

MASTER

What to inspect? What to expect?

order acceptance and human capacity planning at the "voedsel en waren autoriteit"

Alders, S.T.C.

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Eindhoven, February 2008

**What to inspect? What to expect?
Order acceptance and human
capacity planning at the
“Voedsel en Waren Autoriteit”**

by
Sander T.C. Alders

BSc Industrial Engineering & Management Science – TU/e 2005
Student identity number 0508997

in partial fulfilment of the requirements for the degree of

**Master of Science
in Operations Management and Logistics**

TU/e Supervisors:

dr.ir. S.D.P. Flapper, TU/e, OPAC

dr. T. van Woensel, TU/e, OPAC

Company Supervisor:

Ing. J.M.W.M. Beelen, VWA

Drs. P.W.M. Westgeest, VWA

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I. Introduction

The food and consumer product safety authority (in Dutch: Voedsel en Waren Autoriteit, VWA) is a Dutch governmental organisation. The VWA defines its mission as to work towards safe and healthy food, safe products and healthy animals. To pursue this mission, different teams perform different kinds of work. Three such teams are the "Teams Levensmiddelen Productiebedrijven" (TLP) in the region Northwest, with a focus on companies that produce foodstuff. The workload of these teams consists of different kinds of inspections, partially internally initiated, partially externally initiated. The VWA Northwest has difficulties in meeting the demand for internally initiated inspections. This seems strange as this demand is internally generated and adapted to available capacity. This project aims to analyze this problem, find causes and develop a solution.

After an introduction to the VWA in chapter 1, the current lifecycle of the internally initiated demand for inspections is analysed in chapter 2. This narrows the search for causes down to two areas, the capacity check and the short term (<1 year) planning. Each of those areas is then analyzed more thoroughly in chapters 3 and 4. This results in weak points that are identified in each of those areas. In chapter 5 a redesign of the current short term (<1 year) planning system is proposed.

II. Management summary

The food and consumer product safety authority (in Dutch: Voedsel en Waren Autoriteit, VWA) is a Dutch governmental organization. The VWA defines its mission as to work towards safe and healthy food, safe products and healthy animals. To pursue this mission, different teams perform different kinds of work. Three such teams are the "Teams Levensmiddelen Productiebedrijven" (TLP) in the region Northwest, with a focus on companies that produce foodstuff.

The workload of these teams consists of different kinds of inspections, partially internally initiated, partially externally initiated. The VWA Northwest has difficulties in meeting the demand for internally initiated inspections. This seems strange as this demand is internally generated and adapted to available capacity. This project aims to analyze this problem, find causes and develop a solution.

The lifecycle of internally initiated demand consists of different steps, shown in figure 0.1. Two of those steps are critical for being able to meet the demand for inspections; the capacity check and the short term planning. The other steps can – if not correctly executed – only cause more work in the generation of the demand. Therefore the search for a cause is limited to the capacity check and the short term planning.

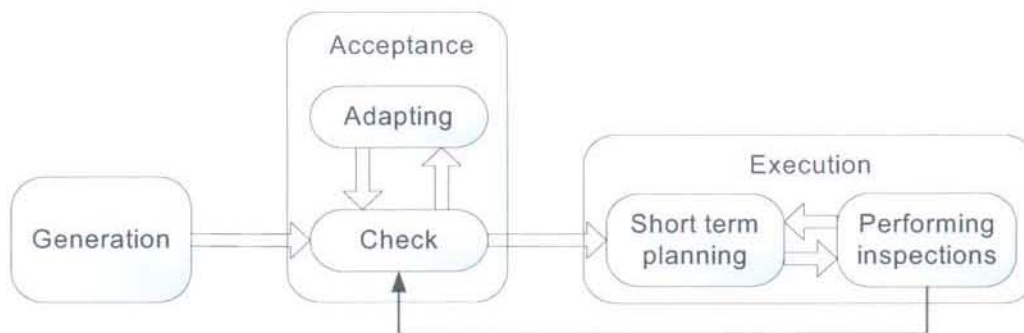


Figure 0.1 The lifecycle of internally initiated demand at the VWA

Capacity check

The capacity check compares the demand for inspections with the available capacity to check whether the generated demand is feasible. To perform this check, different pieces of information are needed. The different pieces of information are gathered from a database, estimated, result of strategic and/or tactical decisions or the product of other pieces of information. How the different pieces of information are interconnected is shown in figure 0.2. Each piece of information is assessed on its quality and its potential to cause the demanded numbers of inspection not to be feasible if of low quality.

The result of this assessment is that the list of companies to visit is of low quality as it changes during the year, where the check is only performed once a year. However as the demanded numbers of inspections are based on the number of companies to visit, and then fixed, being a sample of the tot number of companies that can be visited. Changes in the list of companies during the year do not influence the demanded numbers of inspections. Therefore the low quality of this piece of information can not cause the numbers of inspections not to be met.

The second piece of information that is of low quality is the estimate on the time needed for an inspection. These estimates are subjective and not based on hard data. The accuracy of the estimates can not be checked because hard data is not available. If the estimates are inaccurate it can cause the demanded numbers of inspections not to be reached.

The current information system at the VWA to archive used time (FaTijDec) is scheduled to undergo some changes in the near future. When implementing these changes, the adding of a field which project is worked on should be taken into account. This will provide hard data on time used per inspection, which can be the basis for time-estimates for the next year.

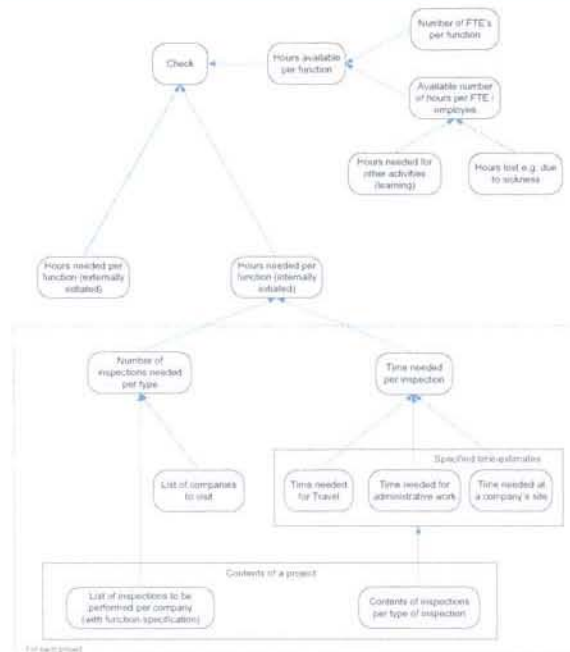


Figure 0.2 The information used for the capacity check is interconnected

Short term planning

Once a year the TLPs are presented a workload to be executed during that year. First the total internally initiated workload is divided into workload per function. Then this workload per function is divided among the inspectors with that function. Each inspector now has an amount of work to execute during the year. The inspectors are free to plan when to do which inspection at which company, no consistent structure is used to plan this. Two weak points can be identified in the current system for short term planning.

The first and most important weakness of the current system for short term planning is the lack of focus on time needed for traveling. The time that is needed for an inspection can be divided into time needed on site, time needed for administrative purposes and time needed to travel. The amount of time needed on site and for administrative purposes cannot be influenced by planning. The time needed to travel depends on the locations that need to be visited and, more importantly, the combination of locations on one day. This is the decision made by the planning system. In the current system for short term planning, there is no focus on minimizing the time needed to travel, while this is the only part of the used time that can be influenced.

The second weakness of the current system for short term planning is that the workload per function is divided among the inspectors, before it is planned when to perform which inspection at which company. This includes the decision which inspections to combine on one day. Dividing the workload among the inspectors first and planning second greatly reduces the number of possible combinations of inspections on one day compared to a situation where the inspections are combined first and then divided among the inspectors. It is still possible that the optimal combination of combinations of inspections can be constructed when first the total workload is divided among the inspectors, though the chance is a lot smaller, compared to a plan-first-divide-second system.

New system for short term planning

A new system for short term planning is proposed. In this system the total workload is still first divided into workload per function. It should be noted that as the current division of skills does not enable any benefits to be gained from the use of crosstraining, this technique is not used. The main difference compared to the current system is that in the new system, first inspections are combined into days of work, and then divided among the inspectors. The new system for short term planning consists of the following steps.

Combine inspections into days of work

The inspections are combined into days of work. The goal is to minimize the time needed to travel. This is done by minimizing the distance between inspections on one day. To minimize the distance between inspection locations, the inspections are clustered per postal code area, where it is assumed that the distance between two locations with the same postal code is negligible compared to the distance between one of these locations and the starting point. If composing the days of work does not result in an integer number of full days, the leftover inspections are planned together with the inspections in an adjacent postal code area. This step of the new system is performed every four weeks. After composing the days of work, some of these days are allocated to inspectors for the next four weeks. Since the list of inspections to perform changes over time, due to re-inspections and complaints, the composing of days of work needs to be done every four weeks, before allocating the days to inspectors.

Executing this step of the planning system requires a lot of repetitive tasks to be performed. To aid the teamleader in using the new system, this step is performed by a program in MS Excel.

Allocating days of work to inspectors

This step of the new system for short term planning consists of two decisions. The first decision is which of the days of work to allocate to inspectors, the second is which inspector the day of work should be allocated to.

The time needed to perform an inspection does not depend on the point in time it is performed. Therefore nothing can be gained with regard to used time while deciding which days of work to allocate to an inspector. In extreme cases a situation may occur where due dates of inspections can not be met. To minimize the risk of such a situation to occur, days of work are allocated to inspectors in a sequence with the earliest due date first (EDD).

The group of inspectors with the same function is assumed to be homogenous with regard to the task that can be performed and the time needed to perform the task. However differences may exist in the inspectors' starting points. To minimize the time needed to travel between an inspector's starting point and the locations of the inspections of a particular day of work, that day is allocated to the inspector with the starting point closest to the locations that need to be visited.

Recommendations

- Enabling the possibility for hard, objective estimates on how much time is needed for an inspection, for instance by including a field in FaTijDec.
- Use a short term planning system that aims to minimize traveling time, for instance the system that is mentioned above and described in more detail in chapter 5



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1. Company description

In this chapter the history of the Voedsel en Waren Autoriteit will be described briefly, followed by a description of its current organisational structure.

1.1 History

1.1.1 Keuringsdienst van Waren (KvW)

For centuries, different communities have had "keuren" or marks to keep infectious products and dirty water or milk from the marketplaces, but it was not until 1893 that the first official inspectorate was installed in the city of Rotterdam. Its first tasks were the check on diluted milk, rotting cheese and the weight of bread.

Various cities followed and in 1919 they got jurisdictional backing by the "warenwet" or food-law, with official quality demands for different types of food. Over time, the various communities' inspectorates joint forces into new regional inspectorates, which had a whole province as their working area. In 1988 eventually, these regional inspectorates joined forces into one national agency, the Inspectorate for Health Protection and Veterinary Public Health ("Keuringsdienst van Waren" - KvW)

1.1.2 Rijksdienst voor de keuring van Vee en Vlees (RVV)

The National Inspection Service for Livestock and Meat ("Rijksdienst voor de keuring van Vee en Vlees"- RVV) was established in 1983. It was a combination of the different agencies that were already active throughout various communities (the "gemeentelijke vleeskeuringsdiensten"). Its main task was to check whether the requirements regarding the public health, animal health and animal wellbeing, which are induced by the law, are met during the production and throughput of animals and animal products.

1.1.3 Voedsel en Waren Autoriteit (VWA)

On July 10, 2002, the "Rijksdienst voor de Keuring van Vee en Vlees" (RVV) and the "Keuringsdienst van Waren" (KvW) joined forces in forming the Food and Consumer Product Safety Authority ("Voedsel en Waren Autoriteit"- VWA), first as different parts of the same bureau and as of January 1, 2006 as one agency, the VWA, with 1800 employees (VWA Jaarverslag, 2006). As a part of the Dutch government, it runs partially on government funding and does not have profit as a goal. In 2006 the VWA has produced an annual turnover of €169 million (VWA Jaarverslag, 2006).

The VWA defines its mission as to work towards safe and healthy food, safe products and healthy animals. The VWA identifies risks, assesses them, communicates on them and makes the risks controllable for society. To accomplish these goals, the VWA has set itself three core-tasks;

- Check whether the laws concerning food, goods and animal's health and wellbeing are obeyed.
- Risk-assessment and research: the identification and analysis of possible threats and conduction of scientific risk-assessment
- Risk-communication: the communication on risks and the control and mitigation of those, based on trustworthy information.

1.2 Organization

The VWA is divided into different functional divisions. One of those divisions is the "dienst uitvoering", with as its main task the execution of inspections, is subdivided into 5 regional headquarters, North, Northwest, Southwest, South and East, a laboratory in Wageningen and 21 local support stations. At the regional headquarters of Northwest in Amsterdam different teams operate, each with a different functional specialty. Three of those are the "Teams Levensmiddelen Productiebedrijven" (TLP). These are teams that focus on companies that produce foodstuff. At the start of this project, the three teams had the same functional specialties and were geographically spread over the region of Northwest. At the end of the project however, the organization has changed into a situation with two teams with different functional specialties, each serving the whole region of Northwest. The TLPs form, together with some other teams, the division "Teams ProductieBedrijven" (TPB). This organizational structure is visualized in the organogram in figure 1.1. The departments of "Singalering & Ontwikkeling" (S&O) and the department of "Financiën, Planning & Control" (FP&C) can also be found in the organogram, these departments will be discussed in chapter 2 "problem description".

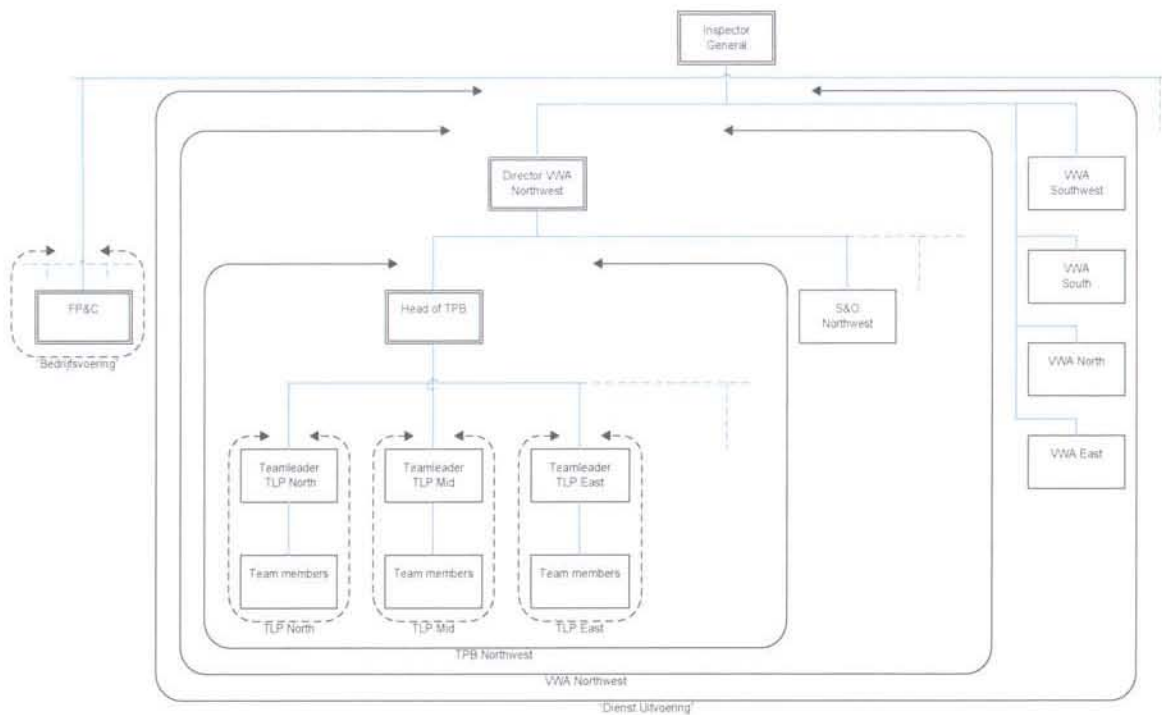


Figure 1.1 Organogram of the VWA (only parties relevant to this project)

1.3 Teams Levensmiddelen Productiebedrijven (TLP)

In the region of Northwest, 3 TLPs are active with a total of 48 FTE's (2007), each with a different geographical focus. During this project the VWA is considering changing this geographical differentiation into a functional differentiation. In the present structure the teams consist of employees with different functional specialisms. The work of the TLPs can also be divided into different types. Which type of employee can do which type of work can be seen in table 1.1 where the columns denote different types of employees and the rows denote the various types of work. A match is marked with a "1". The change of the organizational structure into functional teams changes this matrix in that the matches marked with * are no longer available.

	1 senior toezichthoudend dierenarts (senior TDA)	15 toezichthoudend dierenarts (TDA)	7 Senior System Auditors (assistant TDA)	4 assistant system auditors (TDA)	3 productdeskundigen (SSA)	11 senior controleurs (ASA)	2 assistent controleurs
AM-keuring (ante-mortum)	1	1					
Toezicht PM-keuring (post-mortum)	1	1	1				
Export certificering	1	1					
Systeem audits					1		
Systeem inspecties	1*	1*			1	1	1
Inspecties	1*	1*	1*		1	1	1
Monsternamen	1*	1*	1*		1	1	1

Table 1.1 Different types of work and employees at the TLPs

The goal of the VWA is to work towards safe and healthy food, safe products and healthy animals. This mission is pursued through different types of checks at the concerning companies. Checks on the quality of the companies' procedures to guarantee healthy food and checks on the actual realized quality of the produced food. The precise contents of the different checks as well as the number of checks to be performed change over time. The decision on these contents and numbers of checks is made on a yearly basis, not by the TLPs themselves, but by a different part of the VWA, "Signalering en Ontwikkeling" (S&O). The work that S&O generates consists of different projects. A project generally consists of information on which inspection to do, as well as its contents, at which company or type of company and the functional requirements regarding the performing inspector.

2. Problem description and design of project approach

In this chapter the problem the VWA has is introduced. The research area is delineated and after the theoretical relevance is described, the research question is introduced.

2.1 Problem description

As said earlier, the content of the workload of the TLPs is described in different projects. These projects are generated by S&O, by use of the "jaarplancyclus". This cycle is described in more detail in appendix I. The workload of the TLPs is partially externally initiated and partially internally initiated. Work that is externally initiated is charged to the initiating company. Work that is internally initiated can be subdivided in a part where the company that is subject to inspection is charged and a part where the inspections are paid for by the Dutch government. These different types of work have different priorities induced by law.

1. externally initiated work
2. internally initiated work, charged to the company that is subject to inspection
3. internally initiated work, paid for by the Dutch government

This prioritisation results in the fact that the demand for externally initiated work always has to be met. The demand for internally initiated work that can be charged to the company is met to a large extent. The problem is demand for internally initiated work that cannot be charged to the subjected companies. The VWA has difficulties in meeting this demand.

2.1.1. Validation

To validate the problem, the planned numbers of inspections need to be compared with the realized numbers of inspections. The problem was formulated by the VWA after the planned numbers of inspections were compared to the planned numbers for the year 2006. The planning and execution of inspections in 2007 however differs from the planning and execution in 2006 and looking forward, the planning of numbers of inspections for 2008 has been done different from the planning in 2007. The most recent figures available are the planning and realization of the numbers of inspections for 2007. As the whole system for generating, planning and executing demand is changed every year, but with the active system as a starting point, the most recent system is assumed to be most – yet not fully – representative for the situation on 2008, and are therefore used to validate the problem.

In table 2.1 the 33 projects of which planning and realization figures are available are shown (projects that are charged to the subjected companies are marked with a *). As can be seen in the table, three projects have had more inspections performed than planned due to complaints and re-inspections, for the rest of the projects only four projects have managed to realize more than 90% of the planned numbers of inspections. The projects have realized an average of 80% of the planned inspections, though when the projects with more inspections realized than planned are set at 100%, the average percentage of realized inspections drops to 60%. These percentages indicate that the VWA has a problem realizing the demanded numbers of inspections, justifying further research.

Projectcode	Projectname	Realized	Planning	Percentage
ND071402	Inventarisatie traceerbaarheid verpakkingen	14	23	60,87%
ND071404	Markverkenning ITX in verpakking	1	5	20,00%
NW07015I	Wasplaatsen veeervoermiddelen	200	299	66,89%
NW070260	Verantwoorde toepassing van dierproeven	437	450	97,11%
NW070262	Biotechnologie bij dieren	24	60	40,00%
NW07034E	Inspectie bij reststroomproducenten in de levensmiddelenind	31	60	51,67%
NW07055A*	Exportcertificering pluimvee	10	20	50,00%
NW07055B*	Erkenning verzamelcentra	16	16	100,00%
NW07055C*	Erkenning SWC en ET	2	4	50,00%
NW07055E*	Erkenning dierentuinen	2	3	66,67%
NW071412	Handhaving hygiëncode bij AGF-bedrijven	27	49	55,10%
NW071420	Controle GGO in levensmiddelen en -grondstoffen	17	12	141,67%
OT07041A	Toezicht bij intermediaire bedrijven cat. 1 en 2	10	12	83,33%
OT07041B	Toezicht bij intermediaire bedrijven cat. 3	19	90	21,11%
OT07041C	Toezicht opslagbedrijven	11	12	91,67%
OT07041D	Toezicht verbrandings- en meeverbrandingsinstallaties	4	6	66,67%
OT07041G	Toezicht biogas- en composteerinstallaties	3	6	50,00%
OT07041J	Toezicht technische bedrijven	2	3	66,67%
OT07041L	Toezicht voeding, pelsdierbedrijven en verzamelcentra	9	11	81,82%
OT07041M	Intraverkeer dierlijke bijproducten	52	83	62,65%
OT07041N	Nieuw te erkennen bedrijven	5	44	11,36%
OT07042C	Verwijdering DBP na diagnose, onderzoek en onderwijs	1	2	50,00%
OT07062A*	Erkenningverlening en onderhoud	1146	441	259,86%
OT07064A*	HACCP veterinaire sector industrieel	400	590	67,80%
OT07064B*	HACCP veterinaire sector niet industrieel	134	610	21,97%
OT07064C	Toezicht verord. microbiologische criteria vlees en -product	115	199	57,79%
OT07064D*	Toezicht en traceerbaarheid koel- en vrieshuizen	75	258	29,07%
OT07101A	Kwaliteitsborging COKZ 2007	5	11	45,45%
OT07101C	Kwaliteitsborging CPE	4	5	80,00%
OT0713B1	Brononderzoek n.a.v. meldingen zoönosen en voedselinfecties	2	10	20,00%
OT07153C	Opsporing op verzoek primaire toezichthouder	57	10	570,00%
ZD070820	Nalevers door handhaving - TLP	738	1474	50,07%
ZD071210	Etikettering allergenen	51	115	44,35%
ZD071610	Toezicht BED	712	782	91,05%
			Average percentage realized	80,08%
			Normalized average percentage realized	60,33%

Table 2.1 Planned and realized numbers of inspection at the TLPs in 2007

2.2 Delineation of research area & initial research question

To delineate the research area the lifecycle of internally initiated demand is considered. The lifecycle of internally initiated demand for inspections at the VWA can be divided into three steps, which are visualized in figure 2.1. Each of the steps will be discussed shortly and evaluated on its potential to cause the demanded numbers of inspections not to be met if not executed optimally. This results in areas of interest for further analysis.

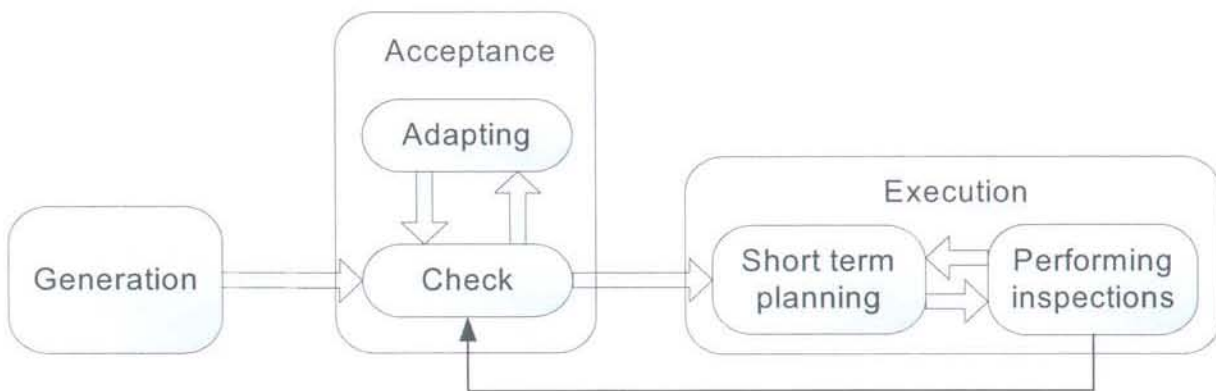
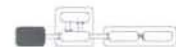


Figure 2.1 The lifecycle of internally initiated demand at the VWA

2.2.1 Generation of demand



Description: The department of S&O generates the demand for internally initiated inspections. This demand is based on what S&O perceives to be necessary to be able to guarantee a certain level of food safety. This perception is influenced by various parties, such as politics, media, companies and the executing teams. This part of the lifecycle covers the contourstage and part of the conceptstage of the "jaarplancyclus" (Appendix I).

Consequences if not done correctly:

Because the demand is generated based on what is perceived to be needed, it is very well possible that the demanded numbers of inspections are not feasible, taking into account the available resources. However if the capacity check is done correctly, the generated demand will not be rolled out to the teams. Therefore generating an infeasible demand for inspections cannot be a cause for the numbers of inspections not to be met.

2.2.2 Acceptance (adapting, capacity check)



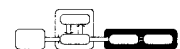
Description: The demand for inspections, as perceived to be necessary to ensure a certain level of quality and food safety, has to be executed by the TLPs. However, these teams have only limited resources, so a decision has to be made on what to do and what not to do. To make this decision, first the demanded numbers of inspections are checked against the available resources for their feasibility. The question to answer is; "are enough resources available to perform the demand numbers of inspections?" Based on the outcome of this check the demanded numbers of inspections are adapted. The decision which inspections to accept and which to reject is made by S&O and is based on the same specific knowledge that was used for the initial generation of the demand. After the adapting, the demand for inspections is checked against available resources again. If the demanded numbers of inspections are still not feasible, it is sent back to be adapted again. If the demanded numbers of inspections are found to be feasible, the projects are rolled out to the TLPs for execution. This part of the lifecycle of demand covers part of the conceptstage, the decisionstage and part of the evaluation and executionstage of the "jaarplancyclus" (Appendix I).

Consequences if not done correctly:

If the adapting is not done correctly, it will continue delivering demands for numbers of inspections that are not feasible to the capacity check. If this check is done correctly, the demand will then continuously be rejected. Depending on the underlying reason for the bad adapting this would either result in a deadlock in the lifecycle or eventually in a demand that is feasible after all. In both cases it will not cause the demanded numbers of inspections not to be realized.

The capacity check can be done incorrectly in two ways; false rejection and false approval. If the capacity check rejects demanded numbers of inspections where they are in fact feasible, it could result in either a deadlock in the lifecycle, or an amount of work that is feasible, though less than possible to be performed. If, however, the capacity check approves demanded numbers of inspections where they are in fact not feasible, the demand cannot be met. A bad capacity check can cause the numbers of inspections not to be met.

2.2.3 Execution (short-term planning, performing inspections)



Description: Demand for internally initiated inspections arrives at the teams once a year. The short term planning (<1 year) when to do which inspection, by whom, at which company is done by the team leader. This part of the lifecycle of demand covers part of the evaluation and executionstage of the "jaarplancyclus" (Appendix I).

Consequences if not done correctly:

If the short term planning of inspections is not done correctly, it is possible for the demand for inspections not to be met. For instance, if inspections with a large distance between them are combined on one day, it will cause long traveling time and with only a limited amount of time available, only a limited number of inspections can be done.

If the execution of the inspections is not done correctly it will result in longer times needed for the inspections. These longer times will be part of the input for the capacity check. Because of this feedback loop, the demand for inspections will still be feasible if the inspections take more time than necessary.

Two steps in the lifecycle have potential for causing the demanded numbers of inspections not to be met if not done optimally; the capacity check and the short term planning (<1 year). The area of research will therefore be limited to these two steps. The initial research question will be how these two steps can be performed optimally. Optimally in this case means against the lowest costs, where costs are generated by the time needed by all inspectors per function. More specific this question is asked for the situation at the TLPs at the VWA, in other words;

How can the demand for different types of work requiring different skills, for different types of workers with different skillsets, be checked for feasibility, and how can these workers be planned to meet this demand against the lowest cost?

2.3 Theoretical relevance & research question

The demand for inspections is rolled out to the TLPs once a year. The planning who does what is done by the team-leader. The planning when to do what and where is done by the team-members. This planning is not entirely free as some projects prescribe certain timeframes for the inspections to be performed within. Furthermore certain prescriptions are given with regard to the time between certain inspections, for instance a re-inspection has to take place at least two weeks but at most six weeks after the first inspection. Altogether this results in fluctuations in the weekly demand for inspections, both in total volume and in the distribution of functional requirements. To cope with these fluctuations, the TLPs have different techniques at their disposal:

- Overtime (flexible working hours)
- Outsourcing
- Crosstraining

2.3.1 Overtime

It is possible for the demand for hours from inspectors, in total or from a specific functional group, to exceed the available number of hours during some periods. To cope with such a situation, the inspectors can work overtime. The extra hours however are not paid for in terms of extra money, but in extra free time, leaving the total number of hours to work per inspector during a year unchanged.

The technique of overtime is described in various publications (Pinker & Larson, 2003; Wild & Schneeweiss, 1993), also specific for a service environment (Easton & Rossin, 1997), though with payment in terms of money. The compensation in terms of free time, as is the case at the VWA, is described as "transitory overtime" (Bauer & Zimmermann, 1999; Pannenberg, 2005). As the total number of available hours does not change when using this technique, it has no influence on the capacity check, though it can have an influence on the possibilities during short term planning (<1 year).

2.3.2 Outsourcing

A second way to cope with peaks in demand is to outsource inspections. The VWA uses this technique for specific functional groups (different types of veterinarians). The technique is used frequently and the inspections are outsourced to a specific group of external veterinarians, therefore these external inspectors can also be seen as temporary workers, rather than pure outsiders.

Outsourcing is described in literature (Harland et.al., 2005), though in this situation the literature on temporary workers is more relevant. The technique of outsourcing or temporary workers is only used to cope with fluctuation in externally initiated demand. It could work through to internally initiated demand if in-house veterinarians would perform internally initiated work, though this possibility is never used.

2.3.3 Crosstraining

As the composition of the demand for inspections per function may vary each day, the technique of crosstraining can be useful to cope with these fluctuations. Crosstraining describes a situation where inspectors have more than one skill. As can be seen in table 1.1, the TLPs represent such a situation. The situation at the TLPs is a special case of crosstraining, as the skillsets of the different types of workers are overlapping in a way that hierarchically higher workers have all the skills that "lower" have, and one or more other.

If the technique of crosstraining is available, two decisions have to be made. How many workers should have a particular skillset and when does a multi-skilled worker work using what skill. On the first decision various publications are available, though mainly describing a production environment (Lee & Vairaktarakis, 1997; Zavadlav et.al., 1996; Hopp et.al., 2004). The situation that is most described is with different subsequent production steps (Hopp et.al., 2004), which is not the case at the VWA. On the second decision, different publications are available as well, but again mainly aimed at production environments (Agnihotri & Hishra, 2004, Van Oyen et. al., 2004).

2.3.4 Research question

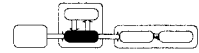
This project analyses the system for manpower planning at the VWA, a situation where possibilities for the use of overtime, outsourcing and crosstraining exist, in a service environment. The existing publications mentioned above, describe situations where overtime, outsourcing and crosstraining are used, either separately or in combinations. At the VWA travelling time plays an important role. A service environment where possibilities for the use of overtime, outsourcing and crosstraining exist, taking into account travelling time is, to my knowledge, not yet described in literature. Studying such a situation will therefore contribute to existing knowledge. Combining this with the initial research question, the research question this project seeks to answer will be;

How can the combined demand for different types of work in a service environment requiring different skills, for different types of workers with different skillsets, be checked for feasibility, and how can these workers be planned to meet this demand against the lowest cost, taking into account flexible working hours, outsourcing, crosstraining and travelling time?



2.4 Practical relevance

The VWA has a problem realizing the numbers of inspections they set themselves. Those numbers are needed to guard the safety and quality of food-production and through that the safety and quality of food in The Netherlands. My master thesis will help identifying the causes of this problem and will help solving them. Through that it will help increasing and/or safeguarding the safety and quality of food in The Netherlands.



3. Capacity check

In this chapter the capacity check is analyzed. Its structure is described, and then assessed, resulting in the identification of some weak points and possibilities for improvements.

As proposed in the problem description, one area of interest for further analysis is the capacity check. If the capacity check is not performed correctly it will allow for an infeasible demand for inspections to be rolled out to the teams, eventually leading to a situation where the demanded numbers are not met. To evaluate the quality of the capacity check, first its structure needs to be known. This results in a list of pieces of information that are used for the check, a tree of how these pieces of information are connected and a description of the translations that are needed to get to these pieces of information. Once this structure is known, the different pieces of it are evaluated and their quality is assessed.

In order to get to the aforementioned, various people have been interviewed.

- Two senior advisors from FP&C (who perform the check)
- Head of TPB (who is responsible for some information that is input to the check)
- Five projectleaders from the department of S&O. (who are responsible for some of the information that is input to the check. In total more than 50 projectleaders are involved, how this sample is taken is described in Appendix II)

3.1 Structure of capacity check

To perform the capacity check various pieces of information are used. The structure of what information is based on what other information is visualized in figure 3.1. Each box represents a piece of information, either gathered from a database, estimated, or the product of other pieces of information, eventually leading to the capacity check. The check will result in a go/no-go decision for the projects whether they will be rolled out to the teams. In case of a no-go, the check provides information on which types of worker have too much work assigned to them and which types of workers too little. A no-go will cause S&O to change some of the contents of some of the projects, before it is checked again.

To evaluate each piece of information used in the capacity check, the four categories of information quality as described by Lee (2002) are used. Each part of the network shown in figure 3.1 is assessed on these four categories to be of high (+), low (-) or non-determinable quality (0);

1. Intrinsic quality
Is the information accurate and objective?
2. Accessibility quality
Is the information easy to access, taking into account security issues?
3. Contextual quality
Is the information on time, relevant and complete?
4. Representational quality
Is the information easy to understand and presented consistent?

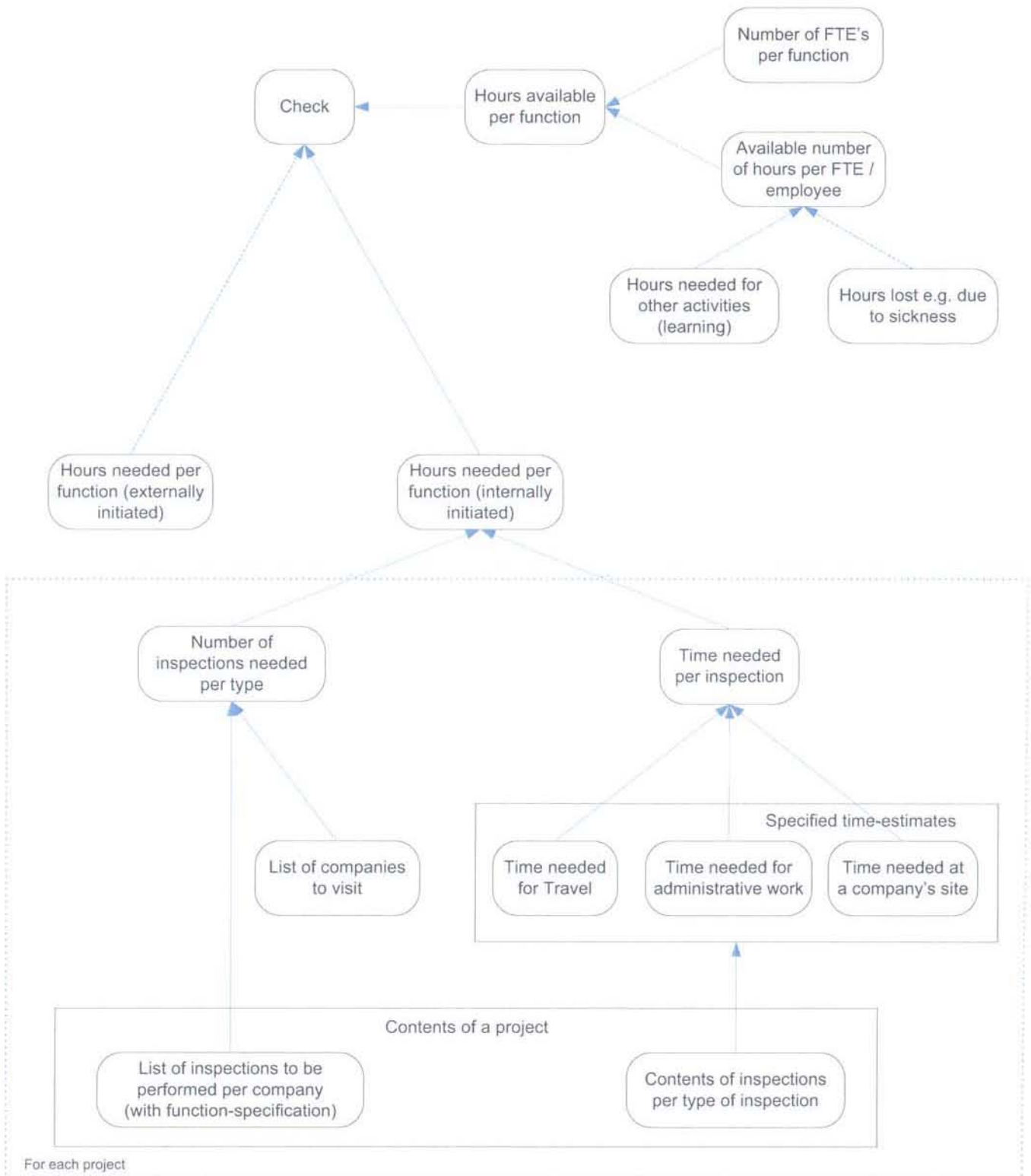
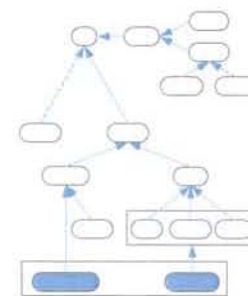


Figure 3.1 The information used for the capacity check is interconnected

3.1.1 Contents of a project

Description

The contents of the projects consist of a list of inspections to perform and the contents of those inspections. This information is the result of decisions made by S&O.



Assessment

Intrinsic quality

The content of inspections is used to make time-estimates. This estimate is made by the same person as who makes decisions on the contents, so any accuracy related problem on the contents of a project would be mitigated in this translation. (+)

Accessibility quality

The information on the contents of a project is easy to access through the internal information system. (+)

Contextual quality

The information on the contents of a project is relevant for determining the number of inspections per type and the total time needed to perform each type of inspection. (+)

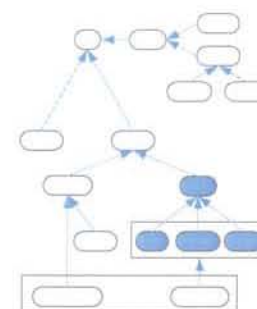
Representational quality

The information is presented the same for each project in a way that is easy to understand for the concerning parties. (+)

3.1.2 Time needed per inspection

Description

The time that is needed per inspection is divided into time needed for travelling, administration and time on site. In previous years the department of S&O estimated these times based on their experience and feedback from the TLPs on the correctness of earlier, similar, time-estimates. No hard data is used for the time estimates. For the projects that are currently being developed at S&O East to be executed in 2008, the head of TPB, together with the TLPs, do the estimates. These estimates are again based on experience and not on hard data.



Assessment

Intrinsic quality

The estimate is not based on hard data and therefore subjective. As hard data on actual times is not present, the accuracy can not be determined.

No time-estimate for any inspection is representative for a time-estimate for any other inspection, therefore no subset of time-estimates for inspections would be representative for the complete set of time-estimates. Furthermore, getting a representative number of inspections from each of the projects performed would need a vast amount of time as a lot of the projects have only a limited number of inspections planned per year. Due to the limited amount of time available for this project the accuracy of the time-estimates will not be determined. (-/0)

Accessibility quality

The information on time-estimates is easy to access through the internal information system (+)

Contextual quality

The time-estimates are relevant to determine the total numbers of hours needed per function (+)

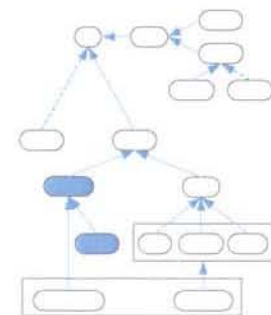
Representational quality

The information on time-estimates is presented in a way that is easy to understand by the concerning parties. (+)

3.1.3 Number of inspections needed per type

Description

To determine the number of inspections needed per type the demanded inspections per company is combined with the list of companies.



Assessment

Intrinsic quality

The list of companies is accurate as it is provided by the executing teams who have everyday experience in the field and are thus adapting the list on a daily basis. The resulting number of inspections per type is objective (+)

Accessibility quality

The information on the numbers of inspections that are needed is easy to access through the internal information system.(+)

Contextual quality

The list of companies to visit is subject to a constant change as companies are created and terminated daily, so the timeliness of the information is somewhat low. (-)

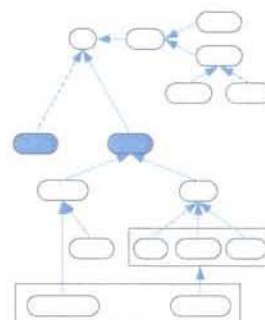
Representational quality

The information on number of inspections needed per type is presented in a way that is easy to understand by the concerning parties. (+)

3.1.4 Hours needed per function

Description

The hours needed per function for internally initiated demand are determined by combining the number of inspections per function and the time needed for such an inspection. The combination is a mere multiplication of the number of inspections and the time needed for one inspection, per type of inspection. The hours needed per function for externally initiated demand is determined based on hard data from previous years. The externally initiated demand is executed by the veterinarian inspectors. Those inspectors solely perform this type of inspections. During the capacity check, the hours needed and available are combined for all types of inspections and function from the TLPs, therefore the externally initiated demand is mentioned in figure 3.2, though because this project is delineated to look only at the internally initiated demand, the estimate and accuracy of it for externally initiated demand will not be described in more detail.¹



Assessment

Intrinsic quality

The information on hours needed for internally initiated demand is a mere multiplication and therefore accurate and objective. (+)

Accessibility quality

To calculate the total number of hours needed per function per region, all project plans are added up into one new Excel-sheet, which is stored on the internal information system that is easily accessible. The concerning Excel-sheet is available at the department of FP&C(+)

Contextual quality

The information on total time needed per function is relevant for the capacity check. (+)

Representational quality

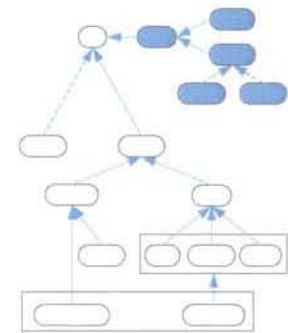
The information on hours needed per function is presented in a way that is easy to understand by the concerning parties. (+)

¹ Sometimes veterinarians are in fact asked for in the internally initiated demand, though this is only because in some cases an inspector with veterinarian qualification is needed to be present during an inspection by law. The TLPs have enough non-veterinarian inspectors that have a veterinarian qualification, making extra help from veterinarian inspectors not necessary.

3.1.5 Hours available per function

Description

The hours that are available per function are determined by combining the numbers of FTE's available per function per region and the number of hours that are available per FTE for work on projects. The numbers of available FTE's are obtained from the executing teams. The numbers are descriptive, the actual numbers of FTE's per function and not on the desired numbers of FTE's per function. One FTE works 200 days per year. From these 200 days, 40 days are reserved for activities that are not related to any project, for instance general learning, or days lost due to sickness. The number of available days per year is induced by VWA policy and prescribing rather than describing. The combination is a mere multiplication.



The combination is a mere multiplication.

Assessment

Intrinsic quality

The numbers of FTE's are obtained from the TLPs and therefore accurate and objective. The number of hours available per FTE is induced by VWA policy and can therefore be seen as accurate. (+)

Accessibility quality

The information on numbers of FTE's is sent to FP&C by the TLPs by e-mail, so it is easily accessible. The number of hours available per FTE is accessible through the internal information system. (+)

Contextual quality

The information on the available number of hours per function is relevant for the capacity check (+)

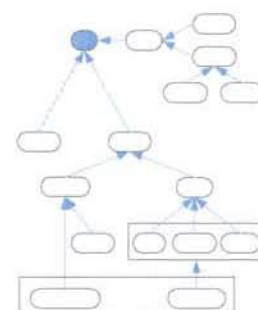
Representational quality

The information on the available number of hours per function as well as the information on the number of hours per FTE and the number of FTE per function is presented in a way that is easy to understand for the concerning parties. (+)

3.1.6 Check

Description

To perform the check, the hours needed per function for internally as well as externally initiated demand are combined. The total numbers of demanded hours per function per region are then compared to the available number of hours per function per region. This results in a "feasible" or "not feasible", with a specification on which function in which region has too much or too little work. If inspector with a certain function have a workload larger than the available capacity, and inspectors with a different function have a workload less than the available capacity, and the division of skills would allow for the different inspectors to cover for each other, making the workload feasible, the demand for inspections is nevertheless declared not feasible. In other words, the use of crosstraining is not considered an option at the capacity check. The specification is sent back to S&O for adaptation. The combination of demanded hours is a mere adding up, which is done by use of Excel. The available numbers of hours are also delivered in Excel, leading to the comparison, which is in fact a subtraction of the demand from the available hours, which should result in a list of non-negatives. If the externally initiated demand should exceed the planned amount, temporary workers are used, called "practitioners". The decision to do so is on a short term (<1 year) basis. Currently the amount of FTE's available for externally initiated demand (veterinarians) is below the desired number. The VWA has difficulties hiring this type of workers, resulting in a situation where practitioners are needed regularly. The Excel sheets that are used for the check are available at the department of FP&C.



Assessment

Intrinsic quality

As the check is a mere adding up and subtracting, the resulting information is objective and accurate. However the check that is done, is on the workload per function per region. In the region Northwest, three TLPs operate, which are geographically spread and functionally identical. As the list of companies to visit is bound to geographical locations, the check is not representing reality very well. In 2008, the VWA Northwest will cease to work with geographically spread teams and start with functionally divided teams, improving the quality of the capacity check. (+)

Accessibility quality

The result of the capacity check is sent to the departments of S&O by e-mail and is therefore easy to access. (+)

Contextual quality

The outcome of the capacity check is relevant for the departments of S&O to be able to adapt the demand for inspections. (+)

Representational quality

The outcome of the capacity check is presented in a way that is easy to understand for the concerning parties. (+)

3.2 Conclusion

The structure of the information tree as shown in figure 3.1 shows how the information needed for the capacity check is interconnected. Each part of this tree is assessed on its quality. When the individual assessments are combined, it results in table 3.1

Some parts of the structure are found to have some weaknesses, resulting in lower quality of the used information. Those weaknesses are now assessed on their potential to cause the number of inspections not to be reached. The weaknesses that are found are;

- List of companies to visit is under constant change, reducing accuracy
- Subjective time-estimates, accuracy can not be checked

Type of quality of information	Contents of a project	Time needed per inspection	Hours needed per type	Hours available per function	Hours needed per function	Check
Intrinsic	+	-10	+	+	+	+
Accessibility	+	+	+	+	+	-
Contextual	-	-	-	+	+	-
Representational	+	-	+	+	+	-

Table 3.1 Quality assessment for the information used for the capacity check

3.2.1 Changing list of companies

The list of companies is under constant change and is used only once a year for the capacity check. The demand for inspections is not presented to the teams as “visit each company of type X one time this year and perform this inspection” but more as “visit 300 companies of type X and perform this inspection”. The number 300 is a sample of the complete set of companies of type X. Fluctuations in the number of companies of type X cause the sample to be less (or more) representative for the complete set. The choice on sample size is outside the scope of my thesis. Important though is that the demanded number of inspections does not change as the list of companies does. Therefore the changes in the list of companies do not influence the quality of the capacity check.

3.2.2 Subjective time-estimates

The time-estimates for projects from S&O east are currently done by the head of TPB, together with the executing teams. For projects from other departments of S&O the time-estimates are still done by those departments themselves. The estimates done by the teams can be considered an improvement when compared to the estimates being done by S&O, as the estimates are done closer to the actual performance. Fact remains that the estimates are subjective and not based on hard data. Basing the time-estimates on hard data would be an improvement. The hard data on time used for inspections is currently not available.

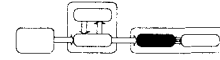


3.3 Recommendations

A system (FaTijDec) currently exists that is used to archive when a worker performs what activities; travelling, administrative tasks, time on site. An inclusion of a field on which particular type of inspection, from which project is worked, would allow for hard estimates to be made on time needed for a particular type of inspection. The current system is scheduled to undergo some changes in the near future, where aforementioned changes should be taken into consideration.

Please note that the low quality of the time-estimates originates in the subjectivity. The estimates may reflect reality very well, though a lack of objective founding of the estimates decreases their quality. However the time-estimates should not be based solely on hard data. The purely objective estimates need to be adjusted for effects that no hard data can capture, such as foreseen developments on the market or new legislation.

4. Short term (1< year) planning



In this chapter the short term planning is analyzed. The current system is described and assessed, resulting in the identification of weak points and possibilities for improvement.

4.1 Workload of the TLPs

One FTE inspector is contracted to work 200 days per year. From these 200 days, 160 are scheduled to be used for work on inspections. The other 40 days are used for activities that are not related to any project, for instance learning, but also possible time lost due to sickness. The workload for the 160 days of work on inspections can be divided into different types. At the VWA, different categorizations are used to do so, based on financier, initiative, type of inspection or functional requirements. As this part of the report has a focus on capacity planning, two categorizations are used, one based on priority - described earlier in chapter 2 - and one on functional requirements – the work needs to be executed at least by an inspector from the mentioned function. The categorizations are visualized in figure 4.1.

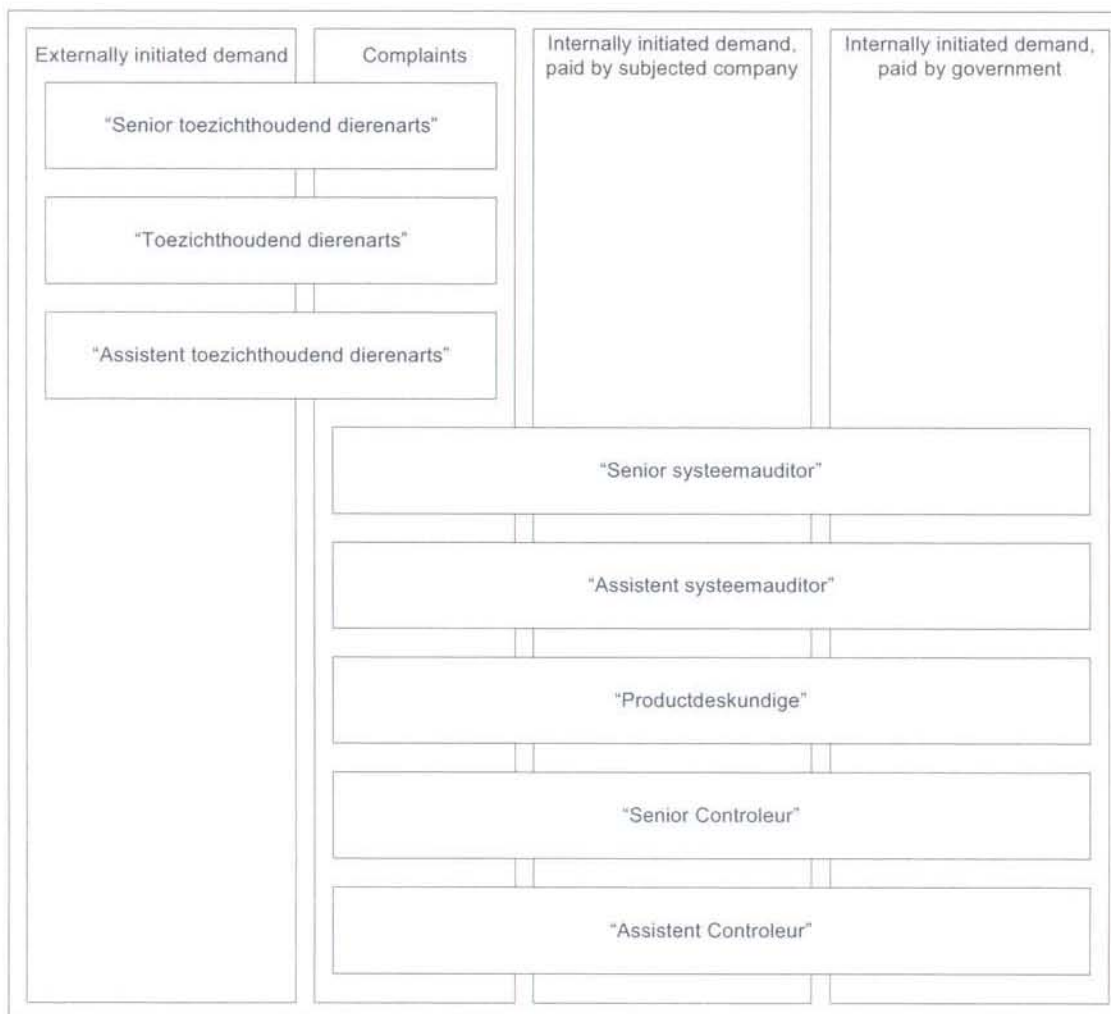


Figure 4.1 The workload of a TLP

Currently there are three TLPs, each containing inspectors from all eight functions. The structure will be changed into a situation where the inspectors with a veterinarian function ("dierenarts"), make up one team, thus only executing externally initiated demand, and one team with inspectors with a non-veterinarian function, executing only internally initiated demand. Besides the internally and externally initiated demand the TLPs are also confronted with complaints. These are complaints from consumers about companies that produce foodstuff, or the produced foodstuff. Depending on the nature of a complaint, it needs to be handled by an inspector of a certain function. Because the complaints can be divided into complaints that need to be handled by a veterinarian and complaints that need to be handled by the other functions, the workload is can be divided into workload for the veterinarians and workload for the non-veterinarians, making the new structure with two functional teams possible with no remaining connection with regard to the workload. The internally initiated workload is presented to the TLPs as a number of projects, each containing one or more subprojects, each containing one or more inspectionlists with for each inspectionlist the functional requirements for the performing inspector, the expected time needed for that inspection, including time needed for travel and administrative activities.

4.2 Current planning system

The internally initiated demand for inspections, both charged to the subjected company and paid for by the government, is presented to the teams once a year. The priority of the first over the latter is not taken into account in the current system; all inspections are planned (which is possible because the demand for inspections is feasible due to the capacity check). The process how this total demand for inspections is translated to actual inspections being performed through different steps is visualized in figure 4.2. This figure only describes the planning of activities, not how the contents of inspections are translated into how the inspections are performed. This report only focuses on the internally initiated demand, though because of possible interference with externally initiated demand, this demand is also mentioned, but not in so much detail.

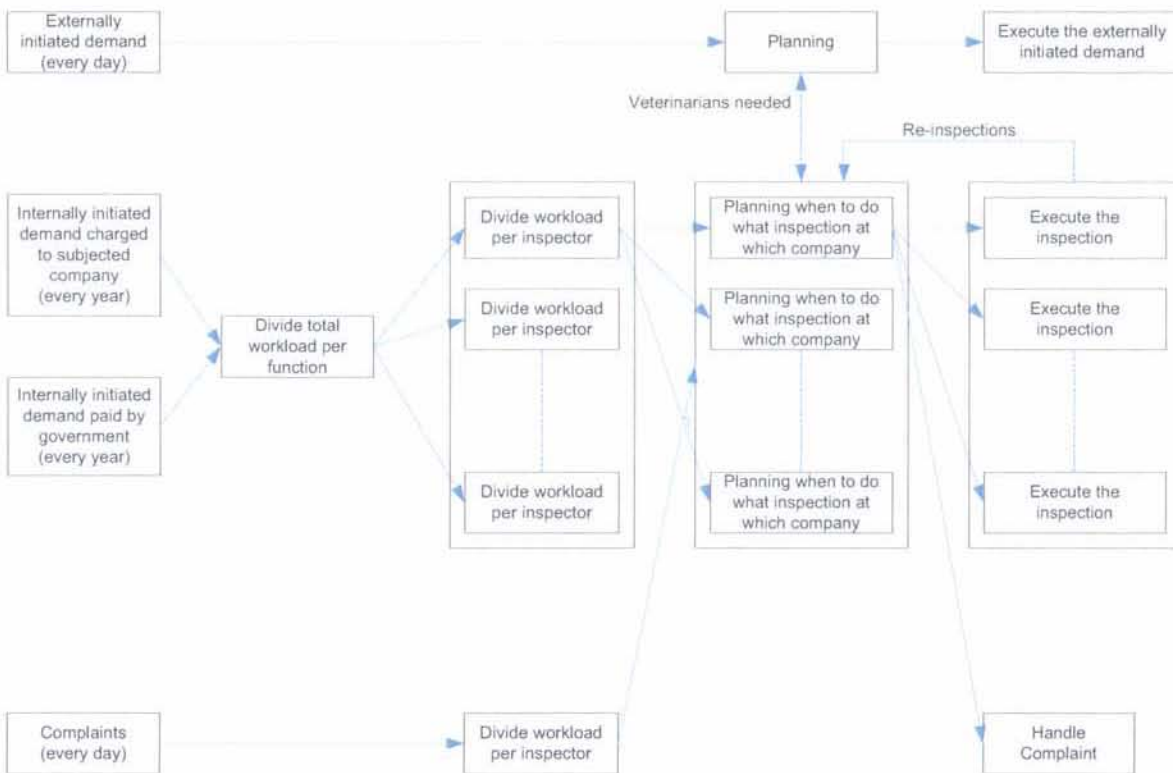


Figure 4.2 Current structure of planning for the TLPs

1. The first step is to divide the total workload into workload per function, based on the functional requirements found in the inspectionlists. The workload is composed in such a way that the workload per function equals the available capacity for that function. Because crosstraining is available - inspectors from a particular function can perform inspections that require a lower function - there are different possibilities in dividing the workload. However, the workload is divided in such a way that the inspections are allocated to the lowest function that is allowed to perform the inspection. This allocation-rule is the same as is assumed during the capacity check.
2. The second step is to divide the workload per function further, allocating a workload of 1280 hours (=160 days) to each inspector. This is done based on the personal preferences and specific experience of the different inspectors. However there is no predetermined system for the division of the workload.
3. The third step is for the individual inspectors to schedule their activities during a year. Each inspector is responsible to reach his set targets. Scheduling all inspections in advance for the whole year is not possible as the list of companies to visit is subject to a constant change during the year, mainly due to re-inspections, but also due to the opening and closing of companies. Some parts of the workload are subject to cyclic or seasonal demands. These demands are presented to the inspector by the project coordinator and are part of the project's contents.
Currently, no consistent structure is used to plan when to perform inspections at which company. If an inspector is confronted with complaints, it needs to be fit in ad hoc. The need for veterinarian presence is accounted for as those inspections are allocated to the inspectors with a veterinarian qualification in the second step.
4. After the activities are planned, the inspections are performed. In some cases this results in the need for a re-inspection, thus input for the scheduling of activities of an inspector.

4.2.1 Complaints

Each day the VWA receives complaints from consumers on a wide variety of topics, from wrong labels to safety issues with small hardware and smoking at prohibited places. After the complaints are filed, each complaint is assigned to a region, a team and an inspector from that team, based on location and topic. During 2006, the TLPs of VWA Northwest received 104 complaints to handle. From these, 80 complaints resulted in an inspection that was already planned. These complaints took an average of 4 hours to handle, including administrative and travelling time. If a complaint is filed at the VWA, it should be handled within 6 weeks. This due date however is more of a guideline than a hard demand; complaints can take more than 6 weeks to handle. As said earlier, the complaints are fit into the inspectors' planning ad hoc.

4.3 Assessment of current planning system

4.3.1 Approach

The workload that is presented to the TLPs should, in theory, match the available hours perfectly. As the inspections have no specific due-dates, the workload can be spread evenly over the year, so no extreme peaks in demand for a particular function arise. Because of the lack of specific due-dates, the sequence of planning has little influence on the feasibility of the workload, at least that is the line of thought at the VWA. If however the evaluation of the planning is approached not starting from the workload, but from the possible merits of good planning, sequence does play a role.

4.3.2 What would be good planning?

The workload of an inspector consists of inspections. For each inspection, time is needed for administrative tasks, travelling and time on site. The time for administrative tasks and the time needed on site do not depend on the sequence in which the inspections are performed. The travelling time does depend on this sequence, so the first merit of good planning would be a minimization of travelling time. Through this minimization the total time needed for inspections is also minimized and thus the number of inspections that can be performed is maximized.

4.3.3 Assessment

The first step of the current system, to divide the workload into workload per function eliminates the possibility to use crosstraining. In practice this is indeed rarely used. Veterinarians do not perform other inspections besides inspections only they can do. For the lower functions, there is no possibility of outsourcing. Combining those two means that with regard to the use of crosstraining, the veterinarians and the other functions can be seen as two separate teams. The highest function of the non-veterinarian team, the senior system auditor, has a workload consisting only of inspections he may perform. If crosstraining would be used, eventually the senior system auditor would see an increase in his workload. As the total workload is compiled in such a way that every inspector has a full workload with inspections only he can perform, the use of crosstraining is not useful. Because crosstraining is not useful, the division of the workload into workload per function, planning separately for each function, is not a bad one.

The second step of the current system, to divide the workload for one function into inspections per year per inspector, limits the possibilities for planning, especially as sequence plays a role. This does not implicate that the optimal schedule is no longer possible, though the chance is less than with a plan-first-divide-second system

The third step, planning when to do what and where (and who), currently does not have a focus on sequence or travelling time, where this is the only part of the total time needed for an inspection that can be influenced by planning. The inspectors are given the freedom to plan their activities at will. This freedom is of great value to the inspectors, so any new system for planning activities will have to leave options to the inspectors or face difficulties on implementation.

Altogether, the main shortcoming of the current system is that the goal of minimising travelling time is not present, where this is the only outcome that can be gained on. This gives room for improvement.

5. Redesign of short-term (<1 year) planning heuristic

In this chapter a new heuristic is proposed for short term planning. Starting from the differences with the current system, the different steps of the heuristic are described, concluding with a description why the proposed heuristic will perform better than the current system for short term planning

In the current system, the workload per function is divided among the inspectors with that function. In the new planning heuristic, different inspections are combined into days of work before dividing among inspectors. The inspectors are no longer presented a workload consisting of inspections to perform, but a workload consisting of days of work. Another difference between the current and new planning system, is that the workload that is presented to the inspectors is not fixed for one year - allowing changes in the workload due to re-inspections or complaints to frustrate the existing plan - but for a shorter amount of time.

As the workload can change every day, the optimal division of the inspections into days of work can also change each day, therefore the smaller the number of days to fix before re-dividing the inspections per day the more optimal the division will be. However, allocating a small number of days to an inspector decreases the freedom an inspector has in choosing when to perform which day of work. This freedom is of great value to the inspectors, so a system where a very small number of days is allocated to inspectors each time will face difficulties being implemented. Apart from the emotional aspect, allocating a very small number of days each time can cause troubles in execution as some inspections require making an appointment in advance, though this is not such a strong argument as it is very well possible to make an appointment for an inspection before knowing which day of work the inspection will be part of.

Large numbers of days being allocated to inspectors will increase the amount of freedom an inspector has in deciding when to perform which day of work. The optimality of the division of inspections among days of work however will be less. Furthermore as the workload changes over time, inspections may be added to the total workload that needs to be executed within six weeks. If more than six weeks of work are allocated to inspectors each time, the added inspections will frustrate the existing schedule.

In the proposed system for short term planning four weeks of work are allocated to inspectors each time. With 160 of the 200 days being available for inspections per inspector, four weeks equals sixteen days of work. Four weeks is chosen because other information-systems at the VWA divide the year into periods of four weeks. It is a period of time small enough not to be frustrated by changes in the total workload and large enough to give the inspectors a certain degree of freedom in choosing when to perform which day of work. The new planning heuristic consists of two steps to be taken consequently, which will be described below.

1. Combining inspections into days of work
2. Allocating days of work to inspectors

5.1 Combining inspections into days of work

In chapter 4 it is already described how travelling time is the only part of the total time needed for one inspection that can be gained on through good planning. Therefore the minimisation of travelling time is the goal of the planning. Because of the focus on travelling time, the sequence of inspections plays an important role. An inspector returns home every day, so the activities on one day do not influence activities on other days, also not the travelling time. Therefore only which inspections to combine on one day and the sequence per day play a role. Some inspections however take more than one day. In the new planning heuristic it is assumed that those inspections need to be performed on consecutive days and by the same inspector, therefore these inspections are seen as packets of work on their own and not divided into parts that are estimated to take one day (please note that inspections that take more than one day are always estimated to take an integer number of days).

The planning is done separately for each function, so the possibility of using crosstraining is not abandoned, as is the case under the current planning system. In the assessment of the current planning system it was described why the use of crosstraining is not desirable with the current division of skills.

As the combining of inspections into days of work requires a lot of repetitive actions, taking a lot of time if done by hand, the transformation of the input into output is programmed in Excel. The program transforms a list of 3000 inspections into days of work in 15 minutes on an Intel Pentium 4 with a 1.70 GHz processor and 256 MB RAM (the typical desktop computer currently used at the VWA). To make sure the program does what the proposed heuristic describes, a series of tests is conducted, which are described in Appendix VI

5.1.1 Input

The input for the first step is a list of all inspections to be performed during the year by the concerning function, with for each inspection information on:

- Which inspectionlist
- Which company (including location – postal code and house-number)
- Release-date
- Due-date

For some inspections, the information on which company to visit may change during the year, due to re-inspections or complaints. As the planning is adapted every four weeks, the changes in locations will not frustrate the planning, as long as the due-dates for inspections with changed locations are further away in time than the next adapting of the planning. Some inspections have cyclical requirements, e.g. need to be visited every three months. In this case the year (or time from overall release-date to overall due-date) is split into a number of equal pieces equal to the number of inspections to be performed at the concerning company, assigning one inspection to each of the parts, and release-dates and due-dates accordingly. This conversion from cyclical requirements into release-dates and due-dates is illustrated in figure 5.1 for a situation where the same inspection needs to be performed four times in one year, resulting in release-dates and due-dates on January 1st, April 1st, July 1st and October 1st. The teamleader is responsible for this part of the input for the program.

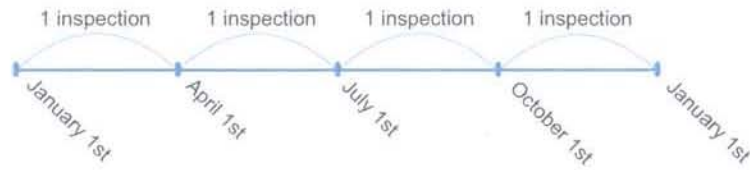
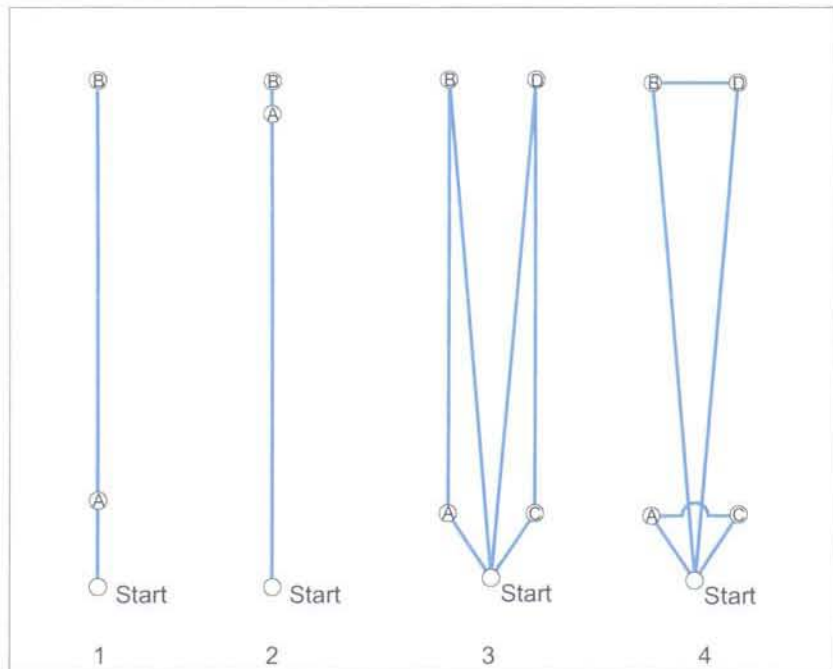


Figure 5.1 Cyclical requirements are transformed into release-dates and due-dates

Apart from the information mentioned above, information is needed on the estimated total time needed for an inspectionlist. The program in Excel will use this information to estimate the total time needed for each inspection. This information is input to the program in Excel as a list of all inspectionlists with for each inspectionlist an estimate on the total time needed (travel-time, administrative time and time on site combined). This part of the input does not change each time the planning is adapted. The teamleader is responsible for this part of the input.



Say two inspections are to be combined on one day (A & B). If only one day needs to be planned, the total travelling time is the same, regardless of whether the locations are far (1) or close (2) to each other, as long as the location of the first inspection (A) is on the route to the location of the farthest inspection (B). When two days of work are planned simultaneously, two options are available, combining one close and one far location (3), or combining locations close to each other (4). The latter has the minimal total travelling time.

Figure 5.2 Short distance between inspection locations minimizes total travel time

5.1.2 Transformation

The desired transformation of the input into output is programmed in Excel using VBA code (Appendix III). This program will transform the list of inspections to perform into days of work. The program will be used by the teamleader, following the user instruction (Appendix V). The goal of the combination of released inspections into a day of work is to minimize the travelling time between different inspection locations on that day. Why seeking for minimal travelling time between locations on one day is beneficial for the total travelling time is illustrated in figure 5.2.

To get to combinations of released inspections with a minimal travelling time between the locations, the postal codes of the locations are used. Areas with the same postal code are relatively small. Therefore the distance and through that travelling time between two locations with the same postal code can be neglected with regard to the time needed to travel from a starting point (the office, home) to one of the locations. The list of inspections is thus divided into lists of inspections per postal code. Each list is then divided into packets of work that are expected to take 1 day. However, situations may occur where the total workload per postal code can not be fully divided into days of work, one or more inspections are "leftover". These inspections are allocated to a day in an adjacent postal code area, and given priority in the filling of days there to avoid being leftover there once again. In the adjacent postal code area, another inspection can be "leftover" and needs to be allocated in yet another area. To determine which of the adjacent postal code areas a leftover is allocated and to ensure that every area has an adjacent

are to leave its leftovers, all postal code areas are linked in a chain. Leftovers are allocated to the next area in the chain. The chain is illustrated in figure 5.3 where the map of the island of Texel is shown with its postal code areas. The blue line shows how the different postal code areas are linked. The chain starts at area 1795. The inspections that need to be performed are combined into days of work. If inspections are left over in this combining, they are added to the inspections to be performed in area 1794 and given priority in the combining into days. In this area also leftovers may occur, which are added to the workload of area 1793, and so on, following the chain of postal code areas. After area 1797 the chain continues on the mainland. The island of Texel is shown for illustrative purposes. The complete chain for the provinces of "Noord-Holland" and "Utrecht" is shown, only in numbers, in Appendix IV. These two provinces are the working area of the VWA Northwest. Please note that the presented chain is a possible chain, where each postal code area is linked to an adjacent one. Other chains are also possible, and may even be more optimal.



Figure 5.3 A possible chain of postal code areas on the island of Texel

The goal of the planning heuristic is to minimize the expected time needed for travel between two inspections. To pursue this, inspections located within one postal code area are combined. To continue pursuing this goal in constructing the chain of postal code areas, the expected distance between a random location in one area and a random location in the next area in the chain should be minimized. If the locations are evenly spread within an area and the areas are of similar shape and size, this distance is minimized if the subsequent areas are adjacent. Different possibilities exist to construct a chain with adjacent areas. In Appendix IV one of the possible chains is shown. In practice, the locations are not evenly spread throughout the areas, nor are the areas of similar shape and size, therefore not all possible chains will be equally optimal. The chain will probably need adapting when used in practice based on everyday experience.

The division of inspections per postal code into days of work is similar to a bin-packing problem. Several heuristics exist to solve this problem to (near-) optimality, though thanks to the geometrical sequence the expected times needed for one inspection are part of (1,2,4,8,16), the "First Fit Decreasing" algorithm (FFD) will always find the optimal solution (minimal number of days needed)(Broekmeulen, 2004).

The inspections are listed in a large-to-small order and are then one by one allocated to the day with the most workload already allocated to it where it will just fit. This technique ensures a minimal number of days to be filled. Due to the geometrical sequence, all days are fully filled with inspections. The priority that is given to inspections that are left over from adjacent areas is implemented in that they are allocated to a day first, before the list of inspections from the area itself.

The intuition behind the optimality of the FFD algorithm in combination with the geometrical sequence is that the size of the days on terms of hours is a multiple of all possible durations of inspections. If an inspection is allocated to a day, the remaining number of hours on that day will also be a multiple of the possible durations of inspection equal to or smaller than the allocated inspection.

5.1.3 Output

The output for the first step of the new planning heuristic is a list of days of work, with for each day, information on

- Which inspections to perform, with for each inspection to perform information on
 - Which inspectionlist
 - Which company
 - What location
 - Expected total time needed
 - Duedate
- Earliest of the duedates of the different inspections on the day (the overall duedate of the day)

5.2 Allocating days of work to inspectors

5.2.1 Input

The input for the second step of the new planning heuristic is the same list that is the output of the first step.

5.2.2 Transformation

After the days of work are composed, these days need to be allocated to inspectors to be performed. Two decisions need to be made;

- Which of the days of work to allocate to an inspector first
- Which inspector to allocate a day of work to

The traveling time on a day of work is not influenced by the date on which this day of work is performed. Therefore the decision which day of work to allocate to an inspector does not influence traveling time. If the decision which day of work to allocate first would be completely random, traveling time would not be influenced. However extreme situations may occur where more days with a certain due date are to be performed than there are days left to perform them on until that due date. For instance, if 12 days of work exist that need to be performed within the next five days, and only two inspectors are available to perform these inspections, only 10 of the days of work can be performed and its due dates met. To minimize the risk of such a situation to occur, the days of work should be allocated to inspectors based on its due dates. The days of work are ordered with increasing due dates, allocating the day of work with the earliest due date first (EDD), then the second and so on. If it is possible to perform all inspections on time, the EDD sequence will do so (Hopp & Spearman, 2000, pp. 492, 513). The output of the program in Excel that is used to perform the first step of the new planning heuristic – the list of days of work – is already ordered based on due dates, with the earliest due date on top and increasing down the list. The teamleader who is using the program in Excel is responsible for this step and will be presented this list by Excel as output of the program.

The second decision is which inspector to allocate a day of work to. The group of inspectors is assumed to be homogenous with respect to time needed for an inspection and time needed to travel a certain distance. The only difference between inspectors with the same function is their starting position. Inspectors can start their day of work either from the office or from their homes. Both options are used. If an inspector starts from the office, traveling time is not influenced by the decision which inspector to allocate a day of work to. If however an inspector starts from his home, traveling time is influenced by this decision. The traveling time is minimized by allocating the day of work to the inspector with his home closest to the first inspection location, and still days left to allocate a day of work to. The teamleader is responsible for allocating days of work to inspectors.

5.2.3 Output

The output of the second step of the new planning heuristic is a list of days of work for each inspector to perform during the next four weeks with for each day the same information on;

- Which inspections to perform, with for each inspection to perform information on
 - Which inspectionlist
 - which company
 - what location
 - expected total time needed
 - duedate
- Earliest of the duedates of the different inspections on the day (the overall duedate of the day)

5.3 Validation

The proposed system for short term planning seeks to minimize the total traveltime. As time needed to travel is the only part of the total time needed for an inspection, the minimization of total traveltime will minimize the total time needed to perform all inspections and through that minimize the costs involved. The question is to what extent the proposed system for short term planning minimizes the time needed for travel.

Inspections are combined into days of work. Which inspections are combined into a day influences the time needed to travel on that day. When this day of work is performed does not influence the time needed to travel. In figure 5.2 it is shown that if more than one day needs to be planned, the total time needed to travel is minimized if the distance between locations that need to be visited on one day is minimized. This is regardless of the starting position of an inspector, as the distance between the starting (or end-) point and a location that needs to be visited is not influence by the decision which inspections to combine on one day. The proposed system for short term planning seeks to minimize the distance between two locations through combining locations within one postal code area. It is assumed that the distance between two locations within one postal code area is negligible when compared to the distance from a random starting point to a random point within that postal code area. The distance between two random locations within a certain area depends on the size of that area. The smaller the area is, the smaller the expected distance between two random points within that area. The postal code areas are chosen as these areas are already available and information on which area a location lies in is also already available, making implementation relatively easy. Adding the fifth or even the sixth digit of a postal code to define the area would decrease the size of the areas even further and thus the expected distance between two random location within that area, however because inspections within one area do not always combine into full days of work, some inspections need to be allocated to another area, making the chain of area necessary. Adding a fifth or even a sixth digit would dramatically increase the total number of areas, making the construction of the chain very hard.

If days of work are performed in a random sequence, situations may occur where duedates cannot be met. To avoid these situations to occur, days of work are allocated to inspector in an EDD sequence. This does not influence the time needed for travel, it merely satisfies the constraint that duedates need to be met.

The decision which day of work to allocate to which inspector only influences the expected distance from a starting point to a location that needs to be visited, as inspectors can start from their homes. To minimize the expected distance between a starting point and a location that needs to be visited, a day of work is allocated to the inspector who lives nearest to the locations that need to be visited and still has days of work to be allocated to him. It is assumed that the group of inspectors with a certain function is homogenous; every inspector can perform every inspection. If this assumption is violated, it may require a different division of the functions. Small violations to this assumption can be coped with without mayor changes, for instance if an inspector can not visit some of the companies due to past arguments with the owner, or possible conflicts of interest, it will require the concerning day of work to be allocate to the inspector living second-nearest to the locations of that day.

Concluding it can be said that the time needed to travel is the only thing that can be influenced by short term planning and minimizing it should therefore be the goal. A system with that goal will outperform a system without it, because it is the only thing to influence. The proposed system has minimization of time needed to travel as a goal and will therefore outperform the current system without that goal.

To get an impression how much better the proposed system for short term planning works, compared to the existing system, the combinations of inspections that were performed in 2007 need to be compared to the combination the proposed system would generate. Calculating traveltime or distance between locations visited on one day for all days of 2007 and all inspectors of the TLPs in the region of Northwest would take a vast amount of time. As said earlier in chapter 3, no sample of inspection is representative for all inspections. Though to get an impression of the proposed system's performance, the inspections performed by one functional group ("senior controleurs") in one of the regions the region of northwest was subdivided in in 2007, during one period of four weeks, are planned using the proposed system. The total distance of the proposed system's planning and the distances that were actually travelled in 2007 are then compared. The planning that was used in 2007 with the concerning distances can be found in table 5.1 (next page). The planning generated by the proposed system can be found in table 5.2 (next page).

In the planning that was used in 2007 the inspections are performed with a total distance between locations of 207,7 kilometres. The proposed system generates a planning with an expected distance between locations on one day of 268. In 2007 18 days were used to perform the inspections, where the proposed system generates a planning that will take only 14 days to perform the inspections. Because in 2007 4 more days are used, the difference in total distance covered between the planning of 2007 and the proposed system's planning is

$$(207,7 - 268) + (4*2)*[\text{average distance between starting point and inspection location}]$$

Therefore the proposed system will outperform the planning used in 2007 if the average distance between the starting point and an inspection location is more than 7,54 kilometres.

What to inspect? What to expect? Order acceptance and human capacity planning at the "Voedsel en Waren Autoriteit"

day-ID	1st location	2nd location	3rd location	4th location	5th location	6th location	7th location	8th location	total distance between locations per day
1	1696AJ	1696AJ	1696AM	1696AM	1627LC	1627LC			4.3
2	1681NS	1681NN	1681NN	1681NN	1681NN	1681NM	1681NM	1681NM	0.5
3	1131PH	1131PH	1446WX	1446WX					7
4	1131NA	1681NN	1131DL						33.2
5	1131PG	1131PG							0
6	1901RV	1901RS							0
7	1507BR								0
8	1506RZ	1507BR	1506RZ						3.2
9	1693AM	1619JE							5.9
10	1704ST	1742NW							13.7
11	1463HA	1602DC							13.7
12	1511GE	1511AR							3.3
13	1695GD								64.8
14	1695JC	1531DK	1815JG						39.9
15	1695GD	1441DD	1622EH						0
16	1946SR								0
17	1141CM	1504AH							18.2
18	1487MD								0
total distance between locations									207.7

Table 5.1 Actual combinations of inspections in 2007

day-ID	1st location	2nd location	3rd location	4th location	total distance between locations per day
1	1742NW	1693AM	1681NM	1681NM	35.6
2	1704ST				0
3	1681NM	1681NN	1681NN	1681NN	0.2
4	1681NN	1681NN	1681NS	1619JE	0.6
5	1602DC	1696AJ	1696AJ	1696AM	18.4
6	1696AM	1627LC	1627LC	1901RS	58.1
7	1622EH	1695JC			4.8
8	1815JG	1901RV	1487MD		48.6
9	1946SR	1531DK			14
10	1441DD	1446WX	1446WX	1463HA	33.1
11	1131DL	1131NA	1131PG	1131PG	3.1
12	1131PH	1131PH	1141CM	1511AR	27.4
13	1511GE	1507BR	1507BR	1506RZ	20.1
14	1506RZ	1504AH			3
total distance between locations					268

Table 5.2 Planning generated by the proposed system for short term planning

6. Conclusion & Recommendations

This final chapter starts with the research question that was posed in chapter 2. Where possible answers to this question are concluded from this report. The recommendations that follow from these answers are summarized and recommendations for further research are described.

6.1 Conclusion

In chapter 2 the research question this project seeks to answer has been introduced. This question is:

How can the combined demand for different types of work in a service environment requiring different skills, for different types of workers with different skillsets, be checked for feasibility, and how can these workers be planned to meet this demand against the lowest cost, taking into account flexible working hours, outsourcing, crosstraining and travelling time?

The techniques to cope with short term fluctuations in demand for human capacity that are available at the VWA are flexible working hours (transitory overtime), outsourcing and crosstraining. Throughout the project it became clear that with the current system for generating demand and the current division of skills, the use of crosstraining is not desirable. Furthermore it became clear that outsourcing is only available for a limited part of the workforce (veterinarians), a part that is no longer inside the scope of this report due to the change from geographically spread teams into functional teams. Only the flexible working hours are available to cope with the fluctuations in short term demand. The decision what technique to make available for use is outside of the scope of this project, therefore crosstraining and outsourcing are not taken into account.

The research question consists of two parts, how to check the feasibility of the demand and how to plan when to do what, where and by whom. Each of those parts is analysed and answered separately.

6.1.1. How to check the feasibility of the demand

The check whether a certain demand is feasible given the available capacity is always a check whether the workload for a certain period does not exceed the available capacity in that period. How this check is done is highly dependent on a company's situation. To answer the question how this check can be done at the VWA the current system is taken as a starting point. To get to the information on workload and capacity, various pieces of information need to be combined. From the assessment of how this is done at the current system at the VWA can be concluded that the weakest point in the current system is the subjectivity of the estimates on how much time is needed for an inspection.

6.1.2. *How to plan when to do what, where, by whom*

Where in the current situation a divide-first-plan-second structure is used, this limits the options in planning when to do what. A new system for short term planning is proposed with a plan-first-divide-second structure. The time that is needed to perform an inspection can be divided in time needed for administrative tasks, time needed on site and time needed to travel. The lengths of the first two depend on the contents of an inspection and are not influenced by short term planning. The travel time however is influenced by short term planning, more specifically through the decision which inspections to combine on one day. It is shown how the total expected travel time can be minimized by combining inspections on one day minimising the expected travel time between the different locations on one day. Allocating days of work to inspector in an EDD sequence minimizes the risk of due dates not being met. In the proposed system the estimates on time needed for an inspection are used to compose days of work. In practice the inspections may take more or less time than estimated, so the total time worked on a day will fluctuate around the estimated total of eight hours. Combining the days into a year the fluctuations will even each other out. To make this possible the technique of transitory overtime is used. The inspectors can work more or less than eight hours on a day to perform the inspections that are planned.

6.1.3 *Theoretical conclusion*

The research question asks for a situation where crosstraining, outsourcing and flexible working hours are used to cope with fluctuations in demand. The situation at the TLPs at the VWA however, is one where only flexible working hours are used. This technique is used to cope with fluctuations in actual time needed for one inspection, not with fluctuations in the expected time needed per day (for instance if more than an expected 8 hours of work are planned to be performed on one day). Because of this reduction in complexity of the situation, the theoretical value as described in chapter 2 is somewhat diminished, though it remains an interesting case-study of a situation where different inspectors need to visit different locations on various days and by planning this the total time needed to travel needs to be minimized. The availability of flexible working hours enables the assumption of deterministic times needed for an inspection.

6.2 Practical recommendations

6.2.1 *Recommendations with regard to the check on the feasibility of demand*

To enable objective estimates on the time needed for an inspection to be made, hard data on how much time is used in the past for similar inspections needs to be available. It is possible to add a field to the current information system that is used to archive how much time is used by an inspector for the various activities; travelling, administrative tasks, time on site (FaTijDec). The information system is scheduled to undergo changes in the near future. The adding of a field requiring information about which project was worked on when travelling, doing administrative work, or being on site, would make the hard data available and enable the objective time-estimates.

6.2.2. Recommendations with regard to the planning when to do what, where, by whom

To minimize the total expected travel time and through that the costs of performing the planned inspections, the system for short term planning that is proposed in chapter 5 should be used. The program in Excel will help in executing the steps of this system. The VWA Northwest is currently starting to use another program in excel to keep track of the inspections that need to be performed. It gives an overview of all inspection that need to be performed throughout a year as well as how many of them already have been performed. It thus also gives an overview of the remaining workload. The program that is described in chapter 5 and appendix III is written in such a way that it is fully compatible with the excel program keeping track of the inspections (the same formats and layout are used). The remaining workload can therefore be input to the program described in this report. On implementation the program can be seen as an add-on to the existing excel program. This will act as an enabler for the implementation of the proposed planning system.

6.3 Recommendations for future research

It is possible for discrepancies between the estimated time needed for an inspection and the actual time needed for an inspection to occur. In this project such a discrepancy is assumed to be an error in the estimate. It could also be possible that the instructions what to do are misinterpreted. To analyze this, specific knowledge is needed with regard to the contents of a project, though it could be a point of interest for future research.

In this project a day of work is assumed to contain 8 hours, or 480 minutes. In practice, inspectors can also work other numbers of hours per day. The system for short term planning described in this report will always construct days of 8 hours of work, where in practice working 9 hours on one day and 7 on the next may result in a smaller amount of time needed to travel. The influence of availability of flexible working hours on a planning level, rather than just an enabler of the assumption estimated times needed for an inspection are deterministic, could be of interest for future research.

Appendix I The "jaarplancyclus"

Throughout the "jaarplancyclus" various decisions are made by various people. To illustrate this, the main decisions as well as the deciding parties are visualized in figure I.1. The cycle "jaarplancyclus" consists of four stages;

- contourstage
- conceptstage
- decisionstage
- evaluation and executionstage

The precise contents of the different stages are highly complex and fill a book on their own. Numerous stakeholders all do their part. For this report a simplified description of the different stages is given. This description should provide enough information to put the project in its context.

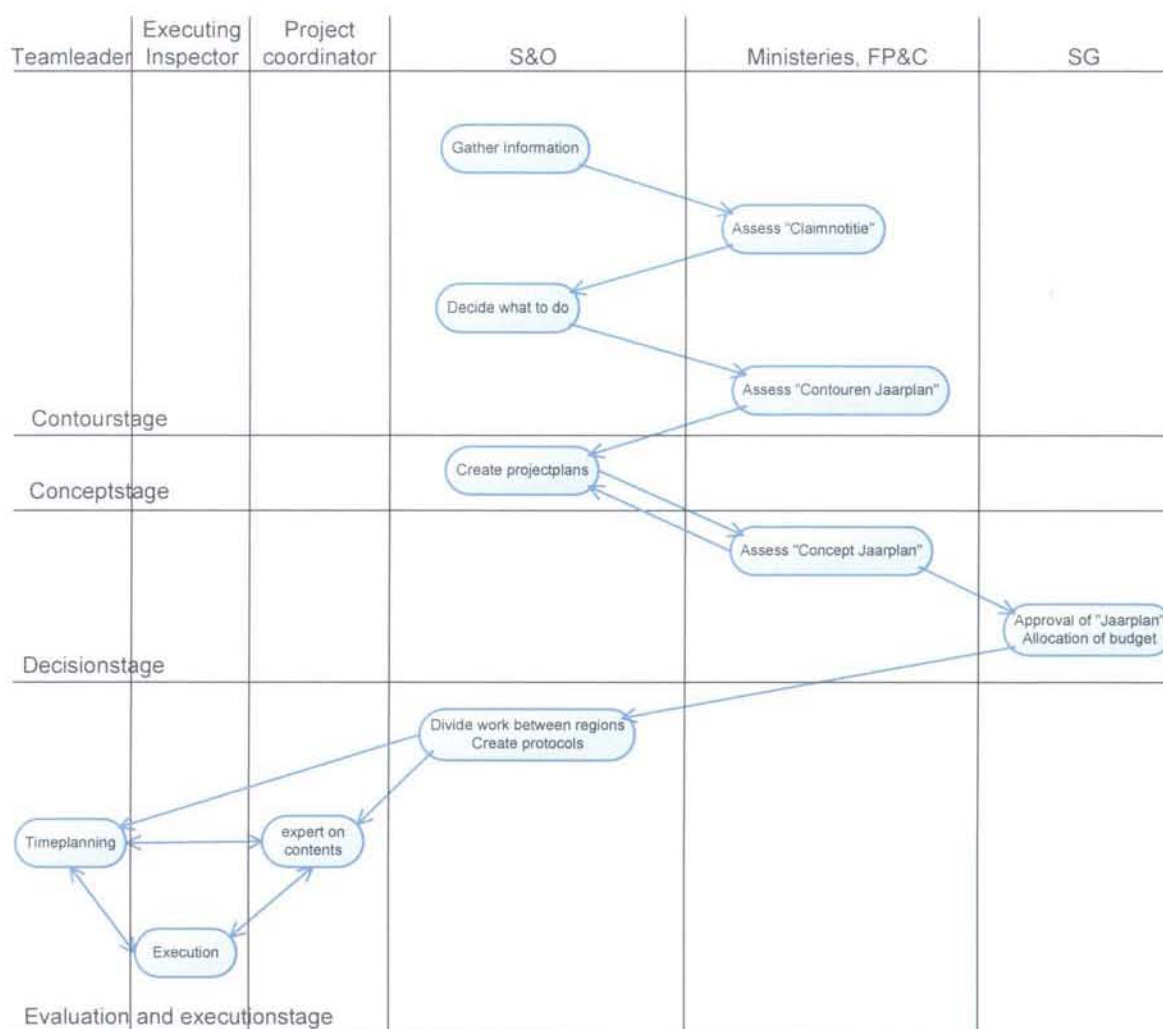


Figure I.1 The "Jaarplancyclus"

Contourstage

Information on concerns regarding food-safety is gathered from the concerning ministries, executing teams and basically all parts of society to compile a document, the "claimnotitie", which is sent to the ministries. They respond with another document, the "kaderbrief". This document contains basic outlines of the desired activities and the preliminary budget. Following this document, decisions are made on what to do and what not to do, based on budget and contents of the suggested work. This results in yet another document, the "contouren jaarplan", which is sent to and assessed by the ministries, leading to the next stage in the cycle.

Conceptstage

Based on the approved "contouren jaarplan" the projectplans are created. These plans contain the numbers of inspections of the different types that need to be executed, by which type of employee, specified per region during the next year. Part of this stage is an estimate on the time that is needed to perform a certain inspection. In previous years this estimate was done by S&O itself, and adapted on a yearly base using feedback from the executing teams. This year however, the department of S&O in the region East, uses a different approach. The estimate on time needed to perform a certain inspection is done by the head of the TPB, of which the TLPs are a part. The estimates are compared to the available capacity and, if needed, the planned numbers of inspections are adapted to fit the available capacity. This check on feasibility is done by the department of "Financiën, Planning & Control", FP&C, the adaptation is done by S&O.

Decisionstage

The projectplans are combined into the "concept jaarplan", which is sent to the ministry of agriculture, nature and food quality and the ministry of health, welfare and sport, the two official assigners. These two ministries assess the concept and advise the secretary general (SG) of the ministry of agriculture, nature and food quality, which is the owner of the VWA. This results in an approval of the SG and an allocation of the budget.

Evaluation and Executionstage

The projectprotocols are made by S&O, with help from the executing teams. These protocols are the documents the teams actually get as their work. Most of the contents of the protocols are already determined in the projectplans mentioned earlier. The protocols describe the goal of the project, the different actions to be taken, the types of employees that are needed, which type of company to visit, which type of inspection to carry out, consequences on malpractice, possible relations with other projects and reporting demands. The protocols are then rolled out to the teams, where the teamleaders are responsible for numbers and daily planning and the project coordinators – also part of the executing team – are responsible for the contents.

Disclaimer

This description of the "jaarplancyclus" is far from exhaustive and insiders will pinpoint shortcomings easily, though it provides the information necessary to put this project into context.

Appendix II Sample selection

For this report, 5 projectleaders are interviewed, where more than 50 are active within the VWA. To get to the sample, projects are selected from the total list of projects and from that the projectleaders are selected. The selected sample set of projects must be representative for the complete set of projects. The work of the TLPs can be divided into different types (table 1.1). To ensure the sample to be representative, it must contain work from all types. Furthermore, the work is done by different types of employees. To ensure the sample to be representative on this axis as well, it must contain projects done by all types of employees. The demand for the sample to be representative still allows for numerous different sample sets of projects to be taken. To select a sample, the planned numbers of inspections for 2007 are compared to the realized numbers of inspections so far (august 2007). This could be an indication of problems existing at these projects. However if these problems eventually turn out to be non-existent, this does not influence the representativity of the sample. Projects running in 2007 are chosen, as these are most representative. The VWA is constantly evolving, and during the interviews it became clear that even the lifecycles of projects running in 2007 are not fully representative for the lifecycles of projects currently being developed to be executed in 2008. As the latter projects have yet to pass the capacity check, the projects that are currently executed are chosen for the sample. The different interviewees are currently working on the creation of the projects that are to be executed in 2008, so information on differences between the sample projects and the projects currently under development are pointed out. The selected sample contains the following projects. The planned and realized numbers of inspections can be seen in table II.1, the different types of work (rows) and employees (columns) concerned with the different projects can be found in table II.2, where the different numbers correspond to the different selected projects, for example a "senior system auditor" performs "Systeem audits" for projects 1,3 and 4 from the following list;

1. OT07041b "toezicht bij intermediaire bedrijven cat. 3"
2. OT07062a "erkenningverlening en onderhoud"
3. OT07064b "HACCP veterinaire sector niet industrieel"
4. OT07064d "Toezicht en traceerbaarheid koel- en vrieshuizen"
5. ZD070820 "Nalevers door handhaving – TLP"

Projectcode	planned number of inspections 2007	realised number of inspection up to august 2007	percentage
OT07041b	90	11	12,222222
OT07062a	441	959	217,46032
OT07064b	610	88	14,42623
OT07064d	258	46	17,829457
ZD070820	1474	537	36,431479

Table II.1 Selected projects for capacity check evaluation



	1 senior toezichthoudend dierenarts (senior TDA)	15 toezichthoudend dierenarts (TDA)	7 Senior System Auditors (TDA)	4 assistant system auditors (SSA)	3 productdeskundigen	11 senior controleurs	2 assistant controleurs
AM-keuring (ante-mortum)							
Toezicht PM-keuring (post-mortum)							
Export certificering							
Systeem audits	2/3/4	2/3/4	3/4	1/3/4	1/2/3/4		
Systeem inspecties	3/4	3/4	3/4	1/5	1/2/3/4		1/3/4
Inspecties					1/2/3/4	5	1/2/3/4/5
Monsternamen							

Table II.2 Representativity of the selected projects

The types of work on the first three rows of table II.2 are externally initiated types of work. This work contains the supervision of slaughter before and after the act and the certification of animals to be transported abroad. This report is delineated to look only at internally initiated demand, so those activities will be left out of the sample.

Appendix III MS Excel VBA Code

Figure III.1 illustrates what steps are taken in the code. Each part corresponds to a part of the code presented below. The excel file that contains this code can be found on the intranet of the VWA at *N:\stage\afstudeerproject capaciteitsplanning TLP\documenten openbaar\scheduler.xls*

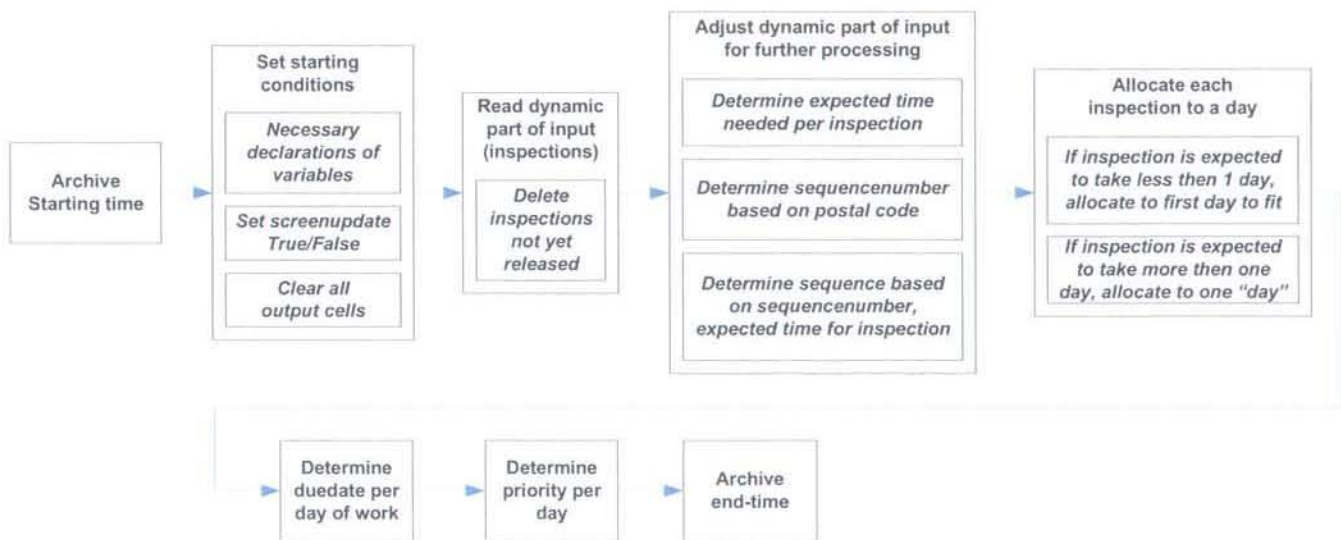


Figure III.1 the different steps of the MS Excel VBA code

III.1 MS Excel VBA Code

```
Sub Allocation()
```

```
'Archive startingtime
```

```
Sheets("uitleg").Select
```

```
Range("d17").Select
```

```
ActiveCell = Now
```

```
'Set Starting conditions
```

```
'Necessary declarations of variables
```

```
Dim update As Integer
```

```
Dim inspectielijst As String
```

```
Dim datum As Date
```

```
Dim nu As Date
```

'Set screenupdate True/False, false increases speed

```
update = MsgBox(prompt:="Wilt u de macro snel uitvoeren?" & Chr(10) & Chr(13) & Chr(10)
& Chr(13) & "JA voert de macro snel uit, zonder schermupdate" & Chr(10) & Chr(13) & "NEE
voert de macro langzaam uit, met schermupdate)", Buttons:=vbYesNoCancel)
If update = vbYes Then
Application.ScreenUpdating = False
ElseIf update = vbNo Then
Application.ScreenUpdating = True
Else: Exit Sub
End If
```

'Clear all output cells

```
Sheets("Blad2").Cells.Clear
Sheets("output").Range("a3:at6500").Clear
```

'Read dynamic part of input (inspections)

```
Sheets("Input").Select
Columns("A:I").Select
Selection.Copy
Sheets("Blad2").Select
Range("A1").Select
ActiveSheet.Paste
Application.CutCopyMode = False
```

'Delete inspections not yet released

```
'sort on releasedate
Selection.Sort Key1:=Range("h1"), Order1:=xlAscending, Header:=xlGuess,
OrderCustom:=1, MatchCase:=_
False, Orientation:=xlTopToBottom
```

'determine total number of inspections

```
Range("g1").Select
Selection.End(xlDown).Select
aantalinspecties = Selection.Row
Range("h1").Select
```

'if releasedate is in the future, delete

```
nu = Date
For i = 1 To aantalinspecties
If ActiveCell > nu Then
ActiveCell.Offset(0, -7).Resize(aantalinspecties, 15).Delete
Else
ActiveCell.Offset(1, 0).Select
End If
Next i
```

'Adjust Dynamic part of input for further processing*'sort inspections on inspectionlist, needed for VLookup function*

```
Range("a1:i1").Select
Selection.Sort      Key1:=Range("G1"),      Order1:=xlAscending,      Header:=xlGuess,
OrderCustom:=1, MatchCase:=_
False, Orientation:=xlTopToBottom
```

'determine number of inspections to allocate

```
Range("g1").Select
Selection.End(xlDown).Select
aantalinspecties = Selection.Row
Range("g1").Select
```

'if number of inspections is 0 or 1, the above will generate 65536 for aantalinspecties

```
If aantalinspecties > 65535 Then
aantalinspecties = 1
End If
```

'read inspectionlist and postalcode for each inspection and store in variables

```
For i = 1 To aantalinspecties
If ActiveCell.Value <> "" Then
inspectielijst = ActiveCell.Value
ActiveCell.Offset(0, -2).Select
postcodecijfers = CInt(Left(ActiveCell.Value, 4))
```

'determine expected time needed per inspection, if not present 7777

```
Sheets("tijd per lijst").Select
If IsError(Application.VLookup(inspectielijst, Range("a1:b200"), 2, False)) Then
tijd = 7777
Else
tijd = Application.VLookup(inspectielijst, Range("a1:b200"), 2, False)
End If
```

'determine sequencenumber based on postal code

```
Sheets("PCvolgorde").Select
If IsError(Application.VLookup(postcodecijfers, Range("a1:b2600"), 2, False)) Then
PCvolgnummer = 99999
Else
PCvolgnummer = Application.VLookup(postcodecijfers, Range("a1:b2600"), 2, False)
End If
```

'store found data

```
Sheets("blad2").Select
ActiveCell.Offset(0, 5).Select
ActiveCell = tijd
ActiveCell.Offset(0, 2).Select
ActiveCell = PCvolgnummer
```

```
ActiveCell.Offset(0, -5).Select
```

```
End If
```

```
ActiveCell.Offset(1, 0).Select
```

```
Next i
```

```
'Determine sequence based on sequencenumber, expected time for inspecton
```

```
Columns("A:L").Select
```

```
Selection.Sort Key1:=Range("L1"), Order1:=xlAscending, Key2:=Range("e1") _
```

```
, Order2:=xlAscending, Key3:=Range("j1") _
```

```
, Order3:=xlDescending, Header:=xlGuess, OrderCustom:=1, MatchCase:= _
```

```
False, Orientation:=xlTopToBottom
```

```
'allocate each inspection to a day
```

```
'Create day-id's
```

```
Sheets("output").Select
```

```
Range("A3").Select
```

```
ActiveCell.FormulaR1C1 = "1"
```

```
Range("A4").Select
```

```
ActiveCell.FormulaR1C1 = "2"
```

```
Range("A5").Select
```

```
ActiveCell.FormulaR1C1 = "3"
```

```
Range("A3:A5").Select
```

```
Selection.AutoFill Destination:=Range("A3:A10000"), Type:=xlFillDefault
```

```
Range("A3:A10000").Select
```

```
'for each inspections store all data in variables
```

```
Range("j1").Select
```

```
For i = 1 To aantalinspecties
```

```
Sheets("blad2").Select
```

```
Cells(i, 1).Select
```

```
Team = ActiveCell.Value
```

```
ActiveCell.Offset(0, 1).Select
```

```
project = ActiveCell.Value
```

```
ActiveCell.Offset(0, 1).Select
```

```
soort = ActiveCell.Value
```

```
ActiveCell.Offset(0, 1).Select
```

```
naam = ActiveCell.Value
```

```
ActiveCell.Offset(0, 1).Select
```

```
postcode = ActiveCell.Value
```

```
ActiveCell.Offset(0, 1).Select
```

```
huisnr = ActiveCell.Value
```

```
ActiveCell.Offset(0, 1).Select
```

```
inspectielijst = ActiveCell.Value
```

```
ActiveCell.Offset(0, 1).Select
```

```
gepland = ActiveCell.Value
```

```
ActiveCell.Offset(0, 1).Select
```



```
gerealiseerd = ActiveCell.Value  
ActiveCell.Offset(0, 1).Select  
indeeltijd = ActiveCell.Value
```

```
Sheets("output").Select  
Range("b3").Select
```

'If inspection is expected to take less then 1 day, allocate to first day to fit

```
If indeeltijd <= 480 Then  
Do  
reftijd = ActiveCell.Value  
If reftijd + indeeltijd <= 480 Then  
huidigetijd = ActiveCell.Value  
ActiveCell = huidigetijd + indeeltijd  
ActiveCell.Offset(0, 1).Select  
huidigeaantal = ActiveCell.Value  
ActiveCell = huidigeaantal + 1  
ActiveCell.Offset(0, -2).Select  
dagnr = ActiveCell.Value  
ActiveCell.Offset(0, 4 + 11 * huidigeaantal).Select  
ActiveCell.Value = Team  
ActiveCell.Offset(0, 1).Select  
ActiveCell.Value = project  
ActiveCell.Offset(0, 1).Select  
ActiveCell.Value = soort  
ActiveCell.Offset(0, 1).Select  
ActiveCell.Value = naam  
ActiveCell.Offset(0, 1).Select  
ActiveCell.Value = postcode  
ActiveCell.Offset(0, 1).Select  
ActiveCell.Value = huisnr  
ActiveCell.Offset(0, 1).Select  
ActiveCell.Value = inspectielijst  
ActiveCell.Offset(0, 1).Select  
ActiveCell.Value = gepland  
ActiveCell.Offset(0, 1).Select  
ActiveCell.Value = gerealiseerd  
ActiveCell.Offset(0, 1).Select  
ActiveCell.Value = indeeltijd  
Sheets("blad2").Select  
Cells(i, 11).Select  
ActiveCell = dagnr  
Else  
ActiveCell.Offset(1, 0).Select  
End If  
Loop Until reftijd + indeeltijd <= 480
```



'If inspection is expected to take more then one day, allocate to one "day"

ElseIf indeeltijd > 480 And indeeltijd < 2000 Then

Do

reftijd = ActiveCell.Value

If reftijd = 0 Then

huidigetijd = ActiveCell.Value

ActiveCell = huidigetijd + indeeltijd

ActiveCell.Offset(0, 1).Select

huidigeaantal = ActiveCell.Value

ActiveCell = huidigeaantal + 1

ActiveCell.Offset(0, -2).Select

dagnr = ActiveCell.Value

ActiveCell.Offset(0, 4 + 11 * huidigeaantal).Select

ActiveCell.Value = Team

ActiveCell.Offset(0, 1).Select

ActiveCell.Value = project

ActiveCell.Offset(0, 1).Select

ActiveCell.Value = soort

ActiveCell.Offset(0, 1).Select

ActiveCell.Value = naam

ActiveCell.Offset(0, 1).Select

ActiveCell.Value = postcode

ActiveCell.Offset(0, 1).Select

ActiveCell.Value = huisnr

ActiveCell.Offset(0, 1).Select

ActiveCell.Value = inspectielijst

ActiveCell.Offset(0, 1).Select

ActiveCell.Value = gepland

ActiveCell.Offset(0, 1).Select

ActiveCell.Value = gerealiseerd

ActiveCell.Offset(0, 1).Select

ActiveCell.Value = indeeltijd

Sheets("blad2").Select

Cells(i, 11).Select

ActiveCell = dagnr

Else

ActiveCell.Offset(1, 0).Select

End If

Loop Until reftijd = 0

End If

Next i

'Determine duedate per day of work

Sheets("output").Select

Range("b3").Select



```
Selection.End(xlDown).Select
aantaldagen = Selection.Row - 2
Range("d3").Select
For i = 1 To aantaldagen

If Cells(i + 2, 13) = Empty Then
DD1 = 999999999
Else: DD1 = Cells(i + 2, 13).Value
End If

If Cells(i + 2, 13 + 1 * 11) = Empty Then
DD2 = 999999999
Else: DD2 = Cells(i + 2, 13 + 1 * 11).Value
End If

If Cells(i + 2, 13 + 2 * 11) = Empty Then
DD3 = 999999999
Else: DD3 = Cells(i + 2, 13 + 2 * 11).Value
End If

If Cells(i + 2, 13 + 3 * 11) = Empty Then
DD4 = 999999999
Else: DD4 = Cells(i + 2, 13 + 3 * 11).Value
End If

If Cells(i + 2, 13 + 4 * 11) = Empty Then
DD5 = 999999999
Else: DD5 = Cells(i + 2, 13 + 4 * 11).Value
End If

datum = WorksheetFunction.Min(DD1, DD2, DD3, DD4, DD5)
ActiveCell = datum
ActiveCell.Offset(1, 0).Select
Next i
```

'Sort days on duedate

```
Cells(3, 2).Resize(aantaldagen, 200).Select
Selection.Sort Key1:=Range("D3"), Order1:=xlAscending, Header:=xlGuess, OrderCustom:=1,
MatchCase:= _
    False, Orientation:=xlTopToBottom
```

'Archive end-time

```
Sheets("uitleg").Select
Range("d18").Select
ActiveCell = Now
einde = Now
```




```
'end of program  
Sheets("output").Select  
Range("a1").Select
```

```
End Sub
```



Appendix IV Postal code sequence

IV.1 "Noord-Holland"

Sequencenumber	Postal code	Sequencenumber	Postal code	Sequencenumber	Postal code
10001	1795	10042	1724	10083	1619
10002	1794	10043	1723	10084	1602
10003	1793	10044	1722	10085	1601
10004	1796	10045	1721	10086	1611
10005	1791	10046	1704	10087	1613
10006	1792	10047	1703	10088	1614
10007	1797	10048	1705	10089	1616
10008	1781	10049	1702	10090	1606
10009	1782	10050	1701	10091	1607
10010	1783	10051	1711	10092	1609
10011	1784	10052	1713	10093	1608
10012	1785	10053	1715	10094	1617
10013	1786	10054	1716	10095	1696
10014	1787	10055	1718	10096	1697
10015	1788	10056	1719	10097	1627
10016	1764	10057	1733	10098	1621
10017	1761	10058	1734	10099	1622
10018	1774	10059	1738	10100	1624
10019	1778	10060	1736	10101	1623
10020	1777	10061	1735	10102	1628
10021	1779	10062	1732	10103	1695
10022	1771	10063	1731	10104	1625
10023	1773	10064	1661	10105	1689
10024	1775	10065	1662	10106	1685
10025	1766	10066	1663	10107	1686
10026	1767	10067	1655	10108	1688
10027	1768	10068	1654	10109	1687
10028	1742	10069	1657	10110	1652
10029	1741	10070	1658	10111	1642
10030	1757	10071	1676	10112	1643
10031	1756	10072	1679	10113	1641
10032	1759	10073	1678	10114	1648
10033	1751	10074	1674	10115	1647
10034	1752	10075	1671	10116	1634
10035	1753	10076	1693	10117	1631
10036	1755	10077	1692	10118	1633
10037	1754	10078	1691	10119	1636
10038	1744	10079	1682	10120	1645
10039	1746	10080	1684	10121	1646
10040	1747	10081	1683	10122	1842
10041	1749	10082	1681	10123	1841



<u>Sequencenumber</u>	<u>Postal code</u>	<u>Sequencenumber</u>	<u>Postal code</u>	<u>Sequencenumber</u>	<u>Postal code</u>
10124	1843	10169	1945	10214	1473
10125	1844	10170	1947	10215	1135
10126	1846	10171	1946	10216	1132
10127	1847	10172	1966	10217	1131
10128	1812	10173	1965	10218	1481
10129	1813	10174	1964	10219	1482
10130	1821	10175	1961	10220	1145
10131	1829	10176	1962	10221	1141
10132	1822	10177	1963	10222	1156
10133	1823	10178	1967	10223	1154
10134	1811	10179	1911	10224	1153
10135	1814	10180	1562	10225	1151
10136	1815	10181	1561	10226	1454
10137	1816	10182	1536	10227	1452
10138	1817	10183	1489	10228	1127
10139	1824	10184	1488	10229	1121
10140	1825	10185	1486	10230	1511
10141	1826	10186	1487	10231	1509
10142	1834	10187	1484	10232	1544
10143	1827	10188	1485	10233	1567
10144	1831	10189	1483	10234	1566
10145	1832	10190	1458	10235	1551
10146	1862	10191	1534	10236	1541
10147	1861	10192	1531	10237	1507
10148	1871	10193	1546	10238	1506
10149	1873	10194	1456	10239	1508
10150	1865	10195	1451	10240	1502
10151	1934	10196	1448	10241	1501
10152	1931	10197	1441	10242	1503
10153	1935	10198	1447	10243	1504
10154	1921	10199	1445	10244	1505
10155	1852	10200	1446	10245	1037
10156	1851	10201	1443	10246	1035
10157	1906	10202	1442	10247	1033
10158	1901	10203	1444	10248	1034
10159	1902	10204	1461	10249	1032
10160	1968	10205	1464	10250	1031
10161	1969	10206	1462	10251	1021
10162	1949	10207	1463	10252	1022
10163	1951	10208	1475	10253	1025
10164	1948	10209	1476	10254	1023
10165	1941	10210	1474	10255	1024
10166	1942	10211	1477	10256	1027
10167	1943	10212	1471	10257	1028
10168	1944	10213	1472	10258	1026



<u>Sequencenumber</u>	<u>Postal code</u>	<u>Sequencenumber</u>	<u>Postal code</u>	<u>Sequencenumber</u>	<u>Postal code</u>
10259	1087	10304	1068	10349	2051
10260	1095	10305	1069	10350	2041
10261	1098	10306	1171	10351	2042
10262	1097	10307	1175	10352	2116
10263	1096	10308	1161	10353	2111
10264	1079	10309	1165	10354	2114
10265	1083	10310	1046	10355	2121
10266	1082	10311	1043	10356	2106
10267	1081	10312	1044	10357	2105
10268	1076	10313	1045	10358	2101
10269	1077	10314	1047	10359	2102
10270	1075	10315	2064	10360	2103
10271	1071	10316	1981	10361	2104
10272	1072	10317	1985	10362	2136
10273	1073	10318	1971	10363	2142
10274	1074	10319	1972	10364	2141
10275	1091	10320	1975	10365	2143
10276	1092	10321	1973	10366	2131
10277	1093	10322	1976	10367	2134
10278	1094	10323	1974	10368	2133
10279	1019	10324	2071	10369	2135
10280	1018	10325	2082	10370	2144
10281	1016	10326	1991	10371	2165
10282	1015	10327	1992	10372	2151
10283	1011	10328	2063	10373	2152
10284	1012	10329	2026	10374	2153
10285	1013	10330	2024	10375	2157
10286	1041	10331	2023	10376	2156
10287	1042	10332	2022	10377	2155
10288	1014	10333	2021	10378	2154
10289	1051	10334	2031	10379	1435
10290	1052	10335	2065	10380	2132
10291	1053	10336	2032	10381	1118
10292	1054	10337	2033	10382	1117
10293	1058	10338	2035	10383	1438
10294	1059	10339	2037	10384	1119
10295	1062	10340	2036	10385	1437
10296	1066	10341	2034	10386	1436
10297	1065	10342	2012	10387	1432
10298	1061	10343	2019	10388	1431
10299	1057	10344	2011	10389	1433
10300	1056	10345	2013	10390	1424
10301	1055	10346	2014	10391	1423
10302	1063	10347	2015	10392	1421
10303	1067	10348	2061	10393	1422



<u>Sequencenumber</u>	<u>Postal code</u>	<u>Sequencenumber</u>	<u>Postal code</u>
10394	1187	10439	1214
10395	1185	10440	1213
10396	1182	10441	1212
10397	1181	10442	1211
10398	1183	10443	1221
10399	1186	10444	1223
10400	1188	10445	1222
10401	1189	10446	1251
10402	1191	10447	1272
10403	1184	10448	1271
10404	1099	10449	1273
10405	1115	10450	1274
10406	1112	10451	1277
10407	1111	10452	1275
10408	1113	10453	1276
10409	1103	10454	1261
10410	1104		
10411	1102		
10412	1101		
10413	1105		
10414	1107		
10415	1106		
10416	1108		
10417	1109		
10418	1398		
10419	1399		
10420	1382		
10421	1381		
10422	1383		
10423	1394		
10424	1241		
10425	1243		
10426	1244		
10427	1418		
10428	1412		
10429	1411		
10430	1401		
10431	1402		
10432	1403		
10433	1404		
10434	1405		
10435	1406		
10436	1217		
10437	1216		
10438	1215		



IV.2 "Utrecht"

Sequencenumber	Postal code	Sequencenumber	Postal code	Sequencenumber	Postal code
20001	3755	20045	3947	20089	3735
20002	3754	20046	3964	20090	3732
20003	3752	20047	3961	20091	3731
20004	3751	20048	3945	20092	3737
20005	3824	20049	3997	20093	3738
20006	3829	20050	3998	20094	3739
20007	3823	20051	3999	20095	3615
20008	3822	20052	3991	20096	3612
20009	3828	20053	3992	20097	3625
20010	3813	20054	3995	20098	1231
20011	3812	20055	3993	20099	3632
20012	3819	20056	3994	20100	3631
20013	3818	20057	3985	20101	3634
20014	3817	20058	3972	20102	3633
20015	3811	20059	3984	20103	1396
20016	3814	20060	3981	20104	1391
20017	3816	20061	3709	20105	3645
20018	3815	20062	3703	20106	3646
20019	3821	20063	3704	20107	3641
20020	3836	20064	3706	20108	3643
20021	3835	20065	3705	20109	3642
20022	3833	20066	3702	20110	3648
20023	3834	20067	3701	20111	3628
20024	3831	20068	3708	20112	3626
20025	3832	20069	3707	20113	3621
20026	3931	20070	3711	20114	3607
20027	3927	20071	3712	20115	3605
20028	3959	20072	3769	20116	3608
20029	3906	20073	3768	20117	3606
20030	3904	20074	3764	20118	3604
20031	3905	20075	3765	20119	3603
20032	3902	20076	3766	20120	3601
20033	3907	20077	3763	20121	3602
20034	3901	20078	3762	20122	3611
20035	3903	20079	3761	20123	3565
20036	3911	20080	3743	20124	3563
20037	3912	20081	3742	20125	3564
20038	3921	20082	3741	20126	3566
20039	3922	20083	3744	20127	3561
20040	3958	20084	3749	20128	3562
20041	3956	20085	3734	20129	3552
20042	3953	20086	3723	20130	3554
20043	3951	20087	3721	20131	3555
20044	3941	20088	3722	20132	3553



<u>Sequencenumber</u>	<u>Postal code</u>	<u>Sequencenumber</u>	<u>Postal code</u>
20133	3551	20178	3413
20134	3513	20179	3415
20135	3515	20180	3405
20136	3514	20181	3417
20137	3571	20182	3454
20138	3573	20183	3453
20139	3584	20184	3451
20140	3585	20185	3455
20141	3582	20186	3481
20142	3583	20187	3461
20143	3581	20188	3446
20144	3572	20189	3445
20145	3512	20190	3444
20146	3511	20191	3471
20147	3521	20192	3474
20148	3522	20193	3443
20149	3523	20194	3449
20150	3524	20195	3442
20151	3525	20196	3441
20152	3526	20197	3447
20153	3528	20198	3448
20154	3527	20199	3464
20155	3533	20200	3425
20156	3531	20201	3421
20157	3532	20202	3467
20158	3534		
20159	3542		
20160	3541		
20161	3544		
20162	3545		
20163	3546		
20164	3437		
20165	3436		
20166	3431		
20167	3438		
20168	3439		
20169	3433		
20170	3432		
20171	3434		
20172	3435		
20173	3402		
20174	3401		
20175	3404		
20176	3412		
20177	3411		

Appendix V User instruction MS Excel VBA program (in Dutch)

Stap 1	Op het tabblad "tijd per lijst" alle mogelijke inspectielijsten met bijbehorende verwachte tijd neerzetten
Stap 2	Op het tabblad "input" alle nog uit te voeren inspecties neerzetten, op elke regel 1 inspectie
	Er zijn een aantal eisen aan het format van de input;
	De postcode moet beginnen met 4 cijfers
	De naam van de inspectielijst moet exact overeenkomen met de naam van die inspectielijst op het tabblad "tijd per lijst"
	De data moeten in het format dd-mm-jjjj
Stap 3	Ga naar tabblad "output" en klik op "uitvoeren"
Stap 4	Kies of de macro snel of langzaam uitgevoerd moet worden
	De schermupdate (het flikkeren van het scherm tijdens de uitvoer) vertraagt de macro aanzienlijk, het geeft wel de zekerheid dat Excel iets aan het doen is.
	De output van de macro is hetzelfde, snel of langzaam uitgevoerd
Stap 5	De output staat in het tabblad "output"
	op elke regel een dag met werk
	gesorteerd op due date, de vroegste bovenaan

Appendix VI Testing the MS Excel VBA program

To make sure the program does what the proposed heuristic describes, the program is presented a number of standard and extreme cases, the outcome of which are checked against manual computations. The following cases have been checked and confirmed.

- 20 inspections with more than one inspection that is not yet released (to check whether the releasecheck functions well)
- 20 inspections with more than one inspection per postal code (to check if the inspections are combined into days well)
- 20 inspections with a non-integer number of days of work per postal code (to check whether the chain is followed well)
- 20 inspections with more than two postal codes (to check whether the chain is followed well).
- 0 inspections to be performed (to check if any zero-related deadlocks exist)
- 1 inspection to be performed (to check if any singularity-related deadlocks exist)

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Abbreviations & Definitions

Abbreviations

FaTijDec

Program used to archive working time. Abbreviation from the Dutch words "Facturering", "TIJdschrijven" and "DECLaratie", invoicing, time writing and declaration.

FP&C

Financiën, Planning & Control

KvW

Keuringsdienst van Waren

LNV – ministerie van ~

Landbouw, Natuur en Voedselkwaliteit

RVV

Rijksdienst voor de keuring van Vee en Vlees

S&O

Signalering en ontwikkeling

TLP

Team Levensmiddelen productiebedrijven

TPB

Teams productiebedrijven

VWA

Voedsel en waren autoriteit

VWS – ministerie van ~

Volksgezondheid, Welzijn en Sport

Definitions

Traveltime

Time needed to travel from one place to another.

Inspectionlist

List of questions that need to be answered during an inspection, used to guide an inspector on what to inspect.