, so that we could propose to let them be served by the same application in the future.

Using DEMO's CM also helped as a *diagnostic instrument for organizational responsibilities*, making complex things better visible and manageable. For example, Traffic Manager needs data about road construction works, as executed by Infraprovider, in order to plan its traffic measures. From the CM it became very simple visible that the data on road construction works are also the responsibility of Infraprovider, and that Traffic Manager needs "just" an query-functionality on that, instead of building own applications. In a sense this was not new, but now it became clear and steerable for all stakeholders.

DEMO's CM also appeared to be a good *structuring instrument* for the appliation portfolio program. It enabled us to derive an objective partitioning into sizeable application domains.

DEMO's CM helped us also to *identify and underpin the need for (better) applicative support*. For example, the control loop for applying traffic measures, which has to be closed by also demonstrating the effect of applied traffic measures, could be significant better supported by IT.

What were critical succesfactors in applying the method?

First of all, it is vital to have a powerful sponsor. In our case the CIO understood the meaning of enterprise ontology, and the need to model the business transactions of RWS. He "sold" the idea wherever he could.

Role and service based thinking is not natural for everyone – communication of this requires time and effort. Some colleagues think more in processes than in transactions / services and in "types of official" instead of roles, and it takes time to see that one official, e.g., *road inspector*, fulfills several actor roles, like viewer, road cleaner and traffic regulator. At the same time we needed the abstraction of the actor roles as a stable anchor point for connecting applications; names of types of official are more subject to change than actor roles. Another example is that we envisioned an important end-user of RWS-products, namely the user of the main road network, as an information consuming actor, not as a business actor with whom RWS executes a transaction. For some colleagues this seemed contradictory with RWS's strategic spearhead *user orientation*, while we saw this as means to clarify exactly what we mean by user orientation in this relationship.

Applying the method is not a mechanical process, it requires good consultancy skills and subject matter expertise. E.g., when connecting applications to business transactions it appeared that quite a few applications support more than one transaction; to get this managed we identified *discussion domains*, using gut feeling and implicit knowledge.

Good tooling to support the method is required. Tooling can efficiently implement traceability and allows for analysis of impact-of-change. Especially when models like the CM and the application portfolio are embeddded in a greater whole of models (information models, data models, technical infrastructure services) related to each other, this becomes more and more important. Also tooling made it possible to model only once and then to build on one or more models several visualizations and views for the several stakeholders, target groups and messages.

What did we experience as limitations of the method applied?

First of all, we could perfectly link applications used in our primary business to the DEMO CM. It was however not so easy to link our generic applications, like the support for Asset Management or the Traffic Management Data Layer.

For a first order rationalization of the application portfolio – phasing out or replacing complete applications – this method worked. However, it was felt that for more radical architectural improvements, like the introduction of Service Oriented Architectures (SOA) or the introduction of one corporate datawarehouse, the method needs extension. Such a method could start with the DEMO transactions delivering Business (B-)services, and use that to identify Information (I-) services and Application (A-)services. In such a way one line of reasoning can be followed from a Service Oriented Enterprise (SOE) to SOA. This could start simple by first deriving I-services and use that for a data consolidation, based on understanding of the meaning of the data.

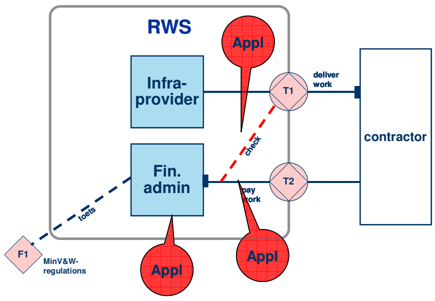

Fig. 12 Alternative notation DEMO information link

We would find it useful to model some extra things in the DEMO CM. For example, we modeled the *user of the main road* as an information consumer only, not as a business actor, which for some felt contradictory to RWS's strategic spearhead *user orientation*. This triggered a discussion whether it would be useful to introduce, next to the transaction link and the information link, another link which we called the *uselink*, expressing that an actor uses a transaction-result. Also we discussed about the information link in the DEMO CM. Many times we know already at the moment a DEMO CM is constructed if an information link is used by the initiator, the executor or both. Then we would like to be able to express that more specific in the CM, e.g., by letting the information link point to the initiation link (see Fig. 12) or the execution link or the transaction, respectively.

5.2 Conclusions by comparing with earlier work

In an earlier case at ING Service Center Securities (Arnold et al 2005), only a list of transactions was used in a proposal for both organization and application portfolio rationalization. We now used a complete DEMO CM, including actors, transaction links and information links. This opened up the possibility to connect applications to each of the three CM-elements. When testing those three options, we found that connecting applications to transactions could be done for 80% of the applications to transactions in 10 minutes. This confirms the intuitive choice in the ING case to connect applications to transactions indeed.

The DEMO CM appeared to be efficient in creation and use. After a short explanation, typically of ½ or ¾ hour, it could be read and audited by subject matter experts, though for some experts the learning curve compared with reading a process model took longer. It was estimated (though not proven) that making the CM took considerably less time than making a process model. This confirms estimations from other sources (Dietz 2006) that the making of a CM can be done in less than 10% of the time than a process model, because it stays on the business level (abstracting from the infological and datalogical level) and because it only shows transactions, compressing coordination acts like request, state, promise and accept.

The DEMO CM also appeared to be effective. The CM clarified organizational responsibilies, especially since it is independent of any organizational implementation. So the communalities between Dry and Wet Traffic Management could be clarified, producing the reuse of processes and applications for Incident Management as benefit. And it made clearly visible that the Infraprovider is responsible for providing data on road construction works, even though Traffic Management is the main user.

The usability of the CM for clarifying organizational responsibilities confirmed our earlier findings in the ING case. In the ING case however we only used the list of transactions for reassigning responsibilities to the new organization. Here we also found that knowing the information links helped in that.

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