

# POLICY DEVELOPMENT:

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## A FRAMEWORK WITH BUSINESS PROCESS MODELLING AND AGENT-BASED MODELLING

SUZANNE VAN POELGEEST



# **Policy development:**

A framework with Business Process Modelling and  
Agent-Based Modelling

**Suzanne van Poelgeest**

Degree: Master of Business Informatics  
Department: Computer Science, Utrecht University  
1st Supervisor: Prof. dr. S. Brinkkemper  
2nd Supervisor: dr. L.M. Ruiz Carmona  
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”You do not start out writing good stuff. You start out writing crap and thinking it is good stuff, and then gradually you get better at it. That is why one of the most valuable traits is persistence.” - Octavia E. Butler

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- Suzanne van Poelgeest

# Abbreviations

<b>Abbreviations</b>	<b>Explanation</b>
AAT	Autonomous Agent Theory
ABM	Agent-Based Modelling
ABS	Agent-Based Simulation
Agro	Is used to form nouns and adjectives which refer to things relating to agriculture, or to agriculture combined with another activity.
ANWB	Algemene Nederlandse Wielrijdersbond (English: General Dutch Cycling Association)
B&I	Business and Innovation
BIBOB	Wet Bevordering integriteitsbeoordelingen door het openbaar bestuur (English: Promotion of integrity assessments by the public administration)
BPM	Business Process Modelling
BPMN	Business Process Modelling Notation
C&E	Climate and Energy
CBS	Centraal Bureau voor de Statistiek (English: Statistics Netherlands)
CCV	Centrum voor criminaliteitspreventie van veiligheid (English: Center for Crime Prevention and Security)
CMD	Commissie Deskundigen Meststoffenwet (English: Committee of Experts for Fertilizers Act)
CPB	Centraal Planbureau
DG	Directorate-Generals
DoMus	Document management system
EC	European Commission
EPC	Event Driven Process Chain
EU	European Union
EZK	Ministerie van Economische Zaken en Klimaat (English: Ministry of Economic Affairs and Climate Policy)
GIS	Geographic Information System
IAK	Integraal afwegingskader beleid en regelgeving (English: Integrated impact assessment framework for policy and legislation)
ICT	Information and Communications Technology
ICTU	ICT Uitvoeringsorganisatie (English: ICT Implementation Organization)
IDEF	Integrated Definition for Function Modelling
IRT	Inter-regional Investigation Teams
IS	Information system
LIEC	Landelijk Information and Expertise Center (English: National Information and Expertise Center)
LLM	National Manure Measurement Network
LNV	Ministerie van Landbouw, Natuur en Voedselkwaliteit (English: Ministry of Agriculture, Nature and Food Quality)
Loess	Is a clastic, predominantly silt-sized sediment that is formed by the accumulation of wind-blown dust. In the province of Limburg (in the south-east), the scenery is also somewhat 'un-Dutch'. Loess can be found there, which is also known as Limburg clay.
MER	Commissie voor de milieueffectrapportage mestbeleid or (English: The Netherlands Commission for Environmental Assessment)
MINAS	Dutch Mineral Accounting System

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NAP	Nitrate Action Program
NVWA	Nederlandse Voedsel- en Warenautoriteit (English: The Netherlands food and consumer product safety authority)
PBL	Planbureau voor de Leefomgeving (English: Netherlands Environmental Assessment Agency)
RAD	Role activity diagrams
RID	Role interaction diagrams
RIEC	Regional Information and Expertise Center
RIVM	Rijksinstituut voor Volksgezondheid en Milieu (English: National Institute for Public Health and the Environment)
RVO	Rijksdienst voor Ondernemend Nederland (English: The Netherlands Enterprise Agency)
RWS	Rijkswaterstaat
SMK	Strategisch Economische Kamer (English: Strategic Environmental Chamber)
VST	Viable system theory
WUR	Wageningen University and Research
WWF	World Wildlife Fund

# Managementsamenvatting

Data wordt gezien als een belangrijk hulpmiddel voor de ontwikkeling van beleid. Hoe data in de huidige context wordt gebruikt, is niet meer voldoende voor de voortdurend veranderende omgeving en zou een meer geïntegreerde rol moeten hebben. Om de Ministeries te helpen hun gegevensintegratie in het beleidsontwikkelingsproces te verbeteren, wordt binnen dit onderzoek het proces van beleidsontwikkeling bestudeerd. Er wordt gekeken naar hoe gegevens worden gebruikt in de huidige situatie en welke agents betrokken zijn. Het is moeilijk om het beleidsontwikkelingsproces van de Nederlandse Ministeries vast te leggen. Dit komt doordat beleidsvorming een dynamisch proces is dat kan veranderen op basis van de context van het beleid.

We hopen meer inzicht te bieden in het beleidsontwikkelingsproces door bedrijfsprocessen te modelleren en agenten te modelleren. Dit twee methodes zou het mogelijk maken om meer inzicht te geven in het beleidsontwikkelingsproces, de agenten en de gegevens die in het proces worden gebruikt. De volgende onderzoeksvraag is hiervoor geformuleerd: "Kan een gecombineerde aanpak van het modelleren van bedrijfsprocessen en agenten ons een beter inzicht geven in het proces, de agents en de gegevens rond de ontwikkeling van beleid?" Tijdens het onderzoek werd de "design science" methodologie gebruikt. Het onderzoek bestond uit drie fasen: het probleemonderzoek, het ontwerpen van de behandeling en de validatie. Als onderdeel van de eerste fase is een literatuurstudie uitgevoerd op drie gebieden: beleidsontwikkeling, modellering van bedrijfsprocessen en het modelleren van agenten.

Om de behandeling te ontwerpen, werden twee casestudies uitgevoerd, een case study over het mestbeleid en een case study over het ondermijnende criminaliteitsbeleid. De deelnemers aan de casestudies zijn; beleidsmakers, projectleiders en andere mensen die betrokken zijn bij het proces van beleidsontwikkeling door hun functie. Als onderdeel van de casestudies zijn interviews gehouden met deze deelnemers. Uit de antwoorden op de vragen in de interviews bleek dat het voor beleidsmedewerkers moeilijk is om precies uit te leggen hoe het beleid wordt gemaakt. Door de beschrijving van de bedrijfsprocessen te modelleren, was het mogelijk om per case study een beleidsproces op te stellen en dit te generaliseren in één beleidsontwikkelingsproces. In dit algemene beleidsproces is aangegeven wanneer het modelleren van bedrijfsprocessen en wanneer het modelleren van agenten in het proces kan worden toegepast. Dit kan beleidsmakers helpen te begrijpen welke methode op welk moment kan worden gebruikt.

De deelnemers konden beter aangeven welke agenten bij het beleidsontwikkelingsproces betrokken zijn. Dit heeft geleid tot de classificatie van vier soorten agenten die terugkwamen in beide casestudies, dit zijn data- en expertise-instituten, de klant, de agenten die uitvoeren en belangengroepen.

Data wordt in beide casussen op een geheel andere manier gebruikt. In de mestbeleid casus wordt data voornamelijk ontvangen. Onderzoeks instituten en experst verstrekken data aan de beleidsmedewerkers, die maken hier gebruik van om het beleid daadwerkelijk te schrijven. In het geval van het ondermijnende criminaliteitsbeleid staat data meer centraal en nemen beleidsmedewerkers zelf deel aan gegevensanalyses die helpen bij het vormen van beleid.

Vanwege ontbrekende literatuur die het mogelijk maakt om een gestructureerd, op agenten gebaseerd model te maken, was het moeilijk om de interacties van de agents te vertalen tot een model. Dit heeft ertoe geleid dat het onderzoek zich ook heeft gericht op het ontwerpen van een meta-model voor op agenten gebaseerde modellen. Daarnaast is er gekeken naar een techniek en taalonafhankelijk meta-model voor het modelleren van bedrijfsprocessen. Het modelleren van bedrijfsprocessen heeft geholpen om inzicht te verschaffen in het beleidsproces. Het maken van op agent gebaseerde modellen was moeilijker vanwege de ontbreken informatie over het formaliseren van agenten in modellen. Vervolgonderzoek zou zich dan ook kunnen focussen op het formaliseren van agent gebaseerde modellen.

# Managementsummary

Data is seen as an important tool for developing public policy. How data is used in the current context is not sufficient anymore for the constantly changing environment and should have a more integrated role. To help the Ministries improve their data integration into the policy development process, we will examine the policy development process and look at how data is used in the current situation. It is difficult to capture the policy development process of the Dutch Ministries, the process is dynamic and can change based on the context of the policy.

We hope to provide more insight into the policy development process by combining business process modelling and agent-based modelling. This would make it possible to give more insight into the policy development process, the agents and the data used in the process. The following research question has been formulated for this: "Can a combined approach of business process modelling and agent-based modelling give us better insight into the process, agents and data around policy development?" During the research, the design science methodology was used. The research consisted of three phases: the problem investigation, the treatment design and the validation. As part of the first phase, a literature study has been conducted in three fields: policy development, business process modelling and agent-based modelling.

To design the treatment, two case studies were conducted a case study on the manure policy and a case study on the undermining crime policy. The participants who participated in the case studies are; policy-makers, project leaders and other people who are involved in policy development process through their position. As part of the case studies interviews have been conducted with these participants. The answers to the questions in the interviews showed that it is difficult for policy staff to explain exactly how policy is made. By applying business process modelling, it has been possible to compile a policy process per case study and to generalize this into one policy development process. On this generalized policy process, it is plotted when business process modelling and when agent-based modelling can be applied in the process. This can help policymakers in understanding which method can be used at what point.

The participants were better able to indicate which agents are involved in the policy development process. This has led to the classification of four types of agents that came back in both case studies, these are data and expertise institutes, the client, the agent that executes and interest groups. Data is used in a completely different way in both cases. Within the manure policy case, information is mainly relied upon from data and expertise institutes that provide data to the executing party that actually writes the policy. In the case of the undermining crime policy, data is central and the policy staff themselves participate in data analyzes that help form policy.

Due to missing literature that makes it possible to create a structured agent-based model, translating the interactions of the agents into an agent-based model was difficult. This has led the research to focus on designing a meta-model for agent-based modelling and a technique and language independent meta-model for business process modelling. The use of business process modelling has certainly helped to provide insight into the policy process. Creating agent-based models was more difficult due to missing information on formalising agents into models. Any follow-up research could focus on formalising the creation of such agent-based models.



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# Chapter 1

## Introduction

A look at the titles of publications about business process modelling (BPM) and agent-based modelling (ABM) in professional and scientific publications shows that a link between these two concepts is never made. The literature illustrate business process modelling as a technique to capture a processes and data in a model. Agent-based modelling enables you to captures the dynamic and complex environment of organisations, which is often a challenge with business process modelling. Our hypothesis lies in the idea that business process modelling in combination with agent-based modelling could help to better understand the combination of process, data and agents. The Ministries of the Netherlands are focusing on improving the use of data, information and ICT in the policy development processes. Data is seen as an important tool for developing policy. How data is used in the current context is not sufficient anymore for the constantly changing environment and should have a more integrated role. To help the Ministries improve their data integration into the policy development process we will examine the policy development process and look at how data is used in the current situation and could be of added value in the future. By combining business process modelling and agent-based modelling, an alignment between process, data and agents should be possible. It could make policy development more transparent and identify important agents and data. We will propose a framework that explains the policy development process in the current environment and explore how data supports the policy development process. We believe that such an alignment of process and data offers added value to the efficiency of policy development. The chapter is organised as follows: Section 1.1 provides the motivation for this research. The next section, 1.2, describes the research approach, including the research questions, research methodology and research activities. Section 1.3 describes the scope of the research. The next section, 1.4, explains the case studies followed by section 1.5 which provides the reader with the structure of the research.

### 1.1 Motivation

Nowadays, policy-makers face uncertainties about a myriad of external factors. Factors such as climate change, population growth, new technologies, economic developments and their impact all play a role in policy development. Not only do environmental conditions change, but also societal perspectives and preferences may change over time. These external factors demand internal organization changes and different perspectives on policy (Offermans 2010; Van der Brugge, Rotmans, and Loorbach 2005). Traditionally, policy-makers in many policy domains assume that the future can be predicted. They develop an optimal plan often based on an extrapolation of trends. If the future turns out to be different from the hypothesized future(s), the policy is likely to fail. (McInerney, Lempert, and K. Keller 2012) referred to this as "dancing on the top of a needle". As the future unfolds, policy-makers learn and usually respond to the new situation by adapting their plans (ad-hoc) to the new reality. To address these deep uncertainties, a new planning paradigm has emerged also referred to as "Dynamic Adaptive Policy Pathways". This paradigm holds that, in light of the deep uncertainties, one needs to design dynamic adaptive plans (Albrechts 2004; Odoni and De Neufville 2003; Haasnoot et al. 2011; Hallegatte 2009; Hallegatte et al. 2012; Reeder and Ranger 2011). Learning to work with the significant increased available amount of data is the first step into this new paradigm. The Ministries of the Netherlands have been working for a long time to improve the use of data, information and ICT in policy development because it is

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a challenge to make good decisions based on limited information. A large number of approaches and computational techniques exist to support decision-making under deep uncertainty (Dessai and Shuijs 2007; Hallegatte et al. 2012; Swanson and Bhadwal 2009). Implementing this into the policy development process can contribute to better decision-making.

## 1.2 Research approach

Research can be done in different ways. The next part will describe our research approach for this thesis. This starts with the research methodology, followed by the research questions and the research activities that help to answer the research questions.

### 1.2.1 Research methodology

During the research, we will use the design science method. Design science is the design and investigation of artifacts in context (Wieringa 2014). The artifacts of research are designed to interact with a problem context in order to improve something in that context. The aim of design science is to produce knowledge about the real world that does not make any unrealistic abstractions, and that has a scope of validity that is as large as possible. For this research project, we will conduct a design cycle of design science, which is restricted to three tasks: problem investigation, treatment design, and treatment validation (Wieringa 2014). To achieve quick results, a more Agile approach to the design science method will be applied. This means that the investigation phase will lead to a part of the treatment design. From here we will go back to the problem investigation, to design a new part of the treatment. This goes back and forth until the treatment design is finished and can be validated. Figure 1 visualizes the research methodology.

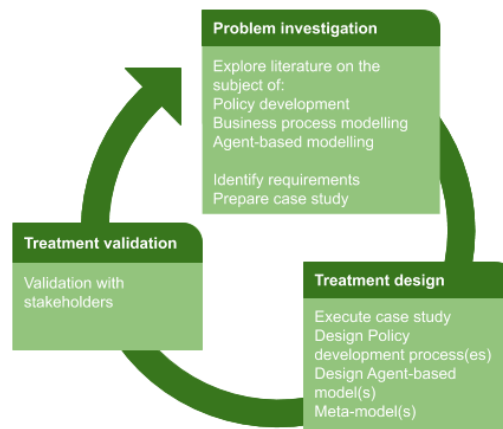


Figure 1: Research methodology.

### 1.2.2 Research questions

The research is designed according to the design science method. To cover all the aspects of the design science method, the research questions are formulated in line with the three design science phases. The first knowledge questions will focus on investigating the problem. The second question also called a technical research question will focus on finding an answer to the treatment design. The third question is also a knowledge question and this question will focus on the treatment validation. The following questions are formulated to find an answer to the main research question: "Can a combined approach of business process modelling and agent-based modelling give us better insight into the process, agents and data around policy development?"

- 
- Q1: Investigating the problem: What are the current processes and methods used in the ministries with respect to policy development?
  - Q2: Treatment design: How would an approach with a combination of business process modelling and agent-based modelling for policy development look like?
  - Q3: Treatment validation: How can a framework based on business process modelling and agent-based modelling be used in practice according to the stakeholders?

The choice for using these two approaches comes from our belief that innovation and ever-growing operational effectiveness should be a company's driving force. Modelling can be a key instrument for innovation. Business process modelling is used to provide an accurate representation of complex business processes. By pointing out all the components of a business (data, organization, processes), a model allows stakeholders to define and evaluate their company better (Russo et al. 2013). Agent-based modelling is useful when the behaviour of individuals is complex, nonlinear, discontinuous, or dynamic. Agent-based models are a means toward better decision-making. They allow us to develop models and simulations that allow ex-ante exploration of the consequences of decisions, while recognizing that real-world systems are made up of a complex myriad of autonomous but interconnected elements (Van Dam, Nikolic, and Lukszo 2012). Combining these two approaches could give us insight into policy development process, the agents and their behaviour and the data used in the policy development process.

### 1.2.3 Research activities

To answer the first research question, we plan to conduct interviews with policy-makers and other stakeholders to discover the characteristics of a typical policy-making process and look into available literature or case studies reporting about this process. We will also investigate what the options or existing artifacts to formalize policy-making processes are. Furthermore we will look at why current practices work or not work and identify the most important stakeholders.

For the second question, we will start with identifying the requirements for business process modelling and agent-based modelling from the point of view of the stakeholders. We will also look at the similarities and difference between business process modelling and agent-based modelling and propose a business process modelling and agent-based modelling framework for policy-makers. The main goal is to answer how a combined solution would look like. Is this parallel or iterative? Or should parts of the approaches be intertwined?

To validate the design, we plan to validate the framework with the stakeholders linked to the development of policy. During the treatment validation, the aim is to investigate the effect of the framework regarding the stakeholders' perception. In terms of a design science project, we will design a framework in order to support the stakeholders of the Ministry in their daily work-related activities concerning policy development.

## 1.3 Scope

This thesis describes multidisciplinary research, that combines aspects from policy development, agent-based modelling, business process modelling and the case studies at different Ministries. We can give an overview of the different fields we will research.

- Dutch policy development on a national level.
- Business process modelling focused on the description and visualisation of the policy development process.
- Agent-based modelling focused on the description and visualisation of the agents, but not through simulation.
- Case studies at the Ministry of Economic Affairs and Climate Policy, the Ministry of Agriculture, Nature and Food Quality, the Ministry of Justice and Security, the Ministry of the Interior and Kingdom Relations and the Ministry of Finance.

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## 1.4 Case studies

To get a better understanding of the relations between a policy, the process, its agents and the use of data, two case studies have been executed. These case studies have been imitated and performed at five different Ministries:

1. The Ministry of Economic Affairs and Climate Policy in collaboration with the Ministry of Agriculture, Nature and Food Quality for the first case study.
2. The second case study is imitated and performed at the Ministry of Justice and Security, the Ministry of the Interior and Kingdom Relations and the Ministry of Finance.

The ministries have been focusing on how to use the available data to the best of their extent in policy development. The case studies are based on researching the development of a policy and examine how the policy process looks like in retrospect, which agents are involved in the policy and how data is used. The case studies are based on different policies. The first case study is about the manure policy and the second case study is about undermining crime. The place of conduction is selected based on the following criteria:

- The policy project needed to be recent
- Political involvement has been minimal
- The involvement of multiple agents is desirable

The scoping has been reduced to more recent projects due to interviewees that still know what is going on and can transfer their knowledge about the policies to the researcher. We wish to openly communicate with interviewees about the policies. That is why cases that have a big political involvement are not used in this study. Political involvement brings a degree of sensitivity with it. It could hinder open conversation and communication, because people do not know what exactly they can share with the researcher about the policy. The last criteria is desirable since it gives us the opportunity to give more grounded conclusions about agent interaction. Cases that would not fit to these criteria would become too complex to research due to time constraint. We believe that case studies that meet these criteria still present interesting and representative outcomes.

To give some structure to the case study research, an framework has been developed with three components: the first component describes the history of the policy. The second component focuses on the structure of the policy and the third component focuses on developing a business process modelling of the manure policy. Figure 2 shows the research structure for the two case studies.

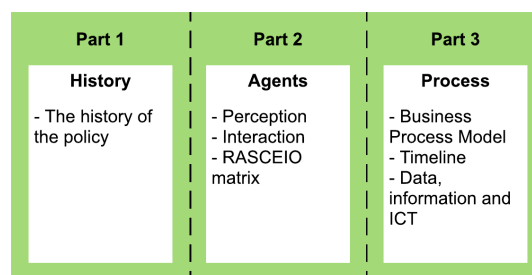


Figure 2: Framework for analysing the case studies.

With this thesis, we hope to contribute to the innovation and changes within the Ministry, by developing a framework that provides insights in the development of policy processes and that take into account the dynamic organization and its requirements. While also describing how data, information and ICT is used during the process. The case study protocol can be found in Appendix A. The case study protocol explains the motivation, validity, objectives, subjects and research questions related to the execution of the case study.



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## 1.5 Thesis structure

This thesis consists of multiple chapters. The chapter structure is as follows:

- Chapter 2 provides the reader with background information about the multidisciplinary research areas and its models and theories. The areas are policy development, business process modelling and agent-based modelling.
- Chapter 3 presents the results of the manure policy.
- Chapter 4 presents the results of the undermining crime policy.
- Chapter 5 presents the analysis on the case studies.
- Chapter 6 presents the framework of business process modelling and agent-based modelling.
- Chapter 7 presents the conclusion and discussion. It discusses the answers to the research questions, the limitations of the research, the contribution, the validity and recommendations for future research.
- The thesis ends with the appendix and bibliography.

# Chapter 2

## Background and related works

This chapter describes the literature related to the research. The chapter describes research on policy development, business process modelling and agent-based modelling. Section 2.1 provides the background information about policies. The next section, 2.2, describes business process modelling (BPM) and all its facets. Section 2.3 describes the basis of agent-based modelling (ABM). The relevant research categorised based on the topic and keywords used in the literature review. These keywords can be bundled in three categories, as show in Table 2.

<b>Policy</b>	<b>Business process modelling</b>	<b>Agent-based modelling</b>
Policy	Business process	Agent-based model
Public policy	Model	Agent-based structure
Policy development	Business process model(ling)	Agent-based modelling and simulation, tools and protocols
External context	Business process modelling techniques	
Actors		

Table 2: Keywords of relevant research literature.

### 2.1 Policy

The term policy has many definitions. It can be hard to pin down what policy exactly means, but there are some central features common to all these definitions:

- It states matters of principle and
- It is focused on actions.

According to the Merriam-Webster (2018) dictionary, policy is “a definite course or method of action selected from among alternatives and in light of given conditions to guide and determine present and future decisions.” A policy can be adopted or proposed by a government, business or individual. For organisations, a policy is a mechanism for controlling the behaviour of an organisations individuals by governing the behaviour of people who work within that organisation. Policies exist to ensure, in a given situation, that people will behave in a way that is predictable, advisable and in the best interests of the organisation and the person. Policies are developed for a reason. A policy is not formulated unless it is thought to be necessary or to have a benefit. In other words, the policy exists for a purpose and this may be often expressed in the form of an underpinning principle.

#### 2.1.1 Public policy

There is a difference between a policy and a public policy. A policy is often seen as a deliberate system of principles to guide decisions and achieve rational outcomes and is linked to procedure or protocols inside an organisation. A public policy does not only guide and determine present and future decisions but it is an attempt of an administrative organization to purposefully influence a

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social issue (Dye 2005). A public policy is not for an organization but a society as a whole. In public policies, decisions are made that affect the public and address issues that affect people in communities. The public sphere or these communities can be as small as the district you live in, a province or the whole nation. Whatever the scale, public policies address problems that are public instead of private. When talking about policies in this thesis, it refers to a public policy that is an attempt of an administrative organization to purposefully influence a social issue. A social issue is a problem that influences a large number of individuals within a society.

### 2.1.2 Policy development

Many scholars have developed theories of how the public policy is developed, but there are two dominant ways in which policy making is considered ('t Hart and Twist 2011):

1. Focuses on analytically solving problems: The analytical vision assumes that policy is the product of deliberate choices. Policy stems from rational considerations of pros and cons by policy-makers. The forces from outside and developments in fields such as technology and the environment do not directly influence policy-making.
2. Is about power and distribution in policy-making: The political vision assumes that policy is the product of differences and contradictions in society. With the political vision, policy does not necessarily have to be well thought out, but there must be enough support from society. The entire process of policy-making is infused with politics.

The following two paragraphs will explain more about the different theories developed around the ways in which policy making is considered. The first theory explained is the "phase model" which is based on the analytical vision. The second theory explains the "stream model", which is based on the political vision. After these two theories, other theories such as the Advocacy Coalition Framework (ACF) and the Diffusion theory are also shortly explained. These theories are more based on a mix of the earlier mentioned visions. The last subsection that explains a policy development approach is more practical.

### 2.1.3 Phase theory

The core principle of the phase model can be traced back to the work of Harold Lasswell (1951). He characterized policy making as a sequence of intelligence: recommendation, prescription, invocation, application, appraisal and termination. There are multiple theories on how to develop policy from an analytical vision made over the years. Anderson (2014) created a version with five phases: agenda setting, policy formulation, decision-making, implementation and evaluation. Bridgman and Davis (2004) describes a policy cycle for Australia with eight steps. The most commonly used policy model has six phases, this is also the one mostly referred to in Dutch literature ('t Hart and Twist 2011). All these models have in common that they are a sequence of activities that address social problems. These phases together form the policy cycle or also named phase-model. Most academics and practitioners consider the model to simple. The phase model oversimplifies, and does not explain the complex policy making system in which stages may not occur in the order as the model describes (Edwards, Howard, and Miller 2001). The practice is more unruly than the rational-analytic approach of policy making. Thus the orderly and linear approach of the policy cycle has only limited explainable power of reality. Despite the shortcomings of the phase model, the model is used by many governments to describe how they work (Cairney 2013). Figure 3 shows such a phase model for rational-analytic policy-making.

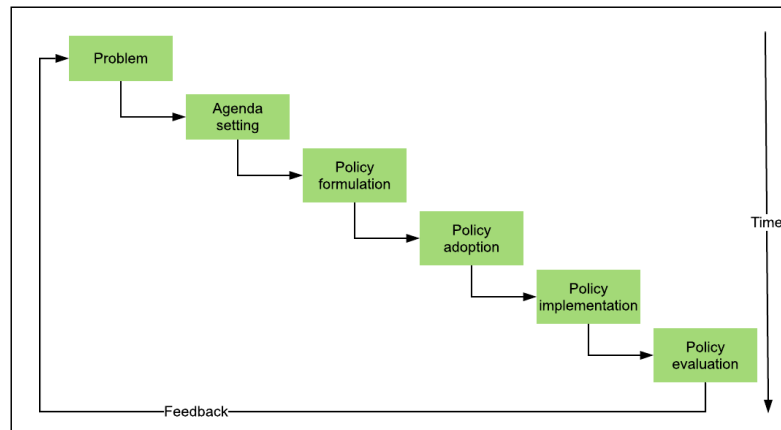


Figure 3: Phase model.

The first phase of forming a policy is the agenda setting. Here is looked at which topics get attention of the policy-makers and what the prioritization is of these subjects. Such subjects come from civil servants, politicians or from citizens that are asking a question or indicate social problems. The agenda is a kind of pre-selection of policy subjects since there are so many social issues. Policy-makers cannot develop policies for all of them. If a social issue is not on the agenda, the chances are slim that a policy for that topic will be developed or changed. Various groups of stakeholders try to influence the agenda of a government. They understand the importance of the agenda and everyone tries to get their subjects as high as possible on the agenda. The experienced urgency is an important variable in getting the issue on the agenda. Secondly, the "how" question is important, some issues such as the reduction of gas use in the Netherlands can come on the agenda from different domains such as from a financial perspective or an economical. The second phase is policy formulation. This is the part where policy-makers are formulating how to solve the challenges of a social issue. The third phase is policy adoption, decision-making takes place in this phases about the policy proposal. A lot of policies do not reach this phase. Why a policy proposal fails to get accepted can have multiple reasons. The reason is different every time since the social context of the policy is different. The fourth phase is policy implementation. Now the policy decisions are translated to a practical solution. The tasks of translating policy to implementation are done by the implementation organisations. This process takes up a lot of time since the implementation organization needs to think about every detail on how to implement the policy into society. Elements never thought of in the policy preparation and determination phase often come to light here. If the policy is implemented into society and has run for some time, an evaluation is in order. Policy evaluation is the fifth phase. This evaluation or review can be done by the implementation organization itself or by an external research agency. Academic institutes can also perform such evaluations. Policy evaluation is important for three reasons: The first is focused on learning. Is the reality matching with the policy assumptions when the policy was determined? Often, there are unexpected results. The second reason for evaluation is learning. Focusing on the faults and understanding it can give new insights into the policy. This is a difficult task since policy-makers are reserved towards evaluators. "What gets measured gets done" is the third reason for policy evaluation. This means that what we measure also influence the truth we measure. When the policy is evaluated, results are assessed and feedback is formulated, which leads to a plan of action to improve the policy.

### 2.1.4 MST: Multiple stream theory

As a reaction on the phase model, models based on the political view were developed. The "stream model" of John Kingdom (Kingdon 2003) is one of those. The multiple streams theory is a framework which attempts to explain how policies are chosen at a high level, national or supranational, under a condition of ambiguity. This framework is a derivative of the garbage can model where it is assumed that there is no beginning and no end within the decision process (Cohen, March, and Olsen 1972). In the garbage can model, it is assumed that no one controls the policy process and the number of opportunities for a policy to rise. The stream theory follows the same principles as

the garbage can model, it contains three streams and has the concept of a policy windows. The difference between the garbage can model and the stream theory are the definitions of ambiguity. Kingdon (2003) provides three indicators for ambiguity: fluid participation, problematic preferences and unclear technology (Zahariadis 2007). The first ambiguity refers to the fact that policies but also policy-makers come and go within organisations and governments. Problematic preferences refer to the fact that people do not know what they want. Their decisions are often forced by time constraints. The technology illustrates that policy-makers are usually not fully aware of their responsibilities with respect to the larger organisation's or government's goals. In the stream theory, policy problems and policy solutions exist next to each other. When these three streams come together under the right political circumstances a window of opportunity is created in which policies can be made. Figure 4 shows such a steam model. The policy stream can be imagined as a

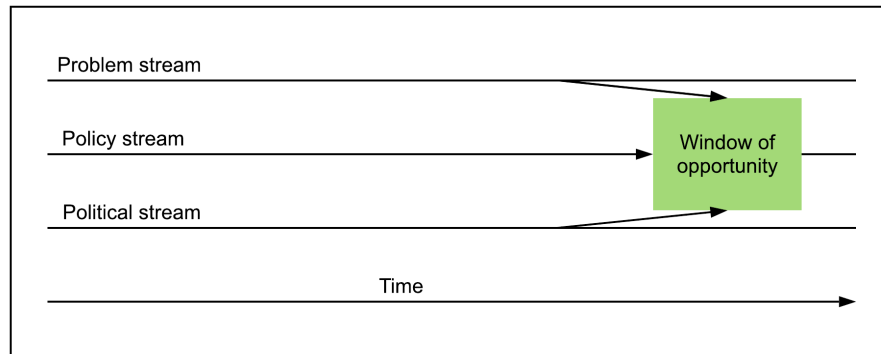


Figure 4: Stream model.

big box full of straws. A large part of these straws will never be drawn, only a few are considered. Within the streams, the straws or policies can be combined together to create new policies. The policy is selected by the policy maker based on different criteria such as the value of acceptability or the feasibility. The problem stream is composed of parameters: the indicators, the focusing events, the feedback and the load. The first parameter helps the policy maker decide on the urgency of a problem and focus on picking up a specific problem. After a series of suicides, it may be that policy-makers pick up this policy. The feedback parameter relates to the fact that previous policy decisions can lead to new problems. The load is related to the fact that policy-makers are unable to do everything. They can only tackle so many problems at once. The last stream is the politics stream. Within this stream, the actors present in the decision making process are considered. There are two type of actors: the policy-makers and the policy entrepreneurs. The policy-makers are only responsible of taking decisions. The policy entrepreneurs cannot make any decisions but can convince the policy-makers to make certain decisions, they can be seen as lobbyist.

### 2.1.5 Advocacy Coalition Framework and diffusion theory

The following two theories are less important for this research but are mentioned to form a complete picture of policy theories. The Advocacy Coalition Framework (ACF) was initially developed by Sabatier and Jenkins-Smith (1993) to attempt to explain and simplify the complexity of the policy making process. The theory sees the policy environment as different policy subsystems. They are considered separately from each other and can represent different concepts, such as security or technology. The subsystems are organised as coalitions where the actors share similar beliefs. Within the subsystems the coalitions attempt to influence each other with as goal to influence the policy-makers and policy change is therefore a reflection of the dominant position in the subsystem (Sabatier and Jenkins-Smith 1993). The ACF is being continuously researched. Several of the hypotheses and the assumptions about the framework are not yet fully validated. This is both due to time but also because some of these hypotheses are hard to effectively validate. Figure 5 visually represents the ACF.

Diffusion is usually studied when a policy might be taken over by another governmental entity. Diffusion happens if the probability of adoption of a policy by one government is influenced by the policy choices of another government. The literature identifies four mechanism of diffusion:

1. The learning mechanism

2. The imitation mechanism
3. The competition mechanism
4. The coercion mechanism (Shipan and Volden 2008)

The first mechanism is the learning mechanism, in this case government entity Y will derive information from government entity X and decide that when a policy is successful, they will adopt the policy. The imitation mechanism describes the imitation of a policy simply because the government organisation sees the policy worthy of copying. The competition mechanism mainly has to do with getting an advantage over another government agency, so the adopt a policy. The last mechanism, the coercion mechanism. A policy is forced upon another government entity. This theory applies well to large federal countries (Klein 2017). In the Netherlands, diffusion would be more applied in regional policy than national policy since regions tend to share some of their norms and values making policy diffusion more acceptable.

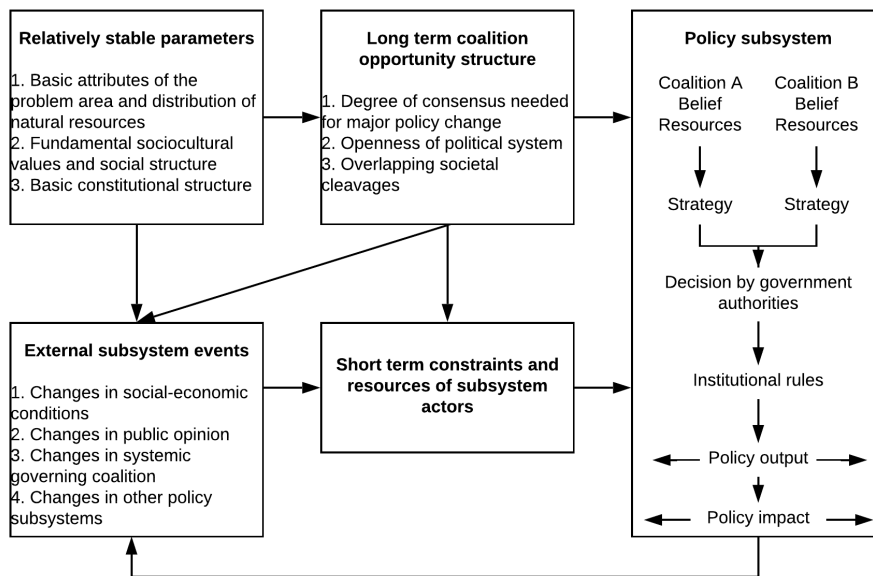


Figure 5: Advocacy coalition framework.

### 2.1.6 Integrated impact assessment framework

In the last few years, the focus on the earlier named theories has shifted to other research areas, such as the role of knowledge in policy development (Knottnerus 2016) or the creation of a more Agile, iterative or adaptive approach to policy development (Walker, Rahman, and Cave 2001; Estrada and Park 2018). This shift arose because researchers and practitioners saw that the traditional way of developing policy is not sufficient for the complex and continually changing world (Estrada and Park 2018). Frameworks from practical backgrounds also emerged. In 2016 the Dutch Ministry of Justice and Security created the integrated impact assessment framework for policy and legislation (IAK) to support Dutch civil servants in the legislative and policy drafting process. The IAK provides structure for formulating policy and legislation. IAK is a working method and a source of background information and tools a civil servant can use to prepare a policy. Figure 6 describes the IAK phases. The framework describes 3 phases. The first phase is the problem analysis, the second phase is the choice of intervention and the third phase the impact assessment. Every proposal for policy or regulation that is submitted to the parliament should go through those three phases and contain an adequate answer to the 7 main questions of the IAK: "What is the reason?", "Who are involved?", "What is the problem?", "What justifies government intervention?", "What is the best instrument?" and "What are the consequences?"

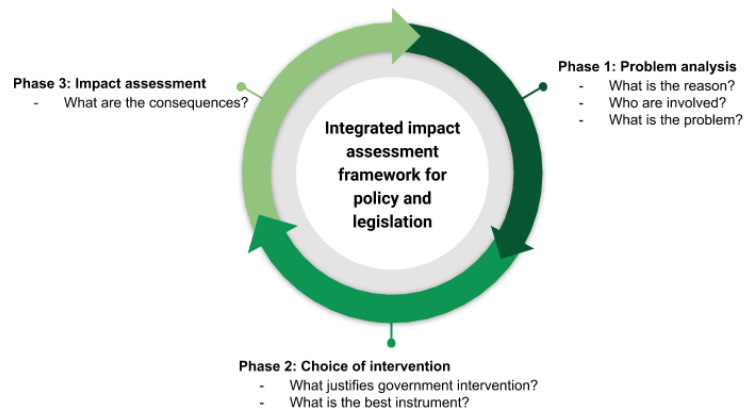


Figure 6: Integrated impact assessment framework for policy and legislation (IAK).

### 2.1.7 External and internal context

Policy influences the surroundings, but the surroundings also influence policy. There are two types of influences on policy making, internal and external. The external influence on policy exist of social factors. These are factors that are important for policy-makers but they can not wield any direct influence on those factors. All these factors together form the context of a policy, the external factors are shown in Figure 7.

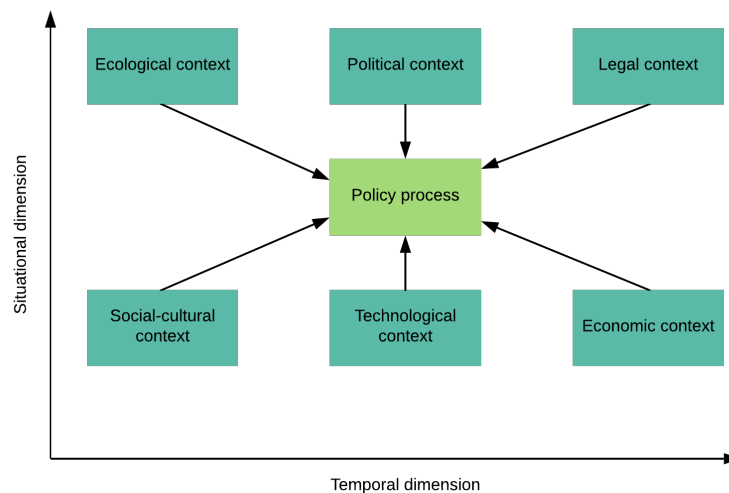


Figure 7: External context (’t Hart and Twist 2011).

#### External context

**Ecological context** are all the factors related to the interactions among organisms and their environment. Climate, for example, is part of this context. The climate in the Netherlands is changing and when developing policy these are important factors to think about. For example, the forecast is that the temperature is going to rise. This has consequences for the Dutch climate. Climate measures need to be formulated and implemented to stop the rising temperature as much as possible. **Social-cultural context** are factors such as the population size, population composition, level of education and religious conviction. These are factors policy-makers need to keep in mind

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while developing policy. A policy focused on education and the distribution of schools that states that only 3% of all the schools can be Islamic is not achievable since 5% of the population is Islamic (CBS 2017b). These characteristics of society are important during the development of policy. The **political context** consists of the whole of political views and power relations. The political context determines to a large extent which policy can count on support. Policy proposals have little chance if it goes against public opinion, the political opinion should be the public opinion. The **technological context** consists of technological developments that are new opportunities for society. Robotisation can improve care, but the fear of unemployment in health care is present. A policy must respond to these new developments. In addition, technology influences policy in a different way. The digital government is a good example of this, arranging all your affairs online so that you can collect your passport as soon as possible. Why would bol.com be able to deliver your package within a day, but do you have to wait three weeks for a passport? **Legal context** is focused on a balanced distribution between legislative, executive and judicial powers. Policy-makers can make the most appropriate policy plans but a policy should be in conjunction with other laws and creates no contradictions. **Economic context** goes hand in hand with the prosperity of a country. If there is a crisis like the euro-zone crisis in 2002-2008, then there is a lot of demand for policy since there are a lot of problems such as unemployment, mortgage credits and many more.

### Internal context

The internal context is another factor that can influence policy. A policy is made in an organization and an organization has its own interests, values and goals which can influence the policy development. Another influence is **time**. If there is a debate planned in the House of Representatives that is associated to a developing policy, then there may be the chance that parts of a policy needs to be finished before the debate. The time pressure can adjust the development of a policy. An example of this could be that there was no time to consult all interested parties. If a policy is formulated, it also needs to be implemented. The **implementation** is another factor that is of great importance because if a policy can not be implemented, what then? A policy that describes that every country can only drive 100% electronic cars by 2025 is a nice policy, but if the infrastructure and industry are not ready for it, implementation is impossible. The last internal factor is **enforceability**. When a policy is implemented it needs to be maintained. Not for every policy is that as easy as it seems. For example, how are you going to check if every person in your club is above 18 and has the legal drinking age? There are enough 16-year-old that still manage to drink alcohol because a friend gets the drinks at the bar.

### 2.1.8 Environmental agents

Around policy there are different actors, as they are called in public administration. Actors are acting units, such as citizens, companies, administrators and countries. It is a collective name for entities that act consciously. In computer science and sociology, actors are also called agents, in this research we use the term agent. Agents are of great importance for policy. A policy focuses on influencing the actions and interactions of agents. There are a few categories of agents that are important from a policy viewpoint (t Hart and Twist 2011). These are citizens, pressure groups, political parties, media and external advisors, as shown in Figure 6. In short **citizens** are the people that have a role in forming policy because they experience social differences. Citizens can play a major role in policy development by expressing their opinion and pointing out social issues. **Pressure groups** are organisations such as ANWB or non-profits such as World Wildlife Fund (WWF). Their goal is to influence policy. They represent specific interests, that is why they are also called “single-issue movements”. Interest groups often represent the interest of a group of people, animals or things. **Political parties** are permanently organised groups that have a specific social vision or program. In the Netherlands do we have local and national political parties, that influence policy. Political parties in the House of Representatives decide if a policy is approved or not. Policy-makers cannot be specialized in everything, that is why they make use of **external advisors**. The advice comes from research institutions and advisory boards such as the Centraal Planbureau (CPB) or the Onderwijsraad. The **Media** is used by agents as a way to share information about a policy. News-articles, blog posts and radio spots are all media outlets that helps us understand what is happening in society. Or rather, what reality the media presents. It is precisely this that makes media an ally and tormentor for the policymaker, media can influence



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a policy immensely. If a policy is presented in bad daylight, the change is that the public opinion refuses a policy. Figure 8 shows the agents around a policy process.

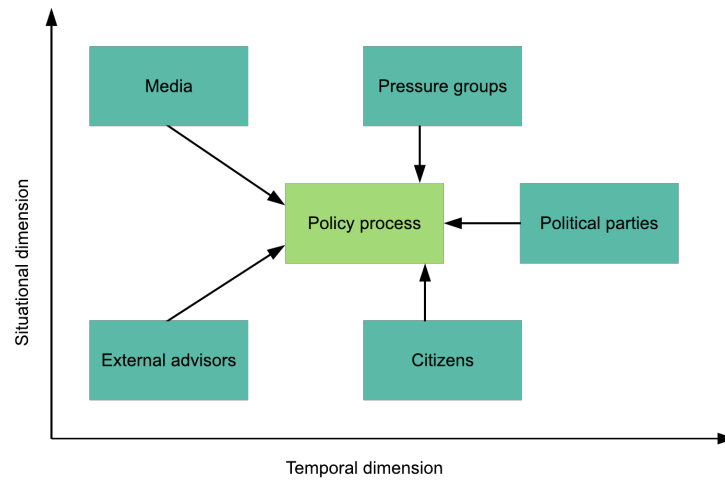


Figure 8: Agents around a policy process ('t Hart and Twist 2011).

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## 2.2 Business process modelling

Business process modelling (BPM) is the activity of representing processes of an enterprise. This representation is a way to analyse current processes, improve, and automate them. Business process modelling is typically performed by a business analyst. The business analyst provides expertise in the modelling discipline. Business process models can be created by deriving information directly from events' logs using process mining tools or by interviews and modelling the processes. The following paragraphs will explain what a business process is, what a model is, the context of business process model(ling) and the techniques that can be used to model business processes.

### 2.2.1 Business process

A business process consists of a set of activities that are performed in coordination in an organizational and technical environment (Weske 2012). These collections of related, structured activities or tasks produce a specific service or product for a particular customer or customers or realise a business goal. Each of these business processes is enacted by one organization and may interact with business processes of other organisations and create value. A business process can be decomposed into several sub-processes, which have their own attributes but also contribute to achieving the goal of the super-process. According to van Von Rosing, Von Scheel, and Scheer (2014), there are three main types of business process:

- Management processes: these govern the operation of a system. Typical management processes include corporate governance and strategic management.
- Operational processes: these constitute the core business and create the primary value stream. Typical operational processes are purchasing, manufacturing, marketing, and sales.
- Supporting processes: these support the core processes. Examples include accounting, recruitment, and technical support.

### 2.2.2 Model

A model is a representation of a person, a thing or a proposed structure, typically used to represent something in the real world. A model can refer to different types of models. A model, for example, may refer to a conceptual model, a physical model or a mathematical model. The models referred to in this thesis are business process models and agent-based models. A business process model is a conceptual model. These models are used to represent real-world state affairs. An agent-based model is also a conceptual model and is a model that purposeful represents actions and interactions of autonomous agents (Starfield, Smith, and Bleloch 1994).

### 2.2.3 Business process model(ling)

Even though it was 1960 when Levitt first mentioned the importance of business processes. It was not until the last decade that business processes have acquired real importance in the organization design. The modelling of the business process became increasingly popular in the first years of the twentieth century. Authors such as Hammer (1990), Harrington (1991) and Davenport (1993) promoted a new perspective. A representation of a business process can be made by producing a business process model. Simply put, this is an illustration of an organization's business process. A business process model consists of a set of activities and execution constraints between them. Business process models are used to map the organization's current (as-is) process to create a baseline. They are also used to create an improved or future business process (to-be). The literature reports on how process modelling has been used in various fields such as supply chain management, customer relationship management, knowledge management, risk assessment and simulation (Eder and Dustdar 2006; Bandara, Gable, and Rosemann 2005; Rosemann 2000; Carnaghan 2006). Information system (IS) implementation studies in combination with business modelling are also well represented. These studies explicitly and implicitly suggest the importance of process modelling and its contribution to the success of IS projects (Clemons, Thatcher, and Row 1995; Bancroft, Seip, and Sprengel 1998; Wreden 1998; Parr, Shanks, and Darke 1999; Kesari, Chang, and Seddon 2003). This research is to our knowledge one of the few research studies that focuses on modelling policy development in an organizational perspective of the government. Past studies have also

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shown the justification of business process modelling in various stages (Bandara, Gable, and Rosemann 2005). Business process modelling is mostly used for model-based identification of process weaknesses, adopting best business practices, the design of a new business blueprint or end-user training (Curtis, M. Keller, and Over 1992; Rosemann 2000; Gulla and Brasethvik 2000; Peristeras and Tarabanis 2000; Rosemann 2006). The main goal of business process modelling is to improve the efficiency of the process. In a big organization, there is a good chance that different departments or teams do the same process differently. Business process models can help by creating a best-practice design and standardization. Creating business process models also helps to identify and to eliminate redundancies and inefficiencies in the business process. It provides transparency, a clear understanding of how the process works for everyone, which helps to provide consistency and control over the process.

## 2.2.4 Business process modelling techniques

The popularity of business process orientation has yielded a number of techniques, languages and methodologies (Hammer 1990). A large part of the published literature on business modelling describes how to use these modelling techniques or describes the application of a modelling language (Zur-Muehlen and Recker 2013). Multiple studies also point out the differences between all these techniques available (Giaglis 2001) and point out the benefits and pitfalls of using business modelling (Rosemann 2006; Indulska, Green, et al. 2009a). These studies are helpful since the process of selecting the right technique has become more complex. All of the existing business process modelling languages or techniques come from different facets of scientific tradition and have been built to suit one perspective or another. The amount of research on business process modelling is overwhelming, and there is no one guide for practitioners that describes all the techniques and concepts involved. The paper of Aguilar-Saven (2004) helps with this problem. As a result of a literature review on business process techniques the most frequently used, or the main techniques where identified. The techniques for business process modelling can be categorised into:

- Flow chart techniques
- Data flow diagrams – Yourdon’s techniques
- Role activity diagrams (RAD)
- Role interaction diagrams (RID)
- Gantt Charts
- Integrated Definition for Function Modelling (IDEF)
- Petri-nets
- Object-oriented methods
- Workflow techniques

All of these techniques have multiple languages or notations in which a business process model can be presented. The flow chart technique can, for example, be presented in the Business Process Modelling Notation (BPMN), Business Object Modelling or Flow SQL. IDEF, for example, has the notation IDEF0, IDEF1 and IDEF3. Finding the right technique and notation for your business process model depends on the requirements of the stakeholders. The purpose of the model relates to some extent to the characteristics of the notations (Aguilar-Saven 2004). With this in mind it is important to define the purpose of the model. For the Ministries, we are looking for a model that shows: the flow of actions and can be used as a means to communicate. The notations should also be flexible and easy to adapt. This is important since the Ministries would like to use the research to start conversations between policy-makers and other parties and use the models and adapt them in the future for other purposes. Business process modelling techniques that match the requirements we are looking for are workflows and flowcharts techniques. Flowchart techniques seem to be the best fit of those two since it provides a graphic representation of flows of actions, that are easy to communicate (Aguilar-Saven 2004). The technique that is interesting for this study is the Business Process Modelling Notation (BPMN) to represent the business process models. Figure 9 shows a simplified BPMN, where we use a sub-set of all the notation components explained in Figure 10.

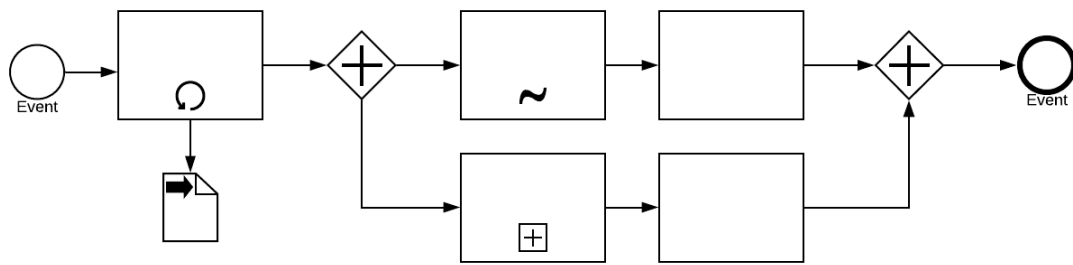


Figure 9: Example of a business process model in BPMN.

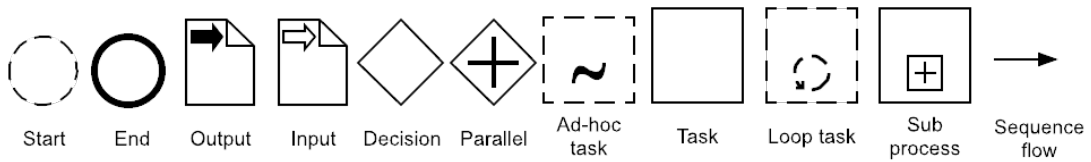


Figure 10: Legend of the BPMN.

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## 2.3 Agent-based modelling

In the following sections will we explain what an agent-based model is and what the common structure for an agent-based models is.

### 2.3.1 Agent-based model

Agent-based simulation (ABS), or agent-based modelling (ABM), is a modelling and computational framework for simulating dynamic processes that involve autonomous agents (Macal and North 2014). An agent is a general concept having broad applicability. An autonomous agent can be both individual or collective entities such as organisations or groups (Gilbert and Troitzsch 2005). Such an agent has behaviours and these behaviours can be described by simple rules, and interaction with other agents. Interaction with other agents influences their behaviour. By modelling agents individually, the effect of diversity that exists among agent can be observed. The contribution of an individual to the system can also be observed. Agent-based models are basically a micro model that simulates the operations and interactions of multiple agents simultaneously, to re-create and predict the appearance of complex phenomena. Agent-based models are most commonly used to model individual decision-making and social and organizational behaviour (Bonabeau 2002). There is a considerable overlap between agent-based modelling and multi-agent system (MAS). The goal of an agent-based model is to search for explanatory insight into the collective behavior of agents rather than solving specific practical or engineering problems. Modelling systems from the “ground-up”- agent by agent and interaction-by-interaction in an agent-based mdoel shows self-organization of the agents, patterns, structures and behaviours that were not explicitly programmed into the models, but arise through the agent interactions (Macal and North 2014). The most fundamental reason for using an agent-based model is the information they can represent compared to other traditional models:

- Agent-based models excel in relating heterogeneous behaviour of agents with different information and decision rules.
- Agent-based models are useful under deep uncertainty where more traditional predictions are not (Macal and North 2014).
- The method is easy to use, even for non-computer programmers (Garcia 2005). Agent-based models are therefore increasingly recognized as a powerful tool for simulating social systems.

Application of agent-based models spans a broad range of areas and disciplines. Application ranges from applying agent-based modelling to predicting the stock market (Kollman et al. 1997), to apply it to the supply chain (Macal, Sallach, and North 2004), to the threat of bio-warfare (Carley et al. 2006) and understanding consumer behaviour (North et al. 2010). A literature review of Heath, Hill, and Ciarallo (2009) shows that in their sample of 279 papers about agent-based modelling the biggest application are in economics, social science and biology, see Figure 11.

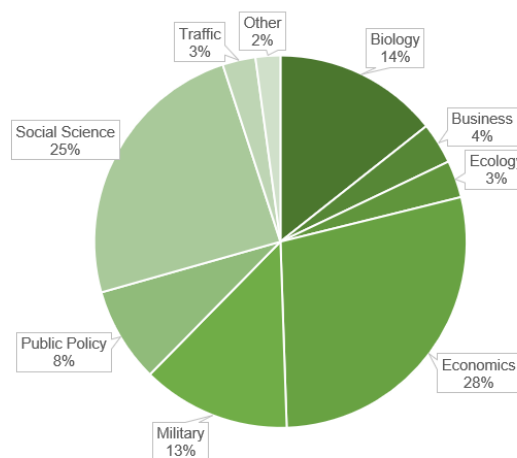


Figure 11: Breakdown of articles per field (Heath, Hill, and Ciarallo 2009).

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### 2.3.2 Agent-based model structure

An agent-based model is based on the autonomous agent theory (AAT) which is a viable system theory (VST) that models autonomous social complex adaptive systems. The theory of a VST is based on the belief of cybernetic processes in relation to the development of dynamic systems (Beer 1960). The system is considered to be living, in the sense that they are complex and adaptive, can learn, and are capable of maintaining an autonomous existence, at least within the confines of their constraints. AAT is a generic modelling approach that has the capacity to anticipate future potentials for behaviour. The theory of AAT can be used to model relationships between an agent and its environment(s) which could include other interactive agencies. A model where the agent and its environment is modelled is called an agent-based model. Creating an agent-based model starts with identifying, modelling and optional programming elements. A typical agent-based model has three elements:

- A set of agents, their attributes and behaviours
- A set of agent relationships and methods of interaction
- The agents' environment (Macal and North 2014)

These three elements for a basic structure are shown in Figure 12 below.

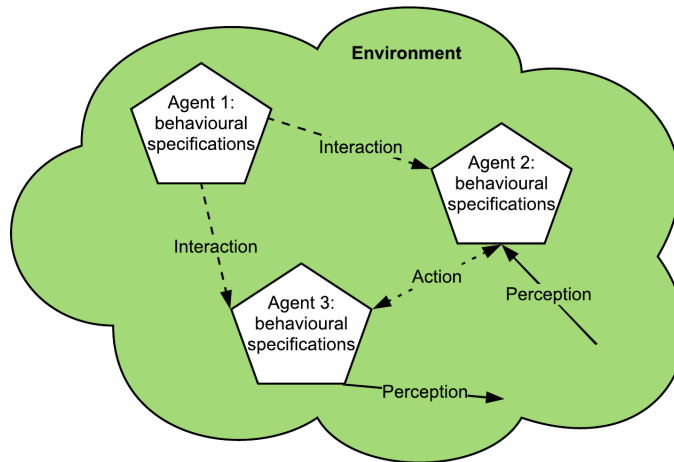


Figure 12: Structure of an agent-based model.

### 2.3.3 Autonomous agent

An autonomous agent is seen as an agent that has the capability to act on its own without external directions. The agent is not influenced by external directions in response to situation it encounters. Agents are seen as active that initiate their actions to achieve their internal goals, rather than passive responding to other agents and the environment. Not all the problems can be solved by agent-based systems. Multi-agent systems can be used to solve problems that are difficult or impossible for an individual agent or a monolithic system to solve. There is no universal agreement in the literature on the precise definition of an agent. A definition from the field of computer science emphasizes the characteristics of autonomous behaviour (Jennings 2000). Other authors consider any type of independent component to be an agent. It could be software, an individual or an organisation (Bonabeau 2002). From a practical modelling standpoint Macal and North (2014) consider agents to have essential and useful characteristics. The essential characteristics are:

- Self-contained: an agent is a unique individual. They have attributes that distinguish them from other agents.
- Autonomous: the agent can function independently in the environment and interact with other agents.

- Behaviours: the agent has behaviour based on information that comes from interaction with the environment and other agents.
- State: an agent has states just like other systems. The state of the whole agent-based model is the collective state of all the agents.
- Social: agents are social when having interactions with other agents. Agents can have protocols for interacting with other agents, but in most models the protocols are missing.

The useful characteristics an agent could also have are:

- Adaptive: the agent could have the ability to adapt its behaviour based on experience.
- Goal-oriented: an agent has goals to achieve with respect to its behaviour e.g. learning.
- Heterogeneous: refers to differences across the agents, because of their state, behaviour or internal information.

The typical structure of an agent is based on these characteristics shown in Figure 13 and the earlier named elements, shown in Figure 12.

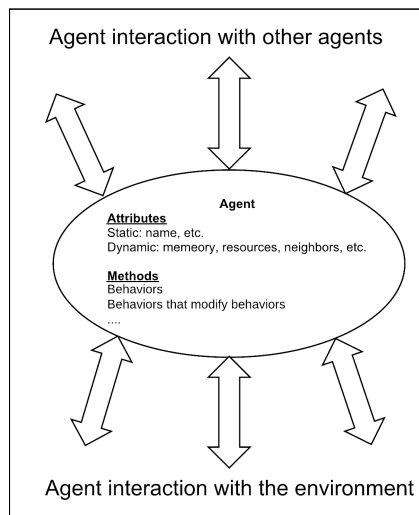


Figure 13: Structure of an agent-based model.

### 2.3.4 Interaction agent

Agent modelling focuses on modelling agents relationships, interactions and behaviours. Typically an agent interacts with its neighbours. The neighbourhood is a general concept that can be applied to whatever space there is defined in the model. The neighbourhood could be defined in the physical space, so geographical or by social space. Agents interact with other agents but not all. Generally, the neighbourhood of the agent changes over time.

### 2.3.5 Environment agent

The agents do not only interact with each other, but also with the environment. The environment of the agent provides information to the agent, this can be simple information about the spatial location of other agents close to the agent or more detailed information such as infrastructure information.

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### 2.3.6 Agent based modelling and simulation, tools and protocols

Creating an agent-based model can be done with different techniques and tools. Models can be created with general, all-purpose software or programming languages such as Java, C++ or Python. There is also software designed that addresses the requirements of agent modelling. The software is called a toolkit, popular examples are Swarm, NetLogo and MASON. Choosing the right approach depends on various factors you should define beforehand, which forms the initial model design:

- What is the problem to be solved with the model?
- What should the agents be in the model?
- What is the agent's environment?
- What agents behaviours are of interest?
- How do agents interact with each other?
- Where could the data come from?
- How will the model be validated?

In recent years, great effort has been put into improving and standardizing how to describe Agent-based models so they can be simulated. Examples include protocols such as the PSPC + 3 protocol proposed by (Grimm and Railsback 2005). The abbreviation "PSPC" referred to the initials of first four elements of the protocol (purpose, structure, process, concepts) and "+3" referred to the remaining three elements. Grimm, Berger, et al. (2006) decided to refine the protocol proposed by Grimm and Railsback (2005). They named the refined protocol "ODD", which stands for the three blocks of elements 'Overview', 'Design concepts', and 'Details'. The ODD protocol is designed as a tool to facilitate the communication and replication of agent-based models. Grimm, Berger, et al. (2006) consider the protocol as a first step for establishing a more detailed common format of the description of agent-based models. ODD is widely used in ecology, and its use for social-ecological modelling seems to be increasing. The TRACE framework for documenting the full modelling cycle is another of these frameworks working on standardizing agent-based models (Schmolke et al. 2010). Also ontology's describing entities and their relationships have been proposed to standardise agent-based models (Parker et al. 2008). In any case, an established standard for model descriptions reduces the effort required by model developers, reviewers and peers to describe and understand a model because the same kind of information is always to be found in the same part of the model description according to Thober et al. (2017).

## 2.4 Reflection

The background literature and related works, already show some commonalities between the different policy theories and identify some of the problems that will arise when looking into how a policy process is really developed. Our policy development process will therefore probably present parts of multiple of these theories.

It is important to mention that the focus will be on only modelling the policy development process with business process modelling. The literature presents a lot of methods and techniques from which you can choose to visualize the business process and we have chosen a technique that fits our research.

Agent-based modelling is a younger field than business process modelling. This is mainly reflected in the amount of literature that discussed formalised protocols, methods or techniques, which makes it harder for users to produce standardized models and compare models. The frameworks and protocols give users a more detailed common format of the description of agent-based model, but still lacks the conceptual representation on how to visualise a model. This could be seen as an issue for further in the research. It could make modelling the agents hard.



## Chapter 3

# Case study results of the manure policy

This chapter presents the case study results. The case study is executed to gather information about the development of a policy process and the interactions of agents. The first section 3.1, will explain the history the manure case study. Followed with the agents in 3.2, the process in section 3.3. The chapter is finished with a short reflection on the case in section 3.3.2.

### 3.1 Part 1: History of manure

This case study has been imitated and performed at the Ministry of Agriculture, Nature and Food Quality, in Dutch "Ministerie van Landbouw Natuur en Voedselkwaliteit" and the Ministry of Economic Affairs and Climate Policy, in Dutch "Ministerie van Economische Zaken en Klimaat". The Ministry of Economic Affairs and Climate Policy promotes the Netherlands as a country of an enterprise with a strong international competitive position and an eye for sustainability. The Ministry of Agriculture, Nature and Food Quality focuses primarily on sustainable food, valuable nature and a vital countryside. The Ministries are committed to creating an excellent entrepreneurial business climate, by creating the right conditions and giving entrepreneurs room to innovate and grow. The Netherlands needs to prevent depletion of soil, freshwater supplies and raw materials, halt the decline in biodiversity and fulfill the commitments to the Paris climate agreement. Circular agriculture is seen as the logical and conclusive answer to these issues. This means closing cycles of minerals and other resources as far as possible, strengthening the focus on biodiversity and respecting the Earth's natural limits, preventing waste and ensuring farmers are paid a fair price for their hard work (Landbouw Natuur en Voedselkwaliteit 2019).

To achieve these higher goals, the Ministries have been focusing on how to use their available data to the best of their extent in policy development. The case study is based on retrospect researching the development of a policy. The case study is based on the policy about manure, which is a policy that concerns both Ministries. The manure policy in the Netherlands is based on the European Nitrates Directive. In the European Union (EU) agreements have been made about the amount of nitrate that is allowed in the ground and surface water. In order to meet the Nitrates Directive objective, measures have been taken over the years in the form of nitrate action programs. These Dutch programs describe measures concerning the protection of waters against pollution caused by nitrates from agricultural sources. The European Union asks the Netherlands every four years for an action program that describes how we will comply with the European directives on manure that have been imposed on us. These action programs have been made since 1991. The completion of the fifth action program and start of the sixth program gives us the chance to research the development of these policies and how the process, agents and data congregate. The action programs that have the most added value for this research are the action programs from 2014 and on-wards. In Figure 14 a timeline of the action programs is shown.

After the Second World War food security became important. Government and society decided that the green space should produce a lot of cheap food. The Netherlands became one of the largest agricultural exporters in the world, but more and more surplus was created at a European level. The enormous amounts of food produced by The Netherlands had one big disadvantage:

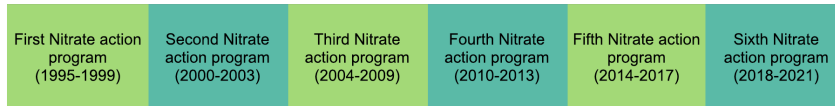


Figure 14: Timeline of the Dutch Nitrate Action Programs (NAP's).

the mineral efficiency decreased, which meant damage to water, nature and the landscape. The introduction of the “interim law limitation of pig and poultry farms” in 1984 would help to decrease food production and thus increase the mineral efficiency. In 1987 this interim law was replaced by the “Manure-law” and the “Soil Protection Act”. The introduction of these laws was not enough to reduce the nitrogen and phosphate production and in 1988 the application standards for livestock manure were tightened. In 1991 and 1995 these standards were extended and tightened again. From 1995 the Manure and Fertilizers Act also represents the Dutch implementation of the European Union (EU) Nitrates Directive. The purpose of the nitrate directives is:

*to reduce the water pollution caused or triggered by nitrates from agricultural sources, and prevent further pollution.*

Action programs to achieve the prescribed standards of the EU are in effect since 1995. Each nitrate action program describes measures for four years to achieve the prescribed standards of the EU. The third and fourth nitrate action program are often seen as the basis for implementing the standards and regulations required by the European nitrate directive. The fifth and sixth nitrate action program built on the previous action programs and their evaluations form a basis for new policies.

### 3.1.1 Fifth nitrate action program

During the third and fourth action programs the Netherlands had implemented all the standards and regulations required by the European Nitrate Directive, as well as most optional measures. The implementation had paid off: through the years, Dutch ground and surface water quality in terms of nutrients had greatly improved. However the evaluation of the fourth nitrate action program pointed out that additional policies were needed to achieve the goals of the European Nitrate Directive. This was evident in the form of environmental results for example. The fifth action program therefore not only presented a tightened package of measures but also described extra enforcement as a way to prevent fraud. In addition to the fourth program, 23 different measures are being introduced to improve groundwater quality in the southern sands “loess” area, the surface water quality at around half of the measurement points and to reduce the pressure on the Dutch manure market.

### 3.1.2 Sixth nitrate action program

From 2018 until 2021, the sixth nitrate action program will be into effect. Just like the fifth nitrate action program, the sixth nitrate action program is also based on, and built on the previous nitrate action programs. The sixth nitrate action program is also based on the most recent Nitrate Directive report, the most recent derogation report, the synthesis of the evaluation of the Fertilizers Act of 2016, a number of opinions from the Committee of Experts for Fertilizers Act and consultation of stakeholders. The biggest difference between the sixth nitrate action program and its predecessors is that the focus shifts from generic policy to policy that is specific for a region, a soil type, the plots and applied agricultural practices. The program describes measurements for the nitrogen usages standards, the phosphate usage standards, the system of user instructions and company-specific and area-specific measures. In order to gain more awareness and knowledge about company-specific and area-specific circumstances, a number of pilots have been started or extended as described in the program.

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## 3.2 Part 2: Agents in the manure case

Interviews with policy-makers paints the picture that forming policy on manure is more complicated than it seems. The manure policy is linked to several programs and other policies that influence the manure policy. In addition, there is a complex field of agents around the manure policy that influences policy development. We acknowledge that there are other policies that are of importance and influence our chosen policy but we do not included those in the research since they are not within the scope. Important related policies are shown in Figure 15.

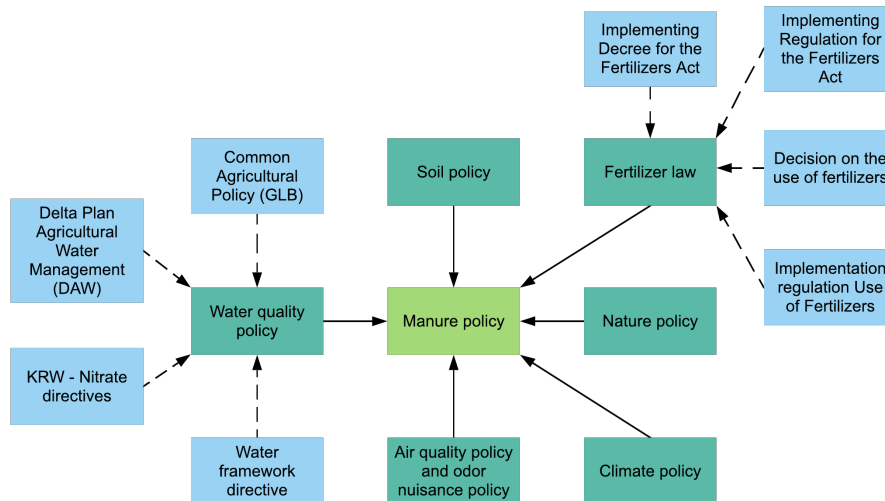


Figure 15: Policies related to the manure policy.

### 3.2.1 Internal and external agents

In this section, the agents around the policy are adescrbed, what their perspectives are and the interaction between agents. On the basis of the interviews, we can make an overview of internal and external agents concerning the manure policy. This is supported by documentation such as the perception study from the WUR that also defines agents linked to the manure policy (Lauwere et al. 2016).

The first section will describe the internal agents. The description of the internal agents of the manure policy starts with three Ministries. The manure policy is officially the responsibility of the Ministry of Agriculture, Nature and Food Quality, but there is a collaboration on the policy with the Ministry of Economic Affairs and Climate Policy and the Ministry of Infrastructure and Water management.

The Ministry of Agriculture, Nature and Food Quality consists of policy departments, staff departments, field services and departments that also work for the Ministry of Economic Affairs and Climate Policy. The development of the manure policy falls under the responsibility of the department of Vegetable agrochains and Food Quality and the manure team. According to the interviewed, there are only approximately three to four policy-makers who actually write the policy. Additionally, there is a project leader and together do they form the manure team. The rest of the agents around the manure policy are involved in the process based on their knowledge that is needed at a given time, agents such as the of communication or finance help the policy-makers with press releases when necessary or finance questions.

In addition the Ministry has an agency named the Dutch Food and Consumer Product Safety Authority (Nederlandse Voedsel- en Warenautoriteit (NVWA) that falls under the responsibility of the Ministry but operates on its own. The NVWA monitors animal and plant health, animal welfare, and the safety of food and consumer products, as well as enforcing nature legislation. Since they operate as a separate entity of the Ministry, but are still under the responsibility of the Ministry, this organisation is seen as an internal agent and not an external agent.

The Ministry of Economic Affairs and Climate Policy has ten additional services that fall under their responsibility, they most important one for this research is the Netherlands Enterprise Agency (RVO) that monitors compliance of the government's manure policy together with NVWA. Figure

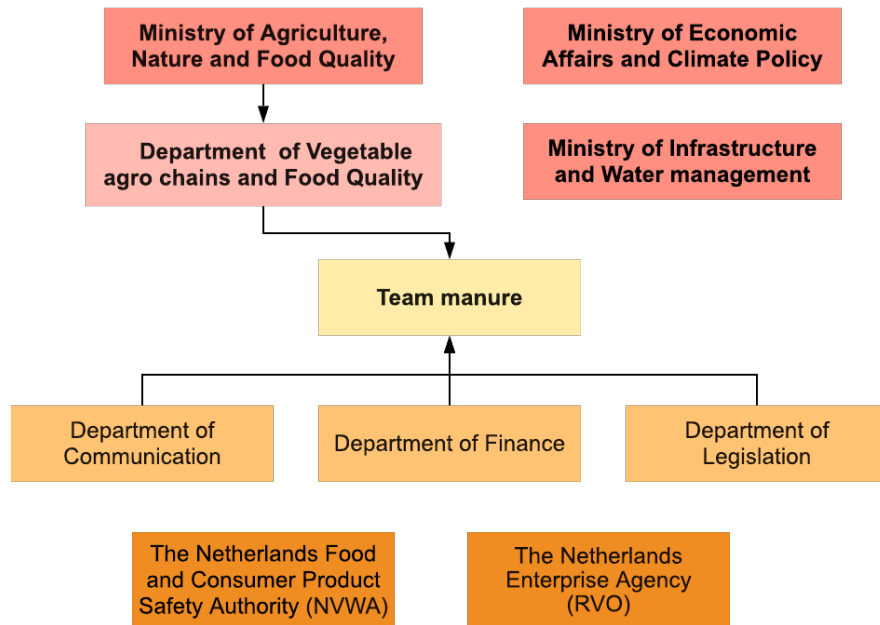


Figure 16: Internal agents of the manure policy.

16 shows an overview of the internal agents of the policy. The external agents around the manure policy can be divided in political agents such as the European Union (EU), European Commission (EC) and the Dutch House of Representatives, interest groups and research institutions. The European Union determines the rules concerning manure at a European level that the Netherlands and all the other European countries must adhere to. These rules are composed in collaboration with all the member states of the European Union. These European rules cannot be copy-pasted and put in the Dutch legal system. That is why the Ministries write policies that adhere to the European rules but fit into the Dutch legal system. The Dutch House of Representatives approves policy proposals written by the Ministries. One of the policy-makers commented on the influence of the House of Representatives on policy. The House of Representatives has a huge influence on policy, since there needs to be enough support from the members of the House of Representatives for a policy, otherwise it will not be approved. This means either the policy needs to be adjusted or it is rejected. The European Commission is the institution that handles the day-to-day business of the EU. The EC is the only institution of the EU that can make formal proposals for legislation and once legislation is passed by the Council and Parliament, it is the commission's responsibility to ensure it is implemented in all the member states of the EU (Union 2019). The manure team consults with the EC about the development of a policy on a regular basis (Policymaker, 2019). This is important because the EC needs to approve the nitrate action programs for the derogation of the Netherlands.

The second group of agents are farmers, interest groups and regional institutions. Farmers are the agents that are most affected by the manure policy. A farmer (also called an agriculturer) is a person engaged in agriculture, raising living organisms for food or raw materials. The term usually applies to people who are raising a combination of field crops or livestock. Farmers are often members of local, regional, or national farmers' unions or agricultural producers' organisations and can exert significant political influence. There are many different farmer unions in the Netherlands that protect the interests of the farmer as an entrepreneur. The biggest national union is the Agriculture and Horticulture Organization the Netherlands (LTO). This national union is a partnership between three regional unions: Agriculture and Horticulture Organization North (LTO North), Southern Agriculture and Horticulture Organization (ZLTO) and Limburg Agriculture and Horticulture Association (LLTB). LTO North is the association of and for agricultural entrepreneurs in the 9 provinces above the Maas. The ZLTO is an association of farmers and gardeners in Zeeland, North Brabant and South Gelderland. The Limburg Agriculture and Horticulture Association is the last one and represents Limburg and focuses on educating farmers in the position at the interface between the entrepreneur and society.

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Raising a combination of field crops or livestock is a general explanation of what a farmer could do. You have farmers that focus solely on raising livestock, but also farmers that only produce milk or make cheese. And since there are so many specializations that you could focus on as a farmer there are also national and regional unions that represent these specializations. The European Milk Board is such a union that lobbies for milk producers in Europe, but also the Producer Organization Pig Farm (POV) is an interest group. In addition, there are also many groups that are committed to, for example, biodiversity restoration and agricultural nature and landscape management. What they all have in common is that they try to influence the policy outcome as much as possible to benefit their specific vision. These unions often work closely with regional politicians and regional institutions to realise this.

A set of those regional institutions are water boards. There are 21 water boards distributed throughout the Netherlands (Waterschappen 2019). Water boards are responsible for the management of flood defenses, regional water management and the treatment of waste water. The national water rules in the manure policy are translated into regional policies together with the provinces. Waterboards and provinces have an interesting position in the manure policy because they are sometimes partly responsible for the policy. According to the Soil Protection Act, groundwater quality management lies with the province.

The research institutions are also an external agent of the manure policy and they provide the Ministry, especially the policy-makers with information and data. The first research institution is the Wageningen University & Research (WUR). According to the website of the WUR, they are researching "how minerals from animal manure, residual flows and fertilizer can be optimized, both in the Netherlands and abroad. Reducing the effects on the environment and the living environment plays an important role in this. In addition, WUR also analyses the policy and legislation and regulations concerning manure (University and Research 2019a)." This is done within one of their nine research institutes called Wageningen Economic Research or LEI as it was called before 2016. The research institute also has an independent scientific committee that advises the Ministry of Agriculture, Nature and Food Quality on the fertilizer law (University and Research 2019b). WUR has multiple partnerships with other institutes to report on manure.

The first partnership of the WUR is with Statistics Netherlands (CBS). Statistics Netherlands annually calculates manure production and the amounts of nitrogen and phosphate in the manure produced. The results form the basis for monitoring the national manure policy (CBS 2017a).

WUR also established a partnership with the National Institute for Public Health and the Environment (RIVM) to provide the government with an image of the effects of the manure policy on farm management and water quality on farms. RIVM is responsible for the National Manure Measurement Network (LMM), which measures changes in the amounts of nitrogen and phosphorus on agricultural land. The National Manure Measurement Network consists of two parts, the basic monitoring network and the derogation monitoring network. The results of the Basic Monitoring Network are used, among other things, for the five-year evaluation of the Fertilizers Act and the updating of the Nitrate Action Programs. The derogation monitoring network is especially to support the annual derogation report.

The five-year evaluation of the Fertilizers Act is done by Netherlands Environmental Assessment Agency. They are responsible for the synthesis of the evaluation (Leefomgeving 2019). They use the data of the RIVM for the evaluation of the manure policy. Figure 17 shows all the internal and external agents of the manure policy.

The last institution that advised the Ministry is the Netherlands Commission for Environmental Assessment (NCEA). The NCEA advises governments on the quality of environmental information in environmental assessment reports.

The internal agents are shown in the middle of the two dotted lines. The agents on the left side are the interests groups, water boards, provinces and farmers. To the right, all the research institutions are represented and the top sums up the political agents, such as the European Union and House of Representatives.

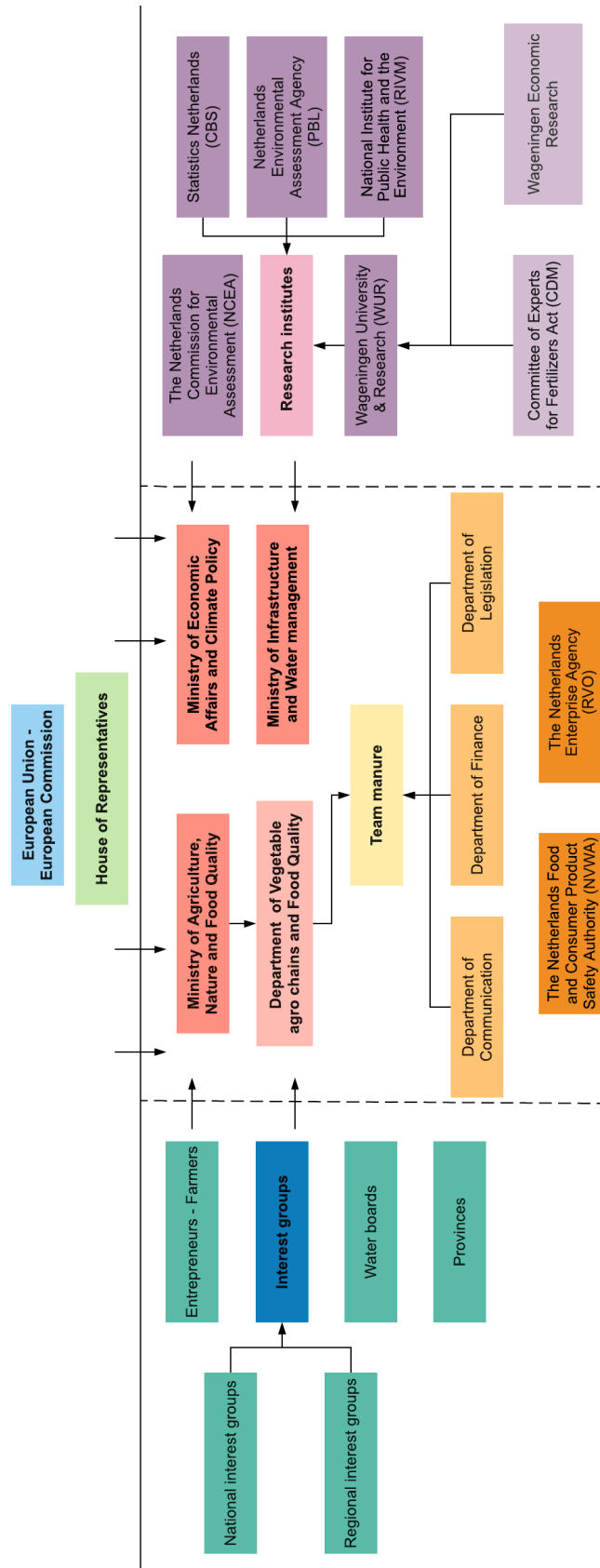


Figure 17: Internal and external agents of the manure policy.

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### 3.2.2 Perspective and interaction

Agent-based modelling focuses on agent relationships, interactions and behaviours. With this in mind, it is important to research the perspectives in which an agent acts. Which agents interact with each other and why they do this. The following section will present the perception of the agents and their interaction based on the observations of the case study.

#### Perspective

A perspective is a particular attitude towards or way of regarding something, a point of view. The interviews provide us with a list of agents that are part of forming the legislation for manure. The agents around the manure policy all act from a different point of view regarding the policy. The list of agents and their perspectives is as follows:

- The Netherlands Commission for Environmental Assessment (NCEA): The NCEA advises on the content of environmental impact reports. An environmental impact report maps out the environmental impact of a project before the government takes a decision. The NCEA's status as an autonomous foundation ensures that its assessments are achieved independently from government accountability and political considerations.
- Committee of Experts for Fertilizers Act (CDM): The CDM has a formal role in advising the Ministry of Economic Affairs on scientific issues substantiation of the manure and ammonia policy and about desired adjustments to assumptions, rules, standards, and fixed fees in the Fertilizer Act. The CDM strives to be transparent, independent and broad in composition to be scientifically authoritative (Velthof and Oenema 2014).
- European Union (EU) - European Commission (EC): The EU is a political and economic union of 28 member states that are located primarily in Europe. The EU works with a standardized system of laws that apply in all member states that aims to ensure the free movement of people, goods, services and capital within the internal market, enact legislation in justice and home affairs and maintain common policies on trade, agriculture, fisheries and regional development. The European Commission is the executive of the European Union and promotes its general interest.
- Farmer (agriculturere): The term farmer is usually applied to people who do some combination of raising field crops, orchards, vineyards, poultry, or other livestock. The farmers are in The Netherlands the people that should adhere to the manure policy.
- House of Representatives: The House of Representatives is the main chamber of the States General. They essentially have three tasks: Control government policy, co-legislation and representing the Dutch population. Discussions of proposed legislation and review of the actions of the cabinet takes place in the House of Representatives.
- Interest groups: The interests groups linked to the manure policy vary in their level of interest and which interest they represent but all of them represent the best interest of the farmer.
- Ministry of Agriculture, Nature and Food Quality: The Ministry stands for sustainable food, valuable nature and a vital countryside. They are the drivers for the change that is needed in the current agricultural system and develop legislation to fit this purpose.
- Ministry of Economic Affairs and Climate Policy: The Ministry is dedicated to creating an excellent entrepreneurial business climate, by creating the right conditions and giving entrepreneurs room to innovate and grow.
- Ministry of Infrastructure and Water management: The Ministry is responsible for air quality in the Netherlands and cooperates with the Ministry of Agriculture, Nature and Food Quality on this topic.
- National Institute for Public Health and the Environment (RIVM): The RIVM is a knowledge institute advising on health and the environment. RIVM is an advisor for the government with impartial advice on infectious diseases, vaccination, population screening, lifestyle, nutrition, pharmaceuticals, environment, sustainability and safety. RIVM also manages the national manure policy effects network where the goal is to collect data on water quality

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and operational management and evaluate environmental quality and nutrient management on farms with the associated reporting to the government.

- Netherlands Environmental Assessment Agency (PBL): The PBL is the national institute for strategic policy analysis in the fields of environment, nature and spatial planning. PBL investigates and documents on current environmental, ecological and spatial quality, evaluates policy, explores future trends and identifies possible strategic options for achieving government objectives.
- Provinces: The provinces have an important administrative and facilitating role to achieve an effective manure policy.
- Statistics Netherlands (CBS): The CBS provides reliable statistical information and data to produce insight into social issues, thus supporting the public debate, policy development and decision-making while contributing to prosperity, well-being and democracy.
- Supporting departments (Communication, Finance, Legislation): The supporting department inside the Ministries support policy-makers in the field of communication, legal affairs and finance when it comes to developing the manure policy.
- Team Manure (policy-makers and project leader): The manure team are a group of people that gather all the provide information of interest groups, research groups, farmers and other agents to develop the manure policy commissioned by the Minister. The group consists of 3 to 4 policy-makers and a project leader.
- The Netherlands Enterprise Agency (RVO): The RVO stimulates entrepreneurs in sustainable, agricultural, innovative and international business. It aims to improve opportunities for entrepreneurs, strengthen their position and help them realize their international ambitions with funding, networking, know-how and compliance with laws and regulations.
- The Netherlands Food and Consumer Product Safety Authority (NVWA): The NVWA provides as one of its tasks policy advice for the Minister of Agriculture, Nature and Food Quality. The NVWA supervises, makes risk assessments and communicates about risk for animal and plant health, animal welfare, and the safety of food and consumer products.
- Wageningen Economic Research (WUR): The WUR explores the latest trends in nutrition and the living environment. They explain what is happening and monitor effects in the sector and offer governments concrete points for improving the impact of policies and strategies.
- Water boards: Water boards are concerned with the management of the water and the care for the technology that must keep the water under control (water management).

## Interaction

Interaction has different meanings in various sciences. We describe interaction as a kind of action that occur as two or more objects have an effect upon one another, for example communication of any sort (Khosrow-Pour 2006). Two or more people talking to each other, or communication among groups, organisations, nations or states. Interaction forms the basis of an agents collaborative problem solving capabilities. Agents are designed to operate in tandem with one another, this includes sharing for example requesting knowledge, negotiating services and coordinating activities. Key to the realization of such activities is to understand what the relationship is between all the agents. Our observation does not include the interaction of the agents with themselves, but we focus on agents who initiate interaction and the response from other agents. In Figure 18, a summary is shown of the interaction between agents. An overview of all the interactions between agents are put in Appendix B. Another way to make the interaction and then in particular the responsibilities of agents more clear is by using a responsibility assignment matrix (RAM), also known as a RACI matrix. A RACI matrix describes the participation by various roles in completing tasks or deliverables for a business process. RACI is an acronym derived from the four key responsibilities most matrices typically use: Responsible, Accountable, Consulted, and Informed. There are a number of alternatives for the RACI matrix such as PARIS, CAIRO and RASCEIO. A RASCEIO matrix was used to link agents to activities. Figure 19 shows the RASCEIO matrix.



	Committee of Experts for Fertilizers Act (CDM)	European Union - European Commission	Farmers	House of Representatives	Interest groups	Ministry of Agriculture, Nature and Food Quality	Ministry of Economic Affairs and Climate Policy	Ministry of Infrastructure and Water management	National Institute for Public Health and the Environment (RIVM)	Netherlands Environmental Assessment Agency (PBL)	Provinces	Statistics Netherlands (CBS)	Supporting departments	The Netherlands Environmental Assessment Agency (NCEA)	The Netherlands Enterprise Agency (RVO)	The Netherlands Food and Consumer Product Safety Authority (NVWA)	Wageningen University & Research (WUR)	Water boards
Committee of Experts for Fertilizers Act (CDM)						Reviews of scientific reports	Advice on scientific issues, submission of ammonia policy	Guidelines	Research reports	Research reports					Test	Advice	Reviews	
European Union - European Commission						Guidelines	Guidelines	Guidelines	National Monitoring Reports of Effects of Manure						Advice			
Farmers						Participation	Advice	Guidelines	Research reports						Administration			
House of Representatives						Advice	Advice	Guidelines	Research reports									
Interest groups						Pressure	Pressure	Guidelines	National Monitoring Reports of Effects of Manure									
Ministry of Agriculture, Nature and Food Quality						Pressure	Pressure	Guidelines	Implementation policy						Implementation policy			
Ministry of Economic Affairs and Climate Policy								Guidelines	Implementation policy						Implementation policy			
Ministry of Infrastructure and Water management						Partnership												
National Institute for Public Health and the Environment (RIVM)																		
Netherlands Environmental Assessment Agency (PBL)																		
Provinces																		
Statistics Netherlands (CBS)																		
Supporting departments																		
Team manure																		
The Netherlands Commission for Environmental Assessment (NCEA)																		
The Netherlands Enterprise Agency (RVO)																		
The Netherlands Food and Consumer Product Safety Authority (NVWA)																		
Wageningen University & Research (WUR)																		
Water boards																		

Figure 18: Summary of the interaction between the agents of the manure case.

Process	Tasks	Committee of Experts on Fertilizers Act (CEFA)	European Commission	Farmers	House of Representatives	Ministry of Agriculture, Nature and Food Quality	Ministry of Economic Affairs and Climate Policy	Ministry of Infrastructure and Water management	National Institute for Public Health and Environment (RIVM)	Netherlands Assessment Agency (PBL)	Provinces	Statistics Netherlands (CBS)	Supporting departments	Team manure	The Netherlands Commission for Environmental Assessment (NCEA)	The Netherlands Consumer Safety Authority (NVWA)	The Netherlands Food and Consumer Product Safety Agency (VWA)	Wageningen University & Research (WUR)	Water boards
Process	1. Define the problem																		
Process	2. Set agenda																		
Process	3. Formulate policy	E	C		C	A	A	A	E	E			S	R					
Process	3.1 Evaluate previous policies and other documentation																		
Sub-process	3.2 Create alternative options for the new policy																		
Sub-process	3.3 Bring agents together																		
Sub-process	3.4 Gather the feedback on alternatives			C	C														
Sub-process	3.5 Decision by the minister																		
Sub-process	3.6 Decision by the House of Representatives							R											
Sub-process	4. Start the process of changing laws and regulations																		
Process	5. Implement policy																		
Process	6. Evaluate policy	C	I	I	I	A	A	A	E/R	E			S	R	C				

Those who do the work to complete the task

The one ultimately responsible for the correct and thorough completion of the deliverable or task

Those who help the responsible to complete the task

Those whose opinions are sought, typically subject matter experts, and with whom there is two-way communication

Third parties that are contracted to execute activities

Those who are kept up-to-date on progress, often only on completion of the task or deliverable, and with whom there is just one-way communication

Those who see whether accountabilities all fit together of all the involved parties

- R** Responsible
- A** Accountable
- S** Support
- C** Consult
- E** Execute
- I** Inform
- O** Overview

Figure 19: RASCEIO matrix for the manure case.

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### 3.3 Part 3: Process of the manure policy

As described in section 2.1, many scholars have developed theories on how public policy is developed. We introduced multiple theories on the development of policy, but do these theories match the reality? The interviews show that there are similarities but also differences in the working methods within the Ministries. Policy-makers indicate that the process starts with a problem or a topic high on the political agenda. Specifically for the manure policy, the problem is based on the evaluation of the previous action program. The policy-makers evaluate what went wrong in the years before and how this can be improved through the to-be developed policy. This is a unique way of working since most policies are developed ad-hoc. This has to do with the pressure from politics, when politicians have decided that a subject should receive attention it becomes a subject on the agenda and so the agenda setting phase is first. The reason that a subject can be put high on the political agenda are often media reports or interest groups that have exerted influence. The order of these two phases does not really matter, the most important thing is that the problem is clear after the phases. Since the order of these phases can deviate, the theory of 't Hart and Twist (2011) seem to be not applicable in case of the manure policy. The start of a new policy is more dependent on the political circumstances and if there is a window of opportunity in which decisions can be made such as described in the stream theory (Kingdon 2003).

If the problem is clear, the policy-makers will have another look at the evaluation of the previous action program. In addition to the evaluation, other recommendations are also taken into account. In the years that the action program was in effect, various reports were published by organisations such as RVO, RIVM, CBS and the WUR about the effects of the policy. Now is the time to take this all in consideration. Important documents for formulating the new policy are:

- The Synthesis report Evaluation Fertilizers Act 2016 from PBL (Grinsven and Bleeker 2017)
- The Threat Assessment for Environmental Crime 2017 from the Strategic Environmental Chamber (Boerman and Grapendaal 2017)
- The report “Trade in the manure market: options for interventions” from the WUR (Koeijer 2018)
- The perception survey from the WUR (Lauwere et al. 2016)
- The report on fraud from the national audit service in 2018
- Advise from the Center for Crime Prevention and Security on improving enforcement.

These recommendations and results are all taken into account when designing various alternatives for the new policy. In addition, policy-makers engage in a dialogue with external agents to listen to their opinions and ideas. These sessions help to shape the various alternatives for the new policy. Meetings with external agents are repeated until a policy has been formed that has sufficient support by the external agents, is scientifically substantiated and has the support of the House of Representatives and European Commission. The Minister of Agriculture, Nature and Food Quality then decides if the policy is sufficient, presents it to the House of Representatives who then vote. If the decision for the policy is positive the policy will enter a new phase, otherwise the policy needs to be modified and will go to through the formulation phase again.

When the policy is adopted by the House of Representatives the policy will be implemented and the process of changing the regulations will start. These activities can run parallel to each other. The implementation of the policy lies largely, in the case of manure, by RVO and NVWA. Those two organisations are responsible for the enforcement and monitoring of the manure policy. The manure policy states that every five years the policy needs to be evaluated. This is the last step in the process and provides the policy-makers with feedback for a new policy. The time span it takes to run through such a policy development process is four years, where the development and the evaluation can overlap. Figure 20 and 21 show the process of policy development in a business process model accompanied by a legend.<sup>1</sup> An extensive legend of the business process modelling notation can be found in Appendix C. Figure 20 shows the overall process of policy development for the manure policy and Figure 21 shows the sub-process of the policy formulation activity. These models are based on interviews with policy-makers.

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<sup>1</sup>We make use of a subset of the Business Process Modelling Notation 2.0 for the figures.

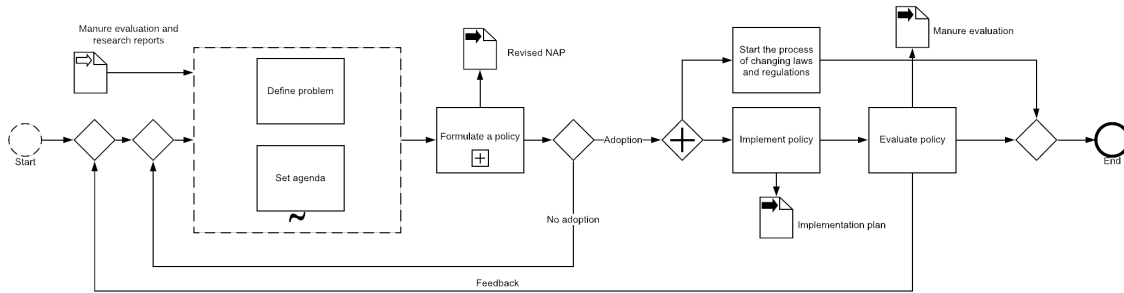


Figure 20: Business Process Model of the manure policy development.

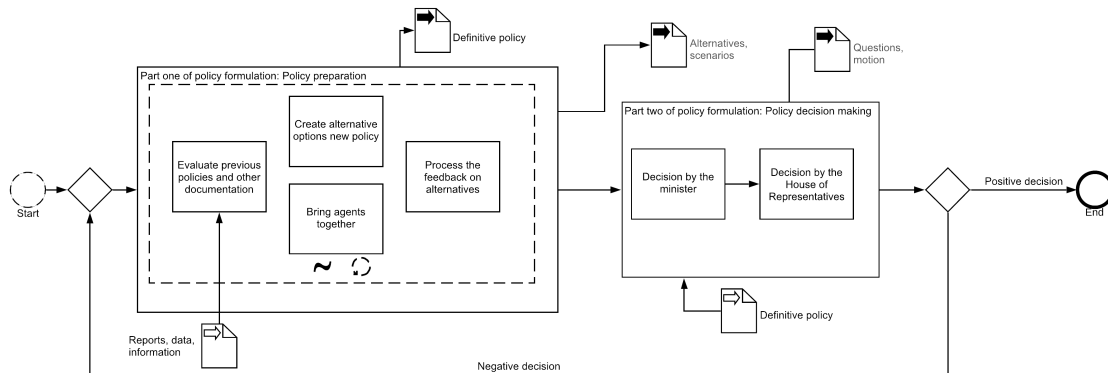


Figure 21: Sub-process of the policy formulation.

### 3.3.1 Timeline development manure policy

The manure policy is developed in a four-year cycle. It takes about two years to come up with a new manure policy. The policy is not definite after two years but keeps changing based on analyses of PBL, Rijkswaterstaat (RWS) and the manure evaluation for example. Since the change of laws takes approximately between one and a half to two years. A parallel process is started in which the legislation and regulations must be adjusted to make parts of the policy possible that do require a change in the law. As one of the policy-makers (2019) said: *“You can not wait until the last minute. Otherwise you do not have a policy that goes into effect after the last policy expires.”* During the development of a new policy the implementation and monitoring of the previous policy continuous. When a new policy goes in to effect they way “how” the policy is implemented and monitored can change, but the activity is still part of the process. The timeline of the activities can be seen in Figure 22. The timeline is a product created on the basis of interviews and a planning of the manure team.

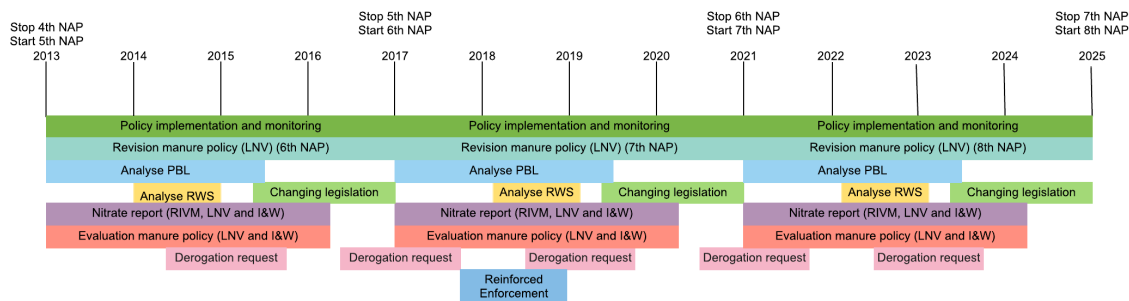


Figure 22: Timeline of the manure policy development.

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### 3.3.2 Data, information and ICT use in the manure case

Technology pervades almost all areas in society. Considering policy development, a trend can be observed: Policies are developed that define the use of technology and business are encouraged to include technology in their operations. The agro-food sector produces big amount of data and new policies encourage the use of this data to improve operational management but also enforcement from the government. The "Versterkte Handhavingsstrategie Mest" is such a policy that describes technological measures to support policy monitoring and enforcement. The strategy describes that the Ministry is devoted to the development of ICT measures at RVO and the provision of digital and real-time accountability for transport and application of manure. Since society is becoming more digital this has an effect on governments, including consequences for policy development. An important aspect during the development of policy is thinking about how technology can be used, next to an aspect such as financial and legal consequences of a policy. Thinking about the application of technology is one thing, but using technology during the process of developing a policy is another.

An important part of a process should be the use of data, resources and information to develop the policy. The policy development process for the manure policy relies on research institution for their data and information. According to the policy-makers (2019), *"it is a process of question and answer."* They identify it as a way to efficiently produce answers.

Policy-makers are during the development of a policy constantly in contact with research institutions to collect the information needed. This is mostly done by e-mail or telephone conversations. The policy-makers also rely on reports of research institutions as mentioned in section 3.3. Other agents such as interest groups are also a source of information, since they represent the opinions of larger groups. They collect information provided by these groups through meetings, debates or surveys such as the "Staat van de boer" (Trouw 2018). "De Staat van de Boer" is a survey conducted among farmers with questions about policy and other topics. The question and answer game happens during the entire process. Only there are other agents who provide information and data to the policy makers based on which part of the policy is formulated. For example, RVO and NVWA are involved in formulating policy enforcement and these parties also provide data for this.

## 3.4 Reflection

The manure case studies shows us a rich history around manure policy. The manure policy has been in affect for a lot of year and has adopted a four year cycle since 1995. A whole lot of different agents are involved in developing the manure policy. Some agents can be categorised as interest groups, other agents write the policy and other agents focus more on providing the right data to the policy-makers. The interactions between these agents are mostly through partnerships where they work towards a common goal or by information and expertise sharing. The process of developing policy is dynamic and this can be seen in the activities that are grouped as ad-hoc or a loop in the business process model. A large part of the real policy formulation contains activities that can be skipped, executed twice or are executed in a different order every-time the policy is developed. While other parts of the process are more fixed. The policy-makers that create the manure policy are very dependent on other organizations when it comes to receiving the right information for the manure policy. It would be interesting to know more about the effectiveness and efficiency of this way of communication, so that recommendations can be made on how to improve the sharing of information.

# Chapter 4

## Case study results of the undermining crime policy

This chapter presents the second case study results. The case study is executed to gather information about the development of the undermining crime policy development process. The observations from the case study are explained according to the analysis structure as described in Chapter 1, starting with the history in section 4.1, the agents in section 4.2 and the process in section 4.3. The chapter is finished with a short reflection on the case in section 4.4.

### 4.1 Part 1: History of undermining crime

The second case study has been performed at the Ministry of Justice and Security (Ministerie van Justitie en Veiligheid) in collaboration with the Ministry of the Interior and Kingdom Relations (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties) and the Ministry of Finance (Ministerie van Financiën). The Ministries are all responsible for different portfolio's:

- The Ministry of Justice and Security maintains the rule of law in the Netherlands, so that people can live together in freedom, regardless of their life-style or views. The Ministry has the legal tasks of providing a workable legislation for the public, the government and the courts, to prevent crime, enforce the law and provide fair, consistent and effective enforcement of punishment and other sanctions. It is also responsible for the coordination of counter-terrorism policy.
- The Ministry of the Interior and Kingdom Relations is responsible for domestic policy, civil service, public administration, elections, local governments, intelligence and kingdom relations.
- The Ministry of Fiance is responsible for the income and expenditure of the Kingdom of the Netherlands, they collect the taxes and develop fiscal legislation. They also supervises the financial markets, banks and financial transfers. It employs almost 1,500 civil servants and has a Directorate General for the Budget, Fiscal Affairs and Taxation.

The Ministries has been seeing new forms of crime in society. One of these new forms is organised crime. Organised crime is becoming more violent and criminals are active in multiple places such as residential areas, businesses and on the internet. Drug trafficking, liquidations and money laundering: these are examples of undermining crime. These crimes are often committed in criminal partnerships and are accompanied by violence, threats and intimidation. Undermining crime damages social structures or trust in them and leads to interweaving of the upper and the underworld. Undermining crime (ondermijnende criminaliteit) means, according to a police report from Amsterdam-Amstelland (2009): “to weaken or abuse society’s structure leading to the corruption of its foundations and/or a decaying integrity of the constitution that protects her”. The easiest way to explain undermining crime is as follows: The Dutch society is founded on a number of key domains, key persons or groups, key locations and key branches or organisations. If these these key domains are the backbone of society and if they function well, the society functions well. But if one of these key domains is affected this means a deterioration of the stability of

the society. These key domains are divided in six social (SEPTED) categories. Some of these categories will be known, since we introduced these in section 2.1.7

- Socio-cultural
- Economic
- Political
- Technological
- Ecological
- Demographic

The responsibility to protect these social foundations is broadly divided. There are many different organisations or institutions in society whose task is to protect one (or more) of the key domains. Together these partners form a type of protective layer that protects the society. In the meantime, in all kinds of places in the society are there attempts to undermine the key domains and its protection. Undermining takes place as the malevolent manages to get between the partners, the building blocks of the protective layer, by sliding and reaching the foundations, as shown in figure 23. Undermining involves a range of activities that take place around criminal offenses to prepare, facilitate or hide them. Undermining is not always a criminal offense and it doesn't even have to have a big impact. Undermining as an act on itself is not always the end goal. Usually undermining is a conscious or unconscious side effect of behaviour that is aimed at acquiring power, status or money of the malevolent.

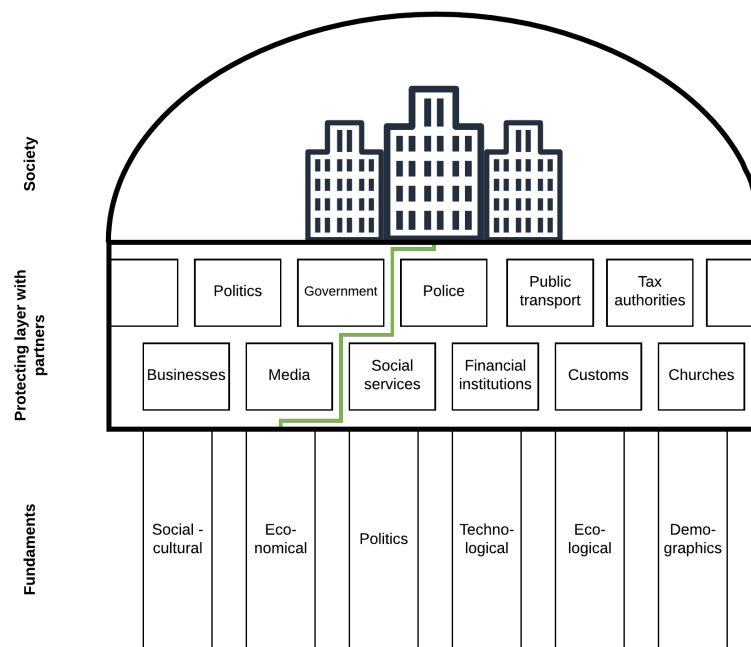


Figure 23: Explanation of undermining crime (Amsterdam-Amstelland 2009).

#### 4.1.1 From the seventies until the eighties

From the beginning of the seventies the production and the trafficking of drugs become the most important part of criminals their livelihood. The drug crime had an effect on the functioning of society and the first parts of the world of organized crime intertwined with society. Over the years, the line between the upper world and the underworld had become a large gray area. More and more companies were becoming consciously or unknowingly involved in helping criminals. The commissioner Jan Blaauw (1974) published an article in the "Algemeen Politieblad" in which he asked for attention on the increasing organised crime, but nothing happened with his research.

#### 4.1.2 From the eighties until the nineties

After a wave of robberies on banks, post offices and companies a cooperation between several parties was developed. In the 1980s, research was conducted on behalf of the Ministry of Justice

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and Security, which led to a series of measures to combat crime. The "society and crime" policy plan provided the first impetus for multiple approaches to crime in the Netherlands. It was recognized that in addition to the police and the judiciary, other authorities can play a role in tackling crime. The first steps were being taken to set up an integrated approach. It had become increasingly clearer during the compilation of this approach that the classic image of a criminal organisation was no longer entirely correct. There were no clear corporate structures but there was more of a cooperative relationships between criminals (Lam, Wal, and Kop 2018).

The Dutch-American Conference on Organised Crime ensured that in addition to the criminal law approach, a preventive administrative law perspective was added to the justice system to catch criminals. The memorandum on combating serious and/of organised crime in the Randstad area of the Netherlands (Randstadnote) is a result of the conference. The Randstadnotes lead to the establishment of the Inter-regional Investigation Teams (IRTs) or core teams, from which new methods and tactics are developed to tackle criminals (Lam, Wal, and Kop 2018). In the first years of their establishment the IRTs go on a hunt for the network of drug baron Klaas Bruinsma and with success they intercept large shipments of drugs. In June 1991 the largest Dutch drug baron of the 80s and 90s is liquidated.

### 4.1.3 The nineties until present day

The administrative approach that had been developed since the 1990s has been continued because of its important contributions to the fight against organised crime. One of the first times that the new approach is being tested is in the Amsterdam Red Light District. A methodology had been developed that made it possible to analyse and investigate areas or branches. The municipality could then take (administrative) measures based on these analyses. In 2003 the administrative approach received a major boost by the introduction of the "Wet Bevordering integriteitsbeoordelingen door het openbaar bestuur" (BIBOB). This law encourages a stricter licensing policy and makes public administration (partly) responsible for tackling organised crime. In addition to the administrative approach and the increasing focus on integrated work, new investigations and crime control concepts are being experimented with and various programs and pilot programs are being set up between 2000 and now. Such as the "Strengthening Approach to Organised Crime", the "Administrative Approach" program, the FinEc program, the Emergo project and the pilot Regional Information and Expertise Center (RIEC). The coalition agreement of the Rutte-III cabinet gives another boost to fighting undermining crime. Ambitions are set to strengthen the approach for organised and undermining crime. With 100 million euro in funds, undermining crime must be tackled better in the coming years.

## 4.2 Part 2: Agents in the case of undermining crime

Tackling undermining crime is regularly confronted with bottlenecks that hinder civil servants and judicial services in their duties. That is why the initiative has been launched to work towards "Undermining legislation". Undermining legislation is a collective name for several legislative proposals, all of which aim to strengthen the approach to undermining, Figure 24 shows the different legislative proposals that should lead to a collective undermining legislation. For example, it should become easier for partnerships between social and government organisations to process data and exchange information, mayors should be given more options to close homes and administrative bodies should be given more opportunities to independently conduct research under the BIBOB Act. In this case study, we acknowledge these other policies are all important legislation but we will focus on the Data Processing Partnership Act and how data is used in the City Deal "View of Undermining". To work towards this policy, several initiatives have been launched, such as the City Deal "View of Undermining". The City Deal "View of Undermining" is a strengthening and improvement of the preventive approach to undermining crime by using methods such as data analytics. The City Deal is an initiative from the Ministry of the Interior and Kingdom Relations who involved the other Ministries in a partnership to search for a solution to undermining crime. Interviews with policy-makers and project managers that are working for the City Deal "View of Undermining" have helped us form a picture of how the project works and how the policy is formed around the Data Processing Partnership Act.



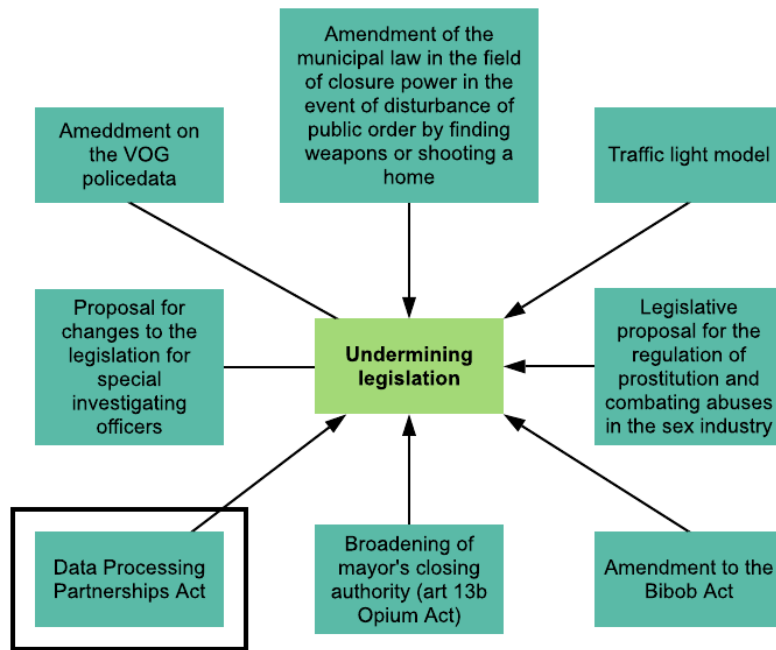


Figure 24: Explanation of undermining crime legislation.

#### 4.2.1 Internal and external agents

The following section will describe the agents around the undermining crime project, what their perspectives are and the interaction between the agents is. Tackling undermining crime can only be achieved by doing continuous research. To facilitate the detection of undermining crime, investigations and data analyses have been conducted for years by the police in collaboration with the public prosecutor.

The City Deal "View of Undermining" builds on the experience of the investigation authorities, but makes it easy to do research through a collaboration between different agents. A large part of the participating agents are companies that provide data and expertise to conduct research. The policy focuses on tackling undermining crime, on a regional or municipal level. This is why the partnership has been set up in such a way that the municipalities are central. The municipalities are in collaboration with the Statistics Netherlands to formulate and execute question-driven investigations. Statistics Netherlands takes the lead in demand-oriented research. They have the analysts who use data analysis to answer questions such as "Why do we see so much sale and purchase of houses by person Y in Rotterdam, district X?". Statistics Netherlands is a Dutch governmental institution that collects statistical information about the Netherlands. For years they have been supporting ministries in making policies with their data. Statistics Netherlands manages a lot of public data, but there is also a lot of data that is private. Some of this data could help with the research that is done. The municipalities have therefore formed partnerships with organisations such as energy companies, brokers and water boards, that have joined the initiative by supplying their private data when necessary for research.

There are five municipalities that have joined the first pilot on the undermining crime policy. These municipalities are Amsterdam, The Hague, Rotterdam, Tilburg and Utrecht. The municipalities are in contact with these local companies and universities to carry out demand-oriented research. The universities have a role of experts in this partnership. They provide context to trends and findings that are found in data analyses conducted by the Statistics Netherlands in collaboration with the municipalities. Since July 2017 the five biggest municipalities of Brabant have also joined the initiative.

Not only is there a partnership with universities, also Regional Information and Expertise Centers (RIEC's) help in the fight against undermining crime. The Netherlands is subdivided into ten RIEC's that work within regional borders. They collect information for ten security regions in the Netherlands, connect information, expertise and the powers of the various government agencies. The National Information and Expertise Center (LIEC) provides a link between the RIEC's and

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other national partners, so that the City Deal "View of Undermining" can not only use data that applies to the safety regions involved, but can also identify national trends.

National parties that are part of the partnership are Kadaster and the Kamer van Koophandel. These organisations have delivered big amounts of data to Statistics Netherlands in various areas to conduct research. The Kadaster, for example manages and facilitates data from homes, ships, aircraft, plots and roads. They also do this underground for networks of cables and pipes. The Kamer van Koophandel operates in a different area, providing information and support on the most important themes in the entrepreneurial field. For example, they manage the Trade Register (Handelsregister) in which all companies and legal entities in the Netherlands are registered. The Belastingdienst is part of the Ministry of Finance and responsible for collecting government revenue. General provisions are paid from this income, such as roads, schools and certain benefits. They have provided a lot of resources to the City Deal "View of Undermining".

There are three ministries that have an interest in reducing undermining crime. These Ministries are the Ministry of Justice and Security, the Ministry of the Interior and Kingdom Relations and the Ministry of Finance. The Ministries are responsible in this project for guaranteeing the cohesion between the municipalities and their research by drawing up a framework. In addition, the Ministries have commissioned ICT Implementation Organization (ICTU) to provide organisational and functional project management for the City Deal "View of Undermining". ICTU organizes partnerships and plays a role in the coordination between the participating parties, evaluates the research and reflect on the objectives to be achieved.

In Figure 25, ICTU is shown on the left side of the figure, they have a project management role in the process. The Ministries are shown next to ICTU, they represent the clients. The municipalities are shown in the middle of the two dotted lines. The agents on the left side are local companies that are in contact with the municipalities when the demand-driven research asks for this. The right side represent, in purple, companies that are research institutions and help with the research. In pink, the police and public prosecutor's office are pictured. They are the investigation authorities of the Netherlands. The agents pictured in a salmon color are national companies that deliver data in various areas for the whole of the Netherlands.

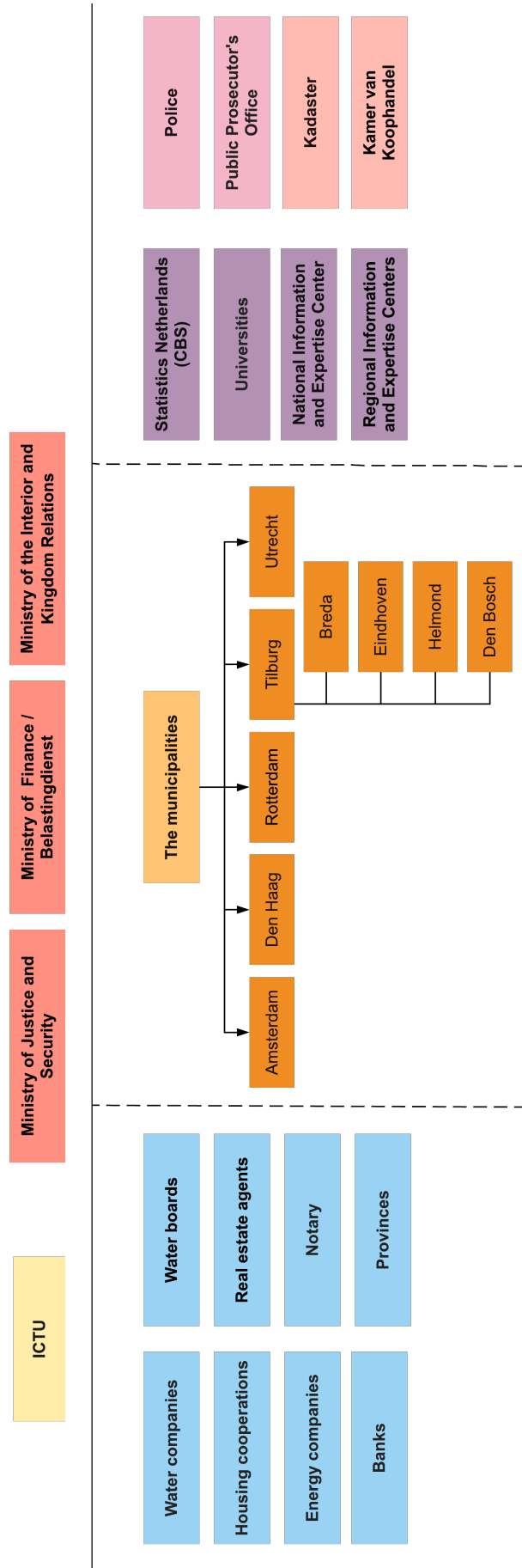


Figure 25: Internal and external agents of the undermining crime policy.

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## 4.2.2 Perspective and interaction

The following section will present the perception of the agents and their interaction based on the observations of the case study.

### Perspective

The interviews provide us with a list of agents that are part of forming the legislation for undermining crime. The agents around the undermining crime project all act from a different point of view regarding the policy. The list of agents and their perspectives is as follows:

- **ICTU:** ICTU is an independent consultancy and project organisation within the government. ICTU provides the organisational and functional project management, the organisation of the partnerships, the coordination between the participating parties, the evaluation and manages the objectives to be achieved.
- **Kadaster:** The Kadaster provides data from homes, ships, aircraft, plots and roads for the data analysis. Kadaster has mainly provided 6 billion in data for property fraud investigations.
- **Kamer van Koophandel:** The Kamer van Koophandel focuses on registering, informing and advising entrepreneurs.
- **Local companies:** All local companies participating in the process provide data and knowledge for research. The role is different for every company, for example, energy companies provide figures on energy consumption and plays a role in tackling weed plantations. Banks, notaries and real estate agents all have their own expertise. They can form a source of information as informers, but the municipality can also use their knowledge if it does not have this in-house. These parties also have a gatekeeper function within the meaning of the Law on the prevention of money laundering and the financing of terrorism. The parties must, among other things, conduct research into their customers and report unusual transactions. In this way they create important barriers to the prevention of money laundering.
- **Ministry of Finance / Belastingdienst:** The Ministry of Finance and the Belastingdienst have made analysis capacity available to help by specifically formulated expertise questions.
- **Ministry of Interior and Kingdom Relations:** The Ministry guarantees the core values of a democratic Netherlands. In this project they have commissioned the ICTU Foundation as project manager.
- **Ministry of Justice and Security:** The Ministry of Justice and Security has made a budget of 50,000 euros available to the City Deal "View of Undermining".
- **Municipalities:** The City Deal "View of Undermining" has 5 municipalities involved in their project. The municipalities are Amsterdam, Den Haag, Rotterdam, Tilburg and Utrecht. Tilburg speaks in the project for the 5 largest municipalities in Brabant (Eindhoven, Breda, Den Bosch en Helmond). Each municipality initiates a concrete data analysis project. The importance of this project is based on the input from co-governments, regional partnerships, social partners and possibly private parties. The municipalities deliver analysts who collaborate with other analysts on the research questions.
- **National Information and Expertise Center (LIEC):** The LIEC identifies and reviews developments in the area of undermining. For cross-border crime problems, the LIEC coordinates the national approach.
- **Police:** The police contributes knowledge of the legislation specifically focused on the police task and the provision of capacity and knowledge whereby specific agreements are made about the deployment of the police for each project of the participating municipality by the relevant unit.
- **Public Prosecutor's Office:** The Public Prosecutor's Office contributes knowledge of the legislation with regard to the Judicial and Criminal Records Information Act.

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- Regional Information and Expertise Centers (RIEC's): The RIEC's collect information for the ten security regions, they also play a role in supporting and strengthening cooperation within the government and public-private partners and they share knowledge and expertise in the field of undermining.
  - Statistics Netherlands (CBS): Has made data and analysis capacity and related activities available on site or via remote access for data analyses.
  - Universities: Universities provide scientific knowledge in the partnership. For example, there are data scientists who help with the data analysis.

### **Interaction**

As explained in the previous chapter, is the interaction between agents the basis for their collaborative problem solving capabilities. Key to the realization of such activities is to understand what the relationship is between all the agents. The interaction between agents can be explained, as done in Table 26. This is a summary of all the interactions between the agents that can be found in Appendix B. We also used a responsibility assignment matrix for the undermining crime case to present the interaction and then in particular the responsibilities of agents. The RASCEIO matrix is used, just as in the manure case. Figure 27 shows the RASCEIO matrix which combines all the agents, and the tasks in the undermining crime policy development process.

	Local companies	ICTU	Kadaaster	Kamer van Koophandel	Ministry of Finance/ Belastingdienst	Ministry of Justice and Security	Ministry of Interior and Kinfdom Relations	Municipalities	National Information and Expertise Center	Police	Public Prosecutor's Office	Regional Information and Expertise Centers	Statistics Netherlands (CBS)	Universities
Local companies														
ICTU														
Kadaaster			Coordination	Coordination	Client	Client	Client	Data and/or expertise transfer					Transfer data	
Kamer van Koophandel								Coordination					Transfer data	
Ministry of Finance/ Belastingdienst		Appointed as project manager					Framework formulation	Resources				Data and/or expertise transfer		
Ministry of Justice and Security		Appointed as project manager			Framework formulation		Framework formulation	Resources		Collaborate	Collaborate		Resources	
Ministry of Interior and Kinfdom Relations		Appointed as project manager			Framework formulation									
Municipalities	Data and/or expertise transfer				Provides input change agenda	Provides input change agenda	Provides input change agenda							Data and/or expertise transfer
National Information and Expertise Center			Receive data	Receive data				Data and/or expertise transfer					Coordination	
Police														
Public Prosecutor's Office														
Regional Information and Expertise Centers													Data and/or expertise transfer	
Statistics Netherlands (CBS)			Data and/or expertise transfer	Data and/or expertise transfer				Data and/or expertise transfer					Data and/or expertise transfer	
Universities								Collaborate						Data and/or expertise transfer

Figure 26: Summary of interaction of agent for the undermining crime case.

Process	Tasks	Local companies	ICTU	Kadaster	Kamer van Koophandel	Ministry of Finance/ Belastingdienst	Ministry of Justice and Security	Ministry of the Interior and Kingdom Relations	Municipalities	National Information and Expertise Center	Police	Public Prosecutor's Office	Regional Information and Expertise Centers	Statistics Netherlands (CBS)	Universities
Process	1. Define problem					R	R	R							
Process	2. Set agenda					R	R	R							
Process	3. Formulation and signing of covenant		C			R	R	R	C		C	C		C	
Process	4. Formulation of legal assessment framework					R	R	R							
Process	5. Analyse the data conform the legal assessment framework								C					R	
Sub-process	5.1 Choose a research question suited for pattern recognition	I	I						R					S	
Sub-process	5.2 Define the purpose of the analysis	I	I						R					I	
Sub-process	5.3 Consider whether processing of anonymised data is sufficient													R	
Sub-process	5.4 Determine and record which categories of personal data are required								S					R	
Sub-process	5.5 Process data of the Statistics Netherlands first													R	
Sub-process	5.6 Process the personal data in pseudonymized form													R	
Sub-process	5.7 Test if special personal data are being processed													R	
Sub-process	5.8 Determine the possible provision of additional personal data									C				R	
Sub-process	5.9 Determine who should be responsible for the processing of personal data								S	C					
Sub-process	5.10 Determine on which legal basis the processing of personal data can take place					A	A	A	I					R	
Sub-process	5.11 Perform the processing of data								I	C				R	
Sub-process	5.12 Check the provision in the case of police, judicial or criminal data against the conditions						I				I	I		R	
Sub-process	5.13 Check whether the processing must be reported to the Dutch Data Protection Authority or the Data Protection Officer					C	C	C						R	
Sub-process	5.14 Ensure that the data to be processed is correct and accurate													R	
Sub-process	5.15 Use algorithms and analysis methods that are scientifically validated													R	C
Sub-process	5.16 Determine the margin of error that may occur													R	
Sub-process	5.17 Ensure adequate security during the data analysis													R	
Sub-process	5.18 Check whether data subjects need to be informed about the fact that personal data is being processed about them													R	
Sub-process	5.19 Ensure that the data additionally obtained is destroyed													R	
Sub-process	5.20 Make the results of the analysis public	I				C	C	C	C					R	
Sub-process	5.21 Ensure a proper evaluation of the analysis process and the outcome thereof								R					C	
Process	6. Bring agents together to obtain data	S/C		S	S	S			R						
Process	7. Create a joint agenda for changes	C	C	C	C	C			R		C	C	C	C	C
Process	8. Start the process of changing laws and regulations					R	R	R							
Process	5. Implement policy					R	R	R	R		I	I			
Process	6. Evaluate policy					R	R	R	C		I	I			

**R** Responsible  
**A** Accountable  
**S** Support  
**C** Consult  
**E** Execute  
**I** Inform  
**O** Overview

Those who do the work to complete the task  
 The one ultimately answerable for the correct and thorough completion of the deliverable or task  
 Those who help the Responsible to complete the task  
 Those whose opinions are sought, typically subject matter experts; and with whom there is two-way communication  
 Third parties that are contracted to execute activities  
 Those who are kept up-to-date on progress, often only on completion of the task or deliverable  
 Those who see whether accountabilities all fit together of all the involved parties

Figure 27: RASCEIO matrix for the undermining crime case.

### 4.3 Part 3: Process of the undermining crime policy

The results of the interviews show that the approach to formulating the policy development is different from what the previous case study show. The interviewees indicate that it all started because of the attention for undermining crime in politics. Thanks to the coalition agreement and the funds reserved for undermining crime, the subject received a boost. The Minister of Justice and Security spoke of changes that needed to be made to the laws and regulations to create a working environment for partnerships, and so the City Deal "View of Undermining" started. With as goal insight into patterns and phenomena of undermining crime and advise on how to change law and regulations to create a working environment for partnerships. The City Deal "View of Undermining" project is therefore a way to gather information and advice on what kind of laws and regulations are needed and how the current laws and regulations must be adjusted to create an environment in which it is easy to collaborate between different agents to tackle undermining crime. Figure 28 shows the policy development process of the undermining crime policy.

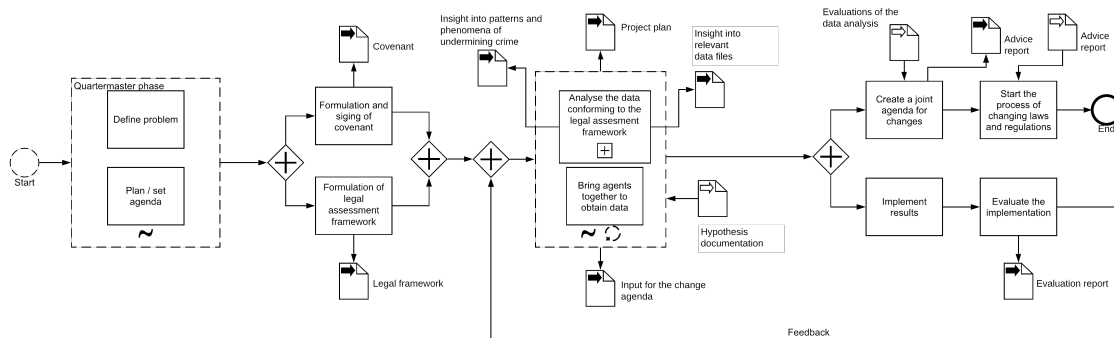


Figure 28: Business process model of the undermining crime policy development.

The process started with a quartermaster (kwartiermaker) phase in the beginning of 2017. This phase is a preparation phase where the problem is defined and the planning and agenda is made for the activities that follow. Eventually a covenant with all the participating agents was formulated and signed. The first agents part of the covenant are the three Ministries with the Belastingdienst, the five municipalities, Statistics Netherlands, the Police and the Public Prosecution Office. To share data safely during the process the Ministries had formulated a legal framework wherein they could work. In the rest of 2017 the agents prepared their resources, data and so on to start the data analysis in January 2018. Within the data analysis, research questions are asked that are suitable for pattern recognition. That is why this activity can also be elaborated on in a sub-process, shown in Figure 30 To formulate an answer for the research questions, different local parties are required per question, which is why these agents are brought together per case. These activities are mostly done ad-hoc. The following example will explain this:

*There have been several telephone calls from concerned citizens to the municipality and police of Rotterdam about weed cultivation in a neighborhood in Rotterdam. The Dutch law system does not allow the police to just rush into those houses and figure out what is going on. So the data-scientists of Rotterdam decide to take a look in to the data to figure out if these calls and reports are well-grounded. The police, in collaboration with the municipality and the Statistics Netherlands start a new data analysis project by formulating a research question they would like to answer. There is a possibility that not all the data they need is available for this project. In this case they need some extra information from an energy company to do an in-dept research, so the municipalities contacted the local energy company. They start with the data analyse and see in the combined data of the CBS and the energy company that unusual amounts of energy are being used in a few houses, which can be an indication of weed cultivation. But still nothing is sure. So, the team working on this project would also like to know more about if these houses have been in name of the same owner for the amount of time the energy use is high. Information is also needed about the purchase and sale of the house where weed cultivation may take place, this is the domain of the Kadaster and a few local real estate offices can also help. After doing a new analysis it appears that the suspicion the police, municipality and citizens had seems to be true. To be sure an expert in energy consumption and a professor from an university in botany are asked to look at the case. They draw the same conclusion, something is really wrong. The local police and the Public Prosecutor's Office can now take measures with these results.*

After the analysis the results are implemented, this could mean that the agents responsible for enforcement, such as the police continue with the results. The implementation needs to be evaluated and will function as input for further data analyses. Parallel to this the municipalities in collaboration with involved agents need to write down matters that hindered the process. This can be, for example, the laws and regulations that hindered the process or parties that are not yet connected to the program but should be. These matters are all bundled in a so called "change agenda". This agenda is the input for advice addressed to the Ministries that can set the process in motion to change laws and regulations.



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### 4.3.1 Timeline development undermining crime policy

The project or process started in 2017 and is still running. The following figure, Figure 29 will give a better explanation of the timeline of the process.

**2017** As shown in the figure, the process started with a **quartermaster phase**<sup>1</sup> where legal matters were sorted and agents were gathered to join the initiative. As one of the interviewees called it, the **preparation phase** started after this. This phase consisted of selecting and arranging the right personnel and resources to ultimately be able to do the data analysis in a structured manner.

**2018** In 2018 the **data analysis** at the Statistics Netherlands really started, with at the end of 2018 some great **results** that could help to tackle undermining crime. The project report "Interim results and new plans of the City Deal Sight on Undermining" of November 2018 shows that the first results of the City Deal "View of Undermining" contribute to strengthening and improving the preventive approach to organised undermining crime.

**2019** Now in 2019 the data analysis is still continuing, but at the same time the **validation phase** started and the agents are focusing on **expansion** with several other municipalities.

**2020** After 2020, the planning is to **present other municipalities the results** of the last years and create a platform so continuously analysing data and sharing knowledge is possible. The project is extended until June 30, 2021 which is the end of the current government term (Staatscourant 2019).

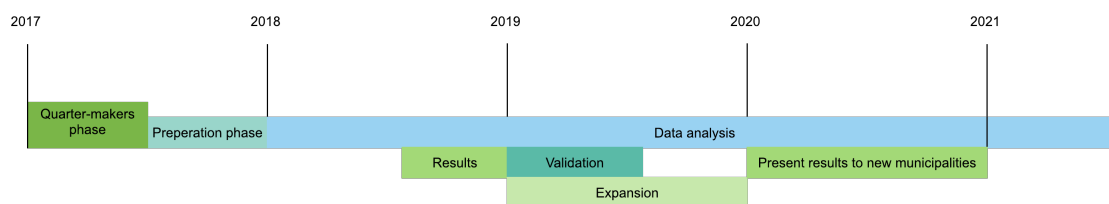


Figure 29: Timeline of the undermining crime policy development.

### 4.3.2 Data, information and ICT use in the undermining crime case

The use of data and sharing data is central to the City Deal "View of Undermining". Therefore a lot of time and effort has been put into decisions regarding the right platform for the data analysis in the quartermaster phase of the process. Ultimately, it was decided to use the data analysis platform of the Statistics Netherlands. Certain people within the municipalities have access to this platform and work on analyses together with Statistics Netherlands to get answers to questions. The people of the municipalities do not have access to all the data that the Statistics Netherlands has, but only the data that is relevant for their research questions. To ensure that everything would be done according to the rules and regulations, the agents formulated a legal framework in the beginning of the policy development process. This legal framework tells the agents step by step what needs to be done to perform the analysis in a right way. It is possible to create a business process model of the successive steps, as shown in Figure 30.

The process starts with choosing the right research question that is suited for pattern recognition. Then the purpose of the analysis is defined and the analysts need to consider if anonymised data is enough to perform the analysis and if there personal data is needed or not. If personal data is required, this should be categorised in such a way that patterns cannot lead to a person. Also needs to be categorised which personal data is needed. Do we need birth dates? Social security numbers? Actual names? The aim is to use as little personal data as possible and therefore the data from Statistics Netherlands is always used first. If personal data is used, this should be pseudonymized first and tested. Then the responsibility for the processing of the data should be determined and on which legal basis the data can be processed. The actual data processing is then done. In case of

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<sup>1</sup>Is an old military term, the meaning of which depends on the country and service. In Dutch the term is meant for troops sent ahead to make preparations before the rest of the soldiers arrive.

data that is from the police, a justicial source or criminal records permission must be given by the Minister of Security and Justice. Fully or partially automated processing of personal data needs to be reported, so these next step is checking if this is the case and otherwise a report needs to go to the Dutch Data Protection Authority or the Data Protection Officer. The data should also be correct and accurate so the analysts need to ensure this. They can also only use algorithms that is scientifically validated and need to determine the margin of error that could occur. During the process security of the data is of importance so measures must be taken to protect the safety of the data. This could mean a confidentiality obligation or measures regarding the transport of the data. Additional data used by the Statistics Netherlands needs to be destroyed after the analysis and the results need to be made public. The data analysis ends with an evaluation, which is used when the process starts again.

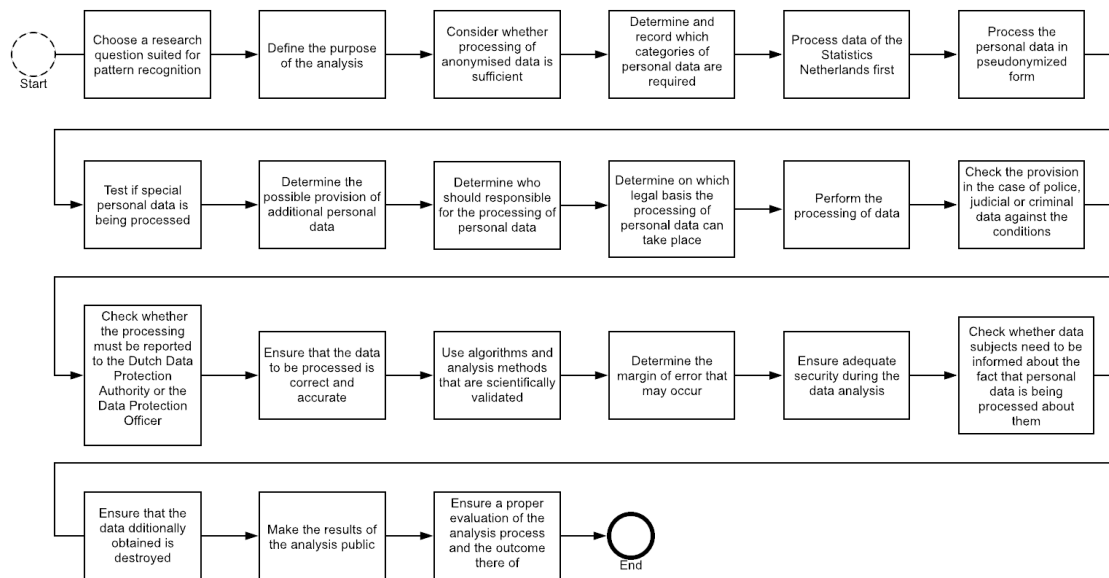


Figure 30: Sub-process of the undermining crime policy development focused on the data analysis.

## 4.4 Reflection

The formation of policy on undermining crime is still in full swing and is flown in as a project that yields an end result. The end result will lead to a policy that describes how government organizations and private organizations should deal with data sharing. The agents surrounding the forming of the undermining crime policy can be divided into the client, organizations that provide data and expertise and a group of agents that perform data analyses and write the policy. The interaction between these agents is mostly about the research they do and the data that is needed. The agents work together through a covenant and a framework, which can be seen in the process description. In addition, a great deal of attention is paid to performing data analyses and exchanging data, and an entire process has been formulated for this. Since the formation of undermining crime policy is a project, the planning for the coming years is focused on expanding the project and sharing the results achieved, so that new municipalities join the project. In addition, the experience gained so far is input for a new policy on undermining crime.

# Chapter 5

## Case study analysis

The case study on manure and the case study on undermining crime show different observations and results. This makes sense since the nature of the cases are very different. In this chapter will we look at the differences and similarities of the cases. The chapter starting with a comparison of the agents in section 5.1, followed by the comparison of the components that make up the process in section 5.2 and the role of ICT, data and information in the process in section 5.3.

### 5.1 Comparing agents

The agents around the manure and undermining crime policy look really different at a first glance, but they have more in common than expected. The manure case has a larger group of agents involved in the process than the undermining crime case, but the agents that are involved in both cases can be compared to explain where the similarities and differences lie. Table 3 presents the agents for both cases.

	<b>Manure case</b>	<b>Undermining crime case</b>
<b>Data and expertise institutions</b>	Committee of Experts for Fertilizers Act (CDM) Netherlands commissions for the environmental assessment Netherlands Environmental Assessment Agency (PBL) Statistics Netherlands (CBS) The Netherlands Enterprise Agency (RVO) The Netherlands Food and Consumer Product Safety Authority (NVWA) Wageningen Economic Research	Universities  Regional Information and Expertise Centers National Information and Expertise Center Kadaster Local companies  Kamer van Koophandel  Police Public Prosecutor's Office
<b>The client</b>	Ministry of Agriculture, Nature and Food Quality Ministry of Economic Affairs and Climate Policy National Institute for Public Health and the Environment (RIVM) European Union - European Commission House of Representatives	ICTU  Ministry of Finance / Belastingdienst  Ministry of Interior and Kingdom Relations Ministry of Justice and Security
<b>Executive party</b>	Team Manure Supporting departments	Municipalities Statistics Netherlands (CBS)
<b>Interest groups</b>	Entrepreneurs - Farmers Interest groups Provinces Water boards	

Table 3: Comparing and categorising agents.

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Some of these agents literally correspond, other agents have the same type of responsibilities or role in the development of policy. Agents that match exactly are the Provinces and the CBS. In addition, are Ministries involved in both cases and plays one or multiple universities a role in the development of the policy. It is possible to categorise agents based on the same kind of role, this leads to 4 categories:

1. Data and expert institutions
2. The client
3. The executives
4. Interest groups

### 5.1.1 Data and expert institutions

Both cases involve research and expertise institutions in the development of policy. The research institutions deliver domain experts that can help with questions about all kinds of subjects regarding the policy. In the manure case are these agents used for their expertise on the National Measurement Effects of Manure Policy which monitors the quality of ground and surface water on farms. Or to state their opinion about new projects regarding manure. For the undermining crime case are the research institutions not only agents that could help answer questions based on their expertise, they also provide a lot of data for the data analyses. A local company such as a real estate agency could for example provide their data about the sale of houses to discover property fraud.

### 5.1.2 The client

Another similarity between the two cases is that both cases have a client that provides frameworks and guidelines. For the manure case, is this the European Union in combination with the House of Representatives. The undermining crime case has the Ministries as client, with ICTU as the project management organisation.

### 5.1.3 The executives

They both have agents that do the actual work on writing the policy. For the manure case, is this the manure team that consults with departments that can help based on their expertise, such as a legal department. The municipalities have a similar role in the undermining crime case, they formulate research questions to use for a data analyse, and involve other parties when expertise is necessary.

### 5.1.4 The interest groups

The last group of agents is only found in the manure case. The interest groups provide the policy-makers with their opinion about the policy and try to influence the policy development as much as possible for their own gain. A agent like this is not found back in the undermining crime case. A reason for this could be because the policy is new. The manure policy has been in effect for decades so people would like to see change when something is not working. The undermining crime policy has not been in effect yet so there is nothing to evaluate on for the public. For undermining crime interest groups could be: criminals, municipalities that would like to join the project or companies.

## 5.2 Generalised process

The tasks in the processes can also be compared for both cases. Figures 31 and 32 both highlight the tasks that are similar in the manure and undermining crime case. The sub-process of the data analysis is not included in the comparison since this part of the process has no similarities with the manure case. It can be seen that tasks such as defining the problem, setting the agenda and bringing agents together can also be found in the process of the undermining crime policy development. Also tasks such as changing laws and regulations, implementing the policy and evaluating the policy are the same in both processes.

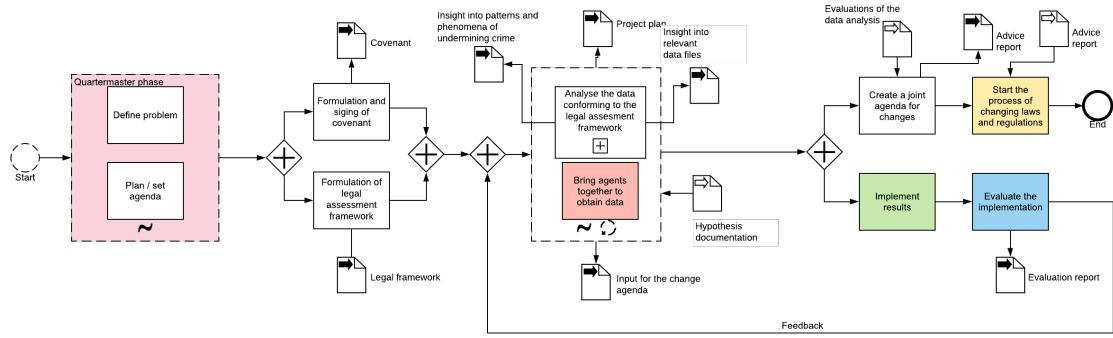


Figure 31: Tasks in the undermining crime case that are similarly to tasks in the manure case.

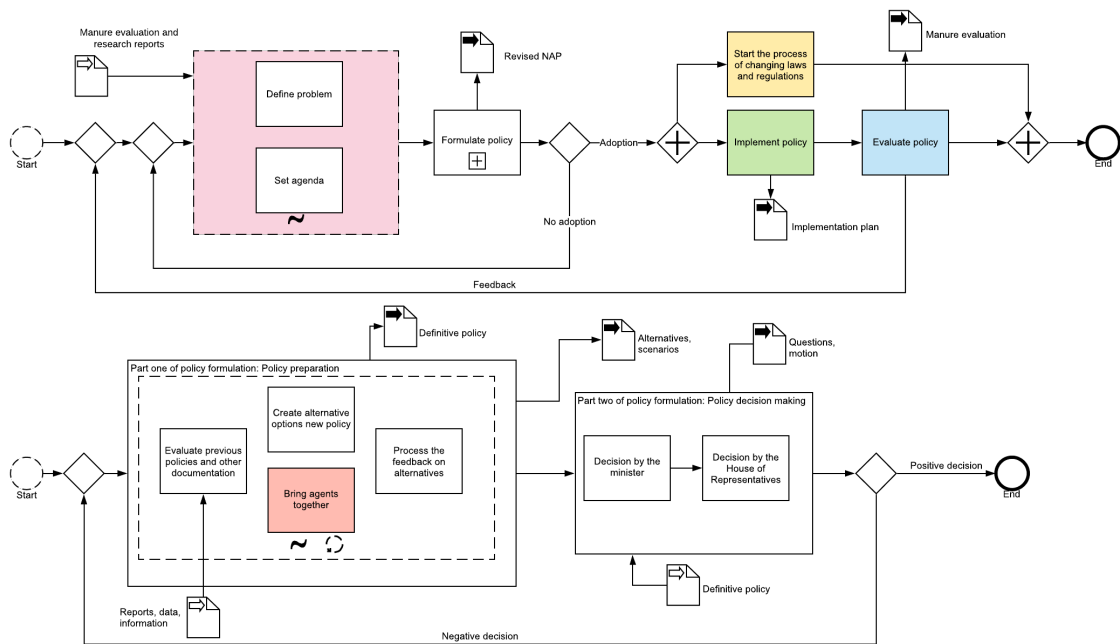


Figure 32: Tasks in the manure case that are similarly to tasks in the undermining crime case.

Because so many activities already match in the processes, we have looked at the possibility of merging the processes to create a process that could serve as a "general policy development process". This process is a combination of the activities of both processes. There is, however, a caveat that one of the interviewees of the undermining crime case has indicated. Their process has not yet been designed to such an extent that they must have their policy regularly approved by the Minister and the House of Representatives. In the present day, the development of the undermining crime policy is categorised as a project or experiment, which gives them more freedom compared to the manure case that has been shaping their policy for years through the described process. The policy-makers of the undermining crime policy see the approval of the policy as a possibility in the future as described in the process. Figure 33 shows how a general policy development process would look like, based on both case studies.

The main processes are very similar, here you can find most of the tasks that occur in both processes. The sub-process that describes the formulation of the policy is more a combination of both processes. Since both processes already had tasks that happened ad-hoc and in a loop so that it could be executed in any order, executed several times, or skipped these these tasks could be categorised together. As mentioned above the decision making part of the process is mandatory for the manure policy, but could be the future for the undermining crime policy development. The documentation around the general process is now renamed to more general terms so that the interpretation is not case dependent anymore. An evaluation report could now be for either the manure policy or the undermining crime policy.

The sub-process or tasks "analysing the data conforming to the framework(s)", does not return at all in the way in which the policy-makers of the manure case make their policy. On the other hand, it is a key task within the undermining crime policy development process. That is why we categorise the task and the underlying process as a task that can be skipped. This is the same for the data analysis task. In this way, a policy development case that executes data analysis in their policy development are represented. But if a processes does not include this in their development, the step can be skipped. In addition, it is important to incorporate this task into the global process, because as indicated by the ministries more data must used during the development of policy. The tasks of the sub-process will not be changed for the general policy development process.

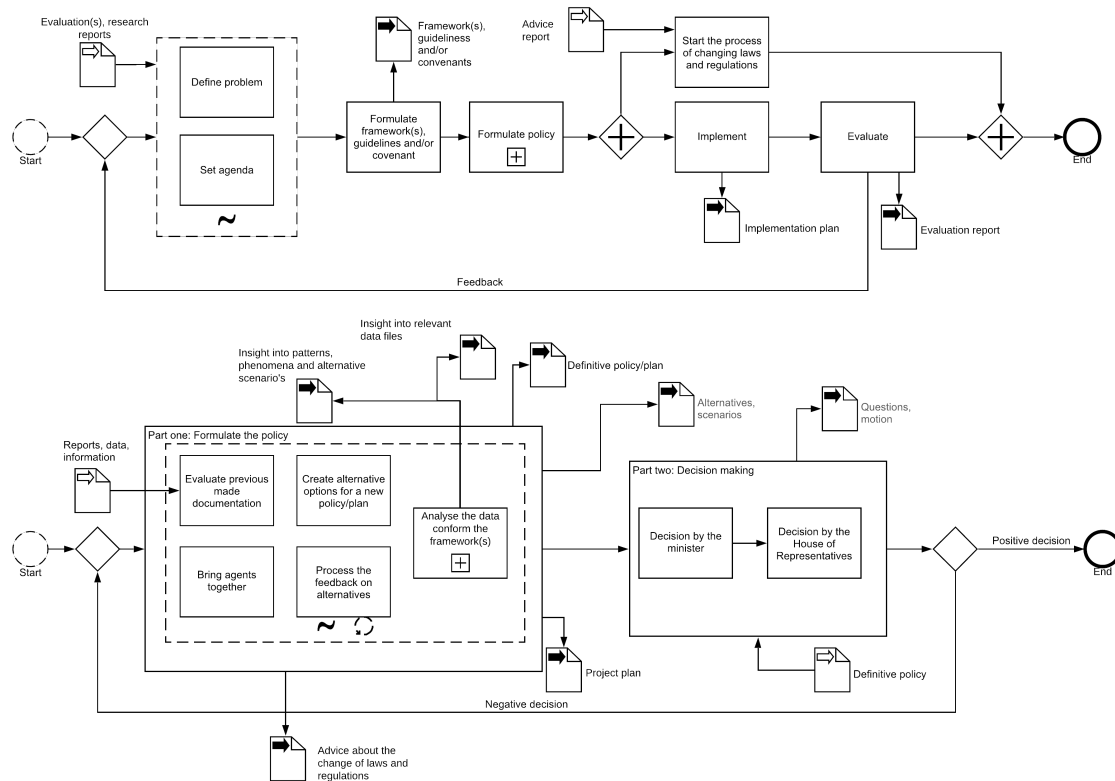


Figure 33: General policy development process.

### 5.3 Comparing information, data and ICT use

The use of data in policy development is completely different in the two cases. When developing the manure policy, data is mainly used from research reports written by RVO, NVWA, PBL and WUR . These organisations manage the data and perform analyses for the manure team that are of value to the policy-makers to form the policy.

In shaping the undermining crime policy, policy-makers are much more involved in analysing data. Together with other parties, they prepare issues, collect data for the issues and perform analyses together with Statistics Netherlands. The results of the analyses are a starting point to identify bottlenecks in the current legislation and are input to find instruments that are already available within the government, that could help solve the problem. If there are no instruments available or can be changed to suit the situation, a policy will be formed or changed to solve the problem. Within the undermining crime case, much attention has been paid to designing a process that explains the data analysis. This is not seen in the manure policy, which can be explained by the fact that the management of the data lies with other agents and they already performs analyses themselves and commissioned by the policy-makers.

## Chapter 6

# BPM and ABM framework

This chapter presents the formalisation and conceptualising of the business process modelling method and the agent-based modelling method, by using metamodelling. This chapter first details the reason why the meta-model approach is used in section 6.1, followed by the description of the business process modelling meta-model in section 6.2. Section 6.3 describes the agent-based modelling meta-model followed with an outline of the differences and similarities in both the meta-models in section 6.4. Section 6.5 describes the use of business process modelling and agent-based modelling in policy development.

### 6.1 Meta modelling

People make pictures, take measurements, draw up plans, orient on examples or build patterns. Be it in thought, with a pen, paper, other material or with the computer, whenever they want to understand or create a complex issue (Hesse and Mayr 2008). In other words they “use models all the time” (Ludewig 2003). In order to support a common understanding between stakeholders and to bridge the gap between the use of business process models and agent-based models, we introduce two meta-models that lets users, model business process and their agents. A model is an abstraction of phenomena in the real world; a meta-model is yet another abstraction, highlighting properties of the model itself. A meta-model is a model of a model. Generating such meta-models is called metamodelling. From a theoretical perspective, it is vital to have a clear understanding of the semantics of the two approaches: business process modelling and agent-based modelling, to describe their overlaps, differences and similarities. The semantics of the two approaches can be represented in meta-models. A meta-model describes the generic concepts that are identified and can be unified in a meta-model. A meta-model is an explicit model of the constructs and rules needed to build specific models within a domain of interest (Heidari et al. 2013). It defines the set of representational primitives with which to model.

As described in Chapter 2, within the business process modelling method, there are several techniques and languages that can be used to visualize business process models. These techniques and languages and their syntax and semantics are well documented and make it possible for users to choose the right one given the situation. There are not only meta-models for every technique, there are also meta-models that are independent of technique or language. Several protocols and methods have also been formulated for agent-based modelling. These protocols and methods are less clearly described than the business process modelling method. This makes it harder for users to compare models or reuse them. The literature is mainly focused on how a conceptual model can be translated into a simulation, but does not focus on how a model is created or how the model of he model looks like.

### 6.2 Meta-model BPM

There is a variation of business process modelling languages and techniques, which makes comparing, analysing and improving business processes a notorious problem. Standardization has been discussed for over ten years, but still no standard is accepted. Heidari et al. (2013) tried to bridge this gap by proposing a conceptual model that combines the seven biggest business process mod-

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elling languages. Translating these different techniques to one conceptual models makes it possible to systematically and objectively understand the potential contribution of each modelling method or technique. Heidari et al. (2013) designed a conceptual model which will be used as a basis for our meta-model to present business process modelling in a policy context. Figure 34 shows the meta-model of the business process modelling method created. The business process meta-model is universal and not dedicated to a single business process modelling language or technique.







agents, embedded systems or robots. With respect to an institutional agent, one has to distinguish between external and internal agents. In the policy development process, the status as an internal or external agent of importance since it determines their contractual status, rights and duties. Regardless of the type of agent, an agent has goals and makes decisions based on these goals or perceptions. These decisions can change based on the current situation. The current situation in policy making can change decisions and actions. Media and politics, for example, can claim a topic of importance which can influence the agenda of a policymaker. Therefore, an agent assesses the current situation in order to make the (best possible) decision. These decisions lead to actions and depending on what kind of action if the action is an **ActionEvent** or **Non-ActionEvent**. An **ActionEvent** is a thing done or an act that other agents can observe. However, there are also events which are not created by actions such as events created by natural forces, the **Non-ActionEvents**. The **ActionEvents** can be divided into events where there is only communication and an event where actions take place, the **CommunicationActionEvent** and **Non-CommunicationActionEvent**.

## 6.4 Overlaps, differences and similarities

The meta-models of the business process modelling method and agent-based modelling method give a clear understanding of the semantics of the two approaches. It is now possible to see their overlaps, differences and similarities. Concepts that overlap are spare, there are only two concepts that have similar meanings in both methods. Table 4 shows that the concepts **FlowObjectContainer(Actor)** and the sub-concept **Pool** from the business process modelling method and the concept **Agent** with its sub-concepts **BiologicalAgent**, **InstitutionalAgent** and **ArtificialAgent** from the agent-based model method are similar. Both concepts and their sub-concepts represent a participant in an action or process. The **Activity** concept and the **Action** concept represent a thing that a person or group does or has done. Both also represent different ways in which the activity or action can be performed. Business process modelling distinguishes between tasks and sub-processes and how they can be carried out, and agent-based model also provides several options for executing a action.

	Concept BPM				Concept ABM		
<b>FlowObjectContainer(Actor)</b>	Pool	BlackBox WhiteBox		<b>Agent</b>	BiologicalAgent InstitutionalAgent ArtificialAgent	SoftwareAgent Robot EmbeddedSystem	
<b>Activity</b>	Task	Manual Automatic Semi-Automic None		<b>Actions</b>	Non-ActionEvent ActionEvent	CommunicationActionEvent Non-CommunicationActionEvent	Atomic Sequence Alternative Loop
	Sub-process	Reusable Embedded	NoneEventSubProcess EventSubProcess				

Table 4: The similar concept in business process modelling and agent-based modelling.

Because both methods are so different and only match on, what we could call, their core concepts, this led us to believe that the methods are good additions to each other. Business process modelling can properly map the process and the associated choices, but has difficulty presenting larger groups of actors due to the lane and pool construction. Whereas agent-based modelling can offer added value by presenting larger groups of agents and their interaction.

### 6.4.1 Benefits ABM

**Realism** The benefit of using agent-based modelling is that whether you are describing how an organization works or how the stock market works, agent-based modelling makes the model seem closer to reality. It is more natural to describe the behaviour of farmers and why they are late with their tax returns than to come up with the equations that govern the dynamics of the farmers.

**Governmental data** Agent-based modelling could also help to realize the full potential of the data the government may have about the society: panel data and surveys provide information about what real people actually do and could lead to great models.

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### 6.4.2 Challenges ABM

**Parameters** To build an agent-based model, one needs to specify a few things such as the types of agents that matter, as we have done in the case study, and the behavioural/interaction rules between those agents. So, one needs to have a pretty good idea about these two things in order to build a useful model, which can be time consuming. Selecting the adequate number of parameters, features, and behaviours to include in the model can be challenging, both on the practical and the theoretical level. In practical terms, integrating a large amount of details will make programming the model more challenging. However, even if the scientist overcomes this hurdle, a model with a large number of parameters will be of limited theoretical value. One reason for this is the so-called “curse of dimensionality”: increasing the variables integrated in the model decreases the number of observations per cell.

**Understanding** Agent-based modelling is not mainstream yet. There’s a problem of acceptance and understanding, in both motivational and cognitive ways. So, even if you build a great model, only a limited number of people are going to be receptive to it right away. This is why research should be focused on forming a standardised protocol, framework or model that helps to create agent-based models.

### 6.4.3 Benefits BPM

**Communication** Whereas we see that agent-based modelling is not yet mainstream, business process modelling is a fundamental pre-requisite for organisations wishing to engage in business process improvement (Indulska, Green, et al. 2009b). Research points out that on an organisational level, business process modelling is used to communicate and create understanding inside and organisation about their processes. It has benefits such as improved transparency or visualisation for management. Participants of the case studies also pointed out that the descriptions of their processes and the description of the people involved are for them valuable documentation that can be used to learn from the choices made.

**Re-use** Business process modelling can help to communicate your process, but it is also a way to understanding the existing processes and change them for improved performance. This is especially attractive for evaluations such in the manure case. It helps to identifying bottlenecks and inefficiencies in the process.

**Knowledge** Formalize existing processes may also help with “informal knowledge”. When formalizing processes, actors need to think about everything they do and use that helps to develop a policy. It helps to capture knowledge that is not written down but that is important.

### 6.4.4 Challenges BPM

**Synergy** As indicated in Chapter 2, there are a lot of techniques and languages that belong to business process modelling. The standardization of process modelling appears to be top on the agenda for process modelling stakeholders (Indulska, Recker, et al. 2009) and is still seen as a challenge. Since process modelling takes place in the context of enterprise architectures, human resource capacity planning, project management, knowledge management, document management, and relationship management and so on. An organisation should be on the lookout for a lack of synergy. In practice, many organisations are modelling the same process independent from each other for different purposes with different organisational groups.

**Dynamic situation** To support a dynamic situation, processes should be defined and implemented in such a way that they can be supplements to, or even overhauled on any moment by direct process owners. This is often not feasible in organisations and makes applying dynamic business process modelling not possible.

### 6.4.5 Combined challenges

For both methods, the challenge of creating a complete model is important. In a business process modelling, the modeller may have missed nodes such as business tasks, gateways, events and data objects, as well as missed connections. This loss affects the semantic completeness of the model. This threat also applies to agent-based modelling, miss an agent and the semantic completeness of

the model is affected. Not only is the completeness of the model of importance, the understandability is also a factor that decides if a model is used in the right way. The enhancement of the understandability is also a factor of a model is a challenge given that poor understandability of the model can lead to a wrong conclusion.

## 6.5 Use of BPM and ABM in policy development

Because we better understand where and when business process modelling and agent based modelling come into their own or can be applied, it is possible to plot the two methods on the in Chapter 5 described policy development process. Figure 36 shows where in the process business process modelling and agent-based modelling could possibly be applied. The upper process is the main process. The lower process represents the sub-process of the activity formulating policy. The activity "analysis the data in accordance with the framework" also has its own sub-process as described in section 4.4 this part of the process is not presented here.

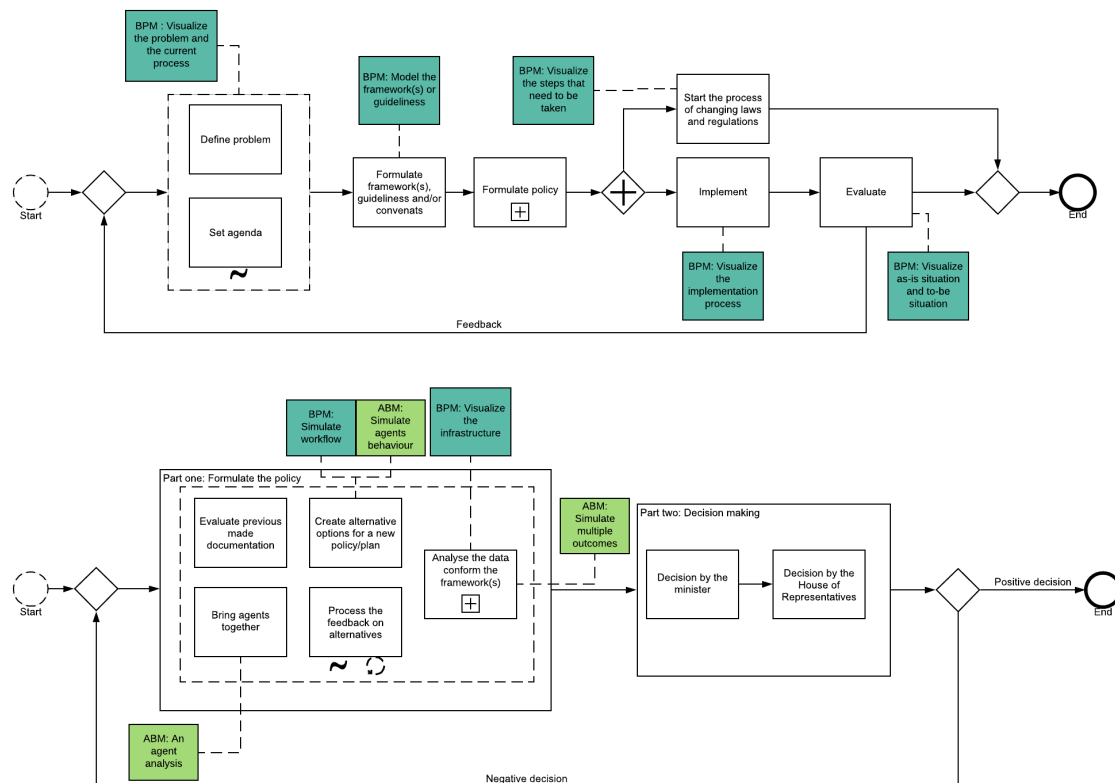


Figure 36: Applying business process modelling and agent based modelling in the policy development process and the sub-process.

When a policy maker defines the problem and sets the agenda the urgency, context, and political importance of the problem is made clearer. The reasons for a new or changing policy can differ from a coalition agreement, a commitment of the House of Representatives or research and evaluation reports. Business process modelling can help in this first phase to structure the process of how such a process should be tackled. After formulating the problem, the policy-makers analyse which parties are involved in the problem. At the moment, this sometimes done through a force field analysis, in which is indicated which party is involved in which part of the process. Agent-based modelling could further help with this by also investigating the underlying relationships and the interests of the parties. A covenant or framework for cooperation is often drawn up and signed by the participating parties after this.

Once the right parties have formed a cooperation agreement, consideration can be given to the policy objectives (the desired situation or behaviour). Instruments, evaluations and previously formulated documents are evaluated to see whether these have added value for the new policy and can be used. Various alternatives are formulated for the policy and these are tested by the

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affiliated parties that provide feedback, but also provide their perception. Agent-based modelling can support in forming an agent analysis, but also by testing and simulating behaviour for example. To support and test the formulated policy proposal, policy-makers can perform data analyses and, if necessary, adjust the policy based on the results. With these data analyses, business process modelling can primarily help to map all the data and infrastructure needed to test the proposals. The activity "analyse the data conform the framework(s)" refers here also to the sub-process described in 4.4. In addition, agent-based modelling can help simulate different outcomes to arrive at the most favorable outcome.

The formulated policy contains topics such as the problem formulation, the policy itself formulated within the national and international legal frameworks, the expected effectiveness of the policy, the feasibility and how the policy should be implemented. The policy must also be evaluated and by properly mapping out the "ex ante" or evaluation, you can make a well-considered decision with regard to proposed regulations. In this context, policy officers should think of different types of consequences such as consequences for citizens, companies and government. But as we mentioned earlier, there are also external influences that can influence policy formulation. These factors must now also be taken into account. New policies and regulations can have consequences for these factors. Such as the environment, technology or the economy. Agent-based modelling can play a role in researching the consequences, by visualizing different scenarios that test the consequences of the policy.

All these subjects together lead to a definitive policy proposal, which must be approved by the Ministers and the House of Representatives. After approval, the process to adjust the laws and regulations is started. At this moment, is there no process description within the Ministries on how laws and regulations are changed. With business process modelling, could this process be mapped. In parallel measures are now being taken to implement the policy. Each implementation is different due to context of a policy, therefore business process modelling could help with planning of the implementation. The evaluation should be well described in the policy during the policy development. During the evaluation, all the described measures and ways to test the policy must now be executed. With business process modelling a model could be made of all the activities during the evaluation and which agent is involved.

## Chapter 7

# Conclusion and discussion

To conclude this work, it is important to reflect on the initial research question formulated in the introduction. The question was: *"Can a combined approach of BPM and ABM give us better insight into the process, agents and data around policy development?"* The research sub-questions helped to establish a direction for the research performed in this thesis. These questions are answered here in section 7.1. Section 7.2 discusses the limitations of this research and in section 7.3 the report is finally concluded with a section that discusses future research.

### 7.1 Answer to research questions

#### **What are the current processes and methods used in the ministries with respect to policy development?**

There are several theories that could describe policy development. Some of these are based on an analytical vision and others focus more on the role of politics in policy development. How policy is made in practice is somewhere in the middle of these two visions and the theories such as the phase model, stream model and ACF. The use of different processes and methods does not play a major role in policy development. There is no policy process description available in the Ministries and the various theories and methods developed to explain policy making are not intentionally used or applied. For example, the policy cycle or phase model is known to every policy maker we have spoken with, but it is mainly used to communicate about policy development to other people. The policy-makers indicate that policy depends more on politics than people think. They continuously move with the political agenda.

When it comes to practical documents used by policy-makers, there are a number of frameworks and guidelines that assist policy-makers to develop policies, but those are *"used more as a checklist"* according to policy-makers (2019). The IAK is an example of this. This framework consists of three phases: problem analysis, choice of intervention and impact assessment. In these phases the policy-makers answer questions to properly formulate the policy. Policy-makers always know how to formulate these answers, but that is not because they apply the framework so well in their work. In addition to the IAK, there is a second set of guidelines that help shape policy in the field of quality and evaluation. The IAK does not explain the quality and evaluation part of developing a policy in detail. So, in addition, a policy guide for quality and evaluation has been drawn up for the policy staff. It supports policy-makers in describing the evaluation of a policy. There are guidelines and methods in place for policy-makers, but the interviews pointed out that they are rarely used in the way they are intended.

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## How would an approach with a combination of business process modelling and agent-based modelling for policy development look like?

Combining business process modelling and agent-based modelling is difficult to implement in practice. Business process modelling is a method that is well documented and for which many literature or practical frameworks have been written. Business process modelling has many different techniques and languages that enable business users to model their business processes, implement and execute those models and refine the models based on as-executed data. All these techniques and languages have their own pros and cons and are suitable for other purposes. This gives the user the opportunity to choose the most suitable technique or language for their purpose. In the two different case studies, we see that a business process models can be made from interviews and company documentation that reflect the development of policy. A time schedule can be linked to the description of these processes and a description about the use of information, data and ICT within the process. Because the process has to do with so many different actors, it is not possible to visualize the different actors in the process drawings, but here agent-based modelling could play a role.

The literature about agent-based modelling is much less focused on describing the different frameworks and methods to form agent-based models. The literature focuses primarily on applying agent-based models in various fields and how to simulate the model. There is a gap in literature that describes how an agent-based model is made on a conceptual level. There are some frameworks and methods, but those are based on case studies and not on a general conceptualisation of agent-based models. Since the frameworks and methods are not that well documented, the description of agent-based models varies greatly. This makes it harder for user to compare and re-use models. That is why in our case study we decided to describe the interaction between agents and their perceptions in text and focus on creating a meta-model as part of our framework. This framework consists of two parts:

1. A meta-model that is independent of technique and language, for business process modelling and;
2. A meta-model for agent-based modelling which describes the most important concepts that should occur in an agent-based model.

These two meta-models were compared with each other based on their concepts. This comparison showed that on the basis of two concepts: *Actor* and *Agent*, and *Activity* and *Actions*. These methods have an overlap. Both concepts and their sub-concepts represent a participant in an action or process. The *Activity* concept and the *Action* concept represent a thing that a person or group does or has done. Both also represent different ways in which the activity or action can be performed. Business process modelling distinguishes between tasks and sub-processes and how they can be carried out, and agent-based model also provides several options for executing an action. The rest of the meta-model concepts are different for both models and have another focus. The meta-model for business process modelling represents concepts that help to properly map the process and the associated choices, but has difficulty with presenting larger groups of actors due to the lane and pool construction. Whereas agent-based modelling can offer added value by presenting larger groups of agents and their interaction, because the concepts are focused on this.

The methods both have their benefits and challenges, the modeller should take this in to consideration. For agent-based modelling, the benefits are the *realism* of the model and the potential it provides for the use of *government data*. Challenges of applying agent-based models are to describe and select the adequate number of *parameters*, features, and behaviours to include in the model. *Understanding* an agent-based model in both motivational and cognitive ways is also a challenge.

For business-process modelling, the benefit of using business-process models lies mainly in communication, re-use and knowledge. Business process modelling is used to *communicate* and create understanding inside and organisation about their processes. But it is also a way to understand the existing processes and *re-use* and change them for improved performance. The modelling process forces users to critically think about their actions and decisions, so it is also a way to capture "informal knowledge", *knowledge* that is not written down but which is important for the business process. The challenge in using business process modelling is that *synergy* is often lost out of sight. In practice, many organisations are modelling the same process independent from each other for different purposes with different organisational groups.



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## How can a framework based on business process modelling and agent-based modelling be used in practice according to the stakeholders?

The use of business process modelling and agent-based modelling lies mainly in the combined application of the methods. In the policy process, the methods together or individually work best at different places in the process. For each activity within the process, which method can help with the policy development has been mapped.

**Defining the problem and agenda setting:** Business process modelling can help in this first phase to structure the process on how such a problem definition should be tackled and which steps should be made to set the agenda.

**Formulating a framework or covenant:** After formulating the problem, the policy-makers analyse which parties are involved in the problem and bring them together. A covenant or framework for cooperation is often drawn up and signed by the participating parties. Agent-based modelling can help to describe the relations between the agents.

**Evaluating previous documentation:** Instruments and previously formulated documents are evaluated to see whether these have added value for the new policy and can be used. In this activity, we see no added value in using business process modelling or agent-based modelling.

**Alternatives:** Various alternatives are formulated for the policy and these are tested by the affiliated parties that provide feedback, but also provide their perception. Agent-based modelling can support in forming an agent analysis, but also by testing and simulating behaviour, for example.

**Data analysis:** To support and test the formulated policy proposal, policy-makers can perform data analyses and, if necessary, adjust the policy based on the results. With these data analyses, business process modelling can primarily help to map all the data and infrastructure needed to test the proposals. In addition, agent-based modelling can help to model or simulate different outcomes to arrive at the most favorable outcome.

**Bring agents together:** With agent-based modelling it is possible to do an agent analysis which would be a little more elaborate than the force analysis policy-makers now perform.

**Processing feedback:** During the feedback process is it not necessary to use either on of the methods.

**Changing current laws and regulations:** At this moment, is there no process description within the Ministries on how laws and regulations are changed. With business process modelling, could this process be mapped.

**Implementation:** Each implementation is different due to context of a policy, therefore business process modelling could help with planning of the implementation.

**Evaluation:** During the evaluation, all the described measures and ways to test the policy must now be executed. With business process modelling a model could be made of all the activities during the evaluation and which agent is involved.

## Can a combined approach of business process modelling and agent-based modelling give us better insight into the process, agents and data around policy development?

A combination of both methods have helped with understanding the policy development process. Both methods have played a different role in making the policy process easier to understand.

Business process modelling has contributed a lot to clarifying the policy development process and the documentation that is used. Due to interviews that were part of the case studies, was it possible to visualise the policy development process into a business process model from both case studies. The use of data within the policy process could only be visualized for one of the two policy processes that we investigated. The reason for this is because this policy was deliberately concerned with the use of data and had established a written process for it. The other policy relied very much on other organisations to provide the right data and information.

Agent-based modelling contributed a lot to recording the behaviour and interactions of the agents that are part of the policy development process. The difficulty here lies in to translating

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these perceptions and interactions into a simple agent-based model, since there is little literature available that explains on a conceptual level how agent-based models should be visualized.

It has, however, been possible to compare the two case studies in order to be able to make more generalized statements about what the policy process looks like, which categories of agents appear in both cases and how data is used.

Precisely because our research revealed that there is almost no literature for conceptual modelling of agents, the research ultimately also focused on designing a meta-model for business process modelling and agent-based modelling, so that in the future an agent-based model can be created in a simple way.

## 7.2 Limitations

Due to the nature of the research questions and the limited amount of literature on the combination of business process modelling and agent-based modelling, this research is mainly exploratory and does it not yield any statistically significant results. While the case studies were rigorously executed and validated, the results are limited to the case study sample size. It is therefore hard to say, considering the two case studies that have been done, if the produced generalises policy process also applies to other Ministries and other policy domains. Recommended is to also apply the results to other policy fields and Ministries.

As the saying goes, "No two people are the same". They differ along a wide range of factors, such in age, behaviour, gender, height, intelligence, and so forth. Eliminating such individual difference is not possible, but they do need to be taken into account. That is why we choose to stick with participants that had the same type of functions to interview about the policy development. During the case study, it is possible that the subjects' responses and behaviour may impose a threat to construct validity as they might respond differently in an attempt to perform better to please the case study which can affect the outcome of the case study.

Another limitation is that we deliberately did not research the influence of policies that are linked to the chosen policies. This has been kept out of scope due to time constraints.

## 7.3 Future work

Although we consider that the goal of the thesis has been accomplished, there are plenty of improvements that could be done in order to achieve better results. In the following sections we present, for each of the three fields policy development, business process modelling and agent-based modelling some of the open issues that deserve further research. There have been several studies focusing on business process modelling conceptualisation and standardisation in recent years. Formulating a method or framework for agent-based modelling has also gained attention. However, this is the first study to our knowledge to combine the two interest fields, with case studies and in the field of policy development.

In future research, validating the general policy development process is important. Executing more case studies on different policies could provide us with an even better understanding of the policy development process. These case studies can be an extension of this research and used for the further development of the policy process. This validation, while useful, might be time consuming. The question whether this is feasible is up to the Ministries.

Moreover, it will be interesting to look at other policies and the process of these policies in other Ministries to compare the policy development process. In this way, threats regarding both the external validity and internal validity of this research can be solved. Another interesting topic for research into policy development is how different types of policy influence each other.

Regarding the application of business process modelling, future research could provide a more detailed policy process. This was not possible for us due to time constraints, and the availability of interviewees.

Regarding the conceptualising of agent-based modelling is it important in the future to further develop the methods and frameworks that describe the forming of agent-based models. In addition, there should be more focus on conceptualizing and standardisation of the methods.

# Appendix A

## Case study protocol

The Ministries have been working for some time on improving the use of data, information and ICT in the policy development process. To do this a solid understanding of the policy development process is needed. There are multiple theories about how policy is developed but does this reflect the practice at the Ministries? Literature shows that the social context of a policy a big influence on how a policy is developed. The social context can cause a development of a policy to be beyond complex or really simple. Understanding the social context and in particular its actors combined with knowledge about the process can provide us with better insight into the data challenge.

### A.1 Motivation

There are multiple reasons to perform the case study at the Ministries. To begin with, literature describing the policy cycle and its phases can be found in abundance. But so far, no case study is found on how policy is in practice developed inside the Ministries. This case study would provide the Ministries with a different view on how policy is developed in practice. This could help to define measures to improve the process and make policy-making more efficient. Secondly, I wish to describe the policy process as a whole and look at the influence of the actors on the process. Thirdly, is it important for the Ministries to figure out where data could have added value into the process. Data could help the decision-making process during the forming of policy. The Ministries allows us to do research into the manure dossiers that forms policy on manure in the Netherlands. The manure policy in the Netherlands is based on the European Nitrates Directive. In the European Union agreements have been made about the amount of nitrate that is allowed in the ground and surface water. In order to meet the Nitrates Directive objective, measures have been taken over the years in the form of nitrate action programs. These Dutch programs describe measures for 4 years concerning the protection of waters against pollution caused by nitrates from agricultural sources. The completion of the fifth action program and start of the sixth program gives us the change to research the development of these policies and how the process, actors and ICT congregate. We collect data from different sources:

- Interviews – To design a model of the development of the policy, interviews will be held with policy-makers that were involved in developing the policy. In the case study data is collected mainly through interviews, i.e. a first-degree method.
- Archival records study – Another method to collect data is to independently review existing artifacts such as documents that describe the policy development process. This data is complemented with second- or third-degree data, e.g. process models. Many of the official documents that are milestones in forming a policy can be found in the document management system of the Ministries. These documents give us an in-depth and detailed view of the policy dossier.
- Direct observations – Since the case study was performed at the Ministries, I will be able to directly observe and document day to day operations.
- Physical artifacts - Physical artifacts could be any physical evidence that might be gathered during the case study. This might include tools, artworks, notebooks, computer output, and other such physical evidence. The choice of looking into these sources comes from a study of

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Yin Yin (1994) who determines six sources of reliable data for a case study. The sources do not have a complete advantage over the other: rather, they are complementary and will be used in tandem.

## A.2 Validity

To validate the outcome of the research, some countermeasures were taken. The interviews will consist of two sessions, one that holds the interview and the second session will be used to cross-reference findings and documentation. Besides these reviews, we also create a case study protocol. To ensure reliability, the case study report will be reviewed by key informants. Documents that will be reviewed could be letters, memorandum, agendas, study reports, or any items that could add to the study. The validity of the documents should be carefully reviewed so as to avoid incorrect data being included in the study. Archival records could be a useful source since they could store survey data of other research. Direct observation in a case study occurs when the investigator makes a site visit to gather data, since I will be working at the Ministries the observations could be of casual activities, but the reliability of the observation is the main concern. Using multiple observers is one way to guard this problem.

## A.3 Objective

Development of policy can be complex. This is why the case study will focus on one policy dossier. To get to the description of the policy development, interviews will be held. During these interviews, researchers and policy-makers will discuss the policy process and user data, information and ICT during the process. The objective of the case study is to describe the policy development process. We want to achieve a description of the policy process, with all its:

- The order of activities or tasks
- The most important actors in the policy development process
- Links to other policies and programs
- Resources used during the policy development
- Data, information, ICT or better said the i-component that is used during the development of the policy

## A.4 Research questions

The main questions that need to be answered by the case study are:

- How does the manure policy development process look like from a Business Process perspective?
- Which data, information and ICT is used during the manure policy development process?
- Which actors are involved in the development of the manure policy?

Research into policy modelling represents a new research field according to Estrada and Park (2018). Policy modelling is a powerful tool to explain complex socio-political and economic problems, but as Cairney (2015) points out; advice about policy modelling may find a wide audience in the academic world, but not necessarily much attention from practitioners. The best hope for complexity research into the policy process is to develop a toolkit, method, technique etc. in cooperation with practitioners since that interaction can produce a language common to both audiences. That is why our research question will look into a detailed description of the policy process that describes the actions, information, people and internal influences in cooperation with practitioners.

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## A.5 Subjects

We attempt to understand phenomena through the participants' interpretation of their context. The subjects in the study will mainly be policy-makers. Also, other stakeholders involved in the policy development could be of relevance for the case study, but those are not identified, yet. Other stakeholders could be of relevance because of the different interpretation of the policy development process. We would like to speak to multiple people that worked on the development of the policy. This could be approximately between the 3-5 people. The respondents have been selected based on 2 criteria: First, the submitter must be a policymaker or have another function that shows their involvement in the policy and can answer each question. Secondly, the submitter needs to be involved in at least 2 or more phases of the policy development otherwise will it be hard to link the multiple stages of the policy development. The respondents have been approached by e-mail twice. The invitation email describes the research in short and the criteria for participating.

## A.6 Interview

The interview will be semi-structured. A list of questions will be prepared but, additional questions can be asked when necessary. Open-ended interviews as recommended by Zainal (2007) to expand the depth of data gathering and to increase the number of sources of information. The interviews will be conducted according to the interviewee's schedule and availability, as suggested by Feagin, Orum, and Sjoberg (1991). The interview should be divided into a number of phases. First, we would present the objectives of the interview and the case study and explains how the data from the interview will be used. Then a set of introductory questions are asked about the background of the interviewee, background of the subject, which is relatively simple to answer. After the introduction come the main interview questions, which take up the largest part of the interview. It would look like the following: *Good afternoon and welcome to our session. Thanks for taking the time to join us to talk about policy development. My name is Suzanne van Poelgeest. I am with the University of Utrecht. I am looking into an iterative way of policy development and how data, information, and ICT can be used more effectively and efficiently within the process. The goal of this interview is to get a perception on how the policy development process looks now and what your needs are towards this process. I want to know what the characteristics are of a typical policy-making process, what you like, what you don't like, and how the process might be improved. We are having discussions like this with several groups based on their function within the company. You were invited because your function bring you in some extension in contact with policy development. So, you're familiar with the process. There are no wrong answers but rather different points of view in this interview. Please feel free to share your point of view even if it differs from others. Keep in mind that we're just as interested in negative comments as positive comments, and at times the negative comments are the most helpful. You've probably noticed the microphone. We're tape recording the session because we don't want to miss any of your comments. People often say very helpful things in these discussions and we can't write fast enough to get them all down. We will be on a first name basis today, and we won't use any names in our reports. You may be assured of complete confidentiality. Well, let's begin.*

Category	Questions
Global	<p>Social context</p> <ol style="list-style-type: none"> <li>1. What is the goal of the manure policy?</li> <li>2. What was the cause of forming the manure policy?</li> <li>3. What is the longer-term vision for the policy?</li> </ol>
Global	<p>The process</p> <ol style="list-style-type: none"> <li>1. What do you think about the current policy development process?</li> <li>2. How do you feel about the alignment of data, information and ICT into the policy development process?</li> </ol>
Global	<p>Successes</p> <ol style="list-style-type: none"> <li>1. If you think back about all the policies that have been designed in the last years, which development process could you describe as a successful or not successful and why?</li> <li>2. Why is this case not successful? What needs improvement to make this case a success story?</li> <li>3. Why were other cases successful and this one not?</li> </ol>
Actors	<p>Roles</p> <ol style="list-style-type: none"> <li>1. What is your role in the development of policy?</li> <li>2. Is there a clear description of your function/role on your involvement in developing policy?</li> <li>3. To what extent were you involved in developing policy?</li> <li>4. Could you mention a number of roles that contribute to the development of policy? (policy staff, lawyers, researcher)</li> <li>5. What are the responsibilities of these other roles in policy development?</li> <li>6. What are the roles that most interact with each other when developing policies?</li> <li>7. What role do external parties such as politics, citizens, media and pressure groups play in policy development?</li> <li>8. Which people / functions are most important in policy development? Or would you say that all roles are equally important?</li> <li>9. Are there people or positions involved in developing policy that representing a group?</li> <li>10. Are there people who represent multiple roles during policy development?</li> <li>11. What role does politics play in policy development?</li> <li>12. What kind of relationship exists between the actors who develops policy and the actors who have to deal with the consequences of the policy?</li> </ol>

Actors	Decisions
	<ol style="list-style-type: none"> <li>1. Are there fixed decision moments during the development of policy? (Who makes the decision? And why?)</li> <li>2. Is a decision about policy based on consensus or unanimity?</li> <li>3. Is there a division of roles that tells who is responsible for which part of the policy? (A researcher for research, lawyer must supply legal matters, etc.)</li> <li>4. Are there sanctions or interventions if the person responsible does not fulfill his/her duties?</li> </ol>
Process	Steps
	<ol style="list-style-type: none"> <li>1. Can you describe in general how you see the process of developing policy??</li> <li>2. What are the activities or tasks?</li> <li>3. Who are the most important actors?</li> <li>4. What kind of resources are used?</li> <li>5. What kind of data, information and ICT is important during development?</li> <li>6. What for information is used to form policy? (Legal documents? Studies that support policy?)</li> <li>7. What are the steps that return with every developed policy?</li> </ol>
Process	Formalization
	<ol style="list-style-type: none"> <li>1. Is the process of developing policy documented? (In there a model? Or a manual? A framework?)</li> <li>2. Are there guidelines that formalize the policy process? (Are these guidelines used?)</li> </ol>
Process	Evaluation
	<ol style="list-style-type: none"> <li>1. Are there regular feedback mechanisms in the process of developing policy?</li> <li>2. Is the development of policy sufficiently flexible? And will it be adjusted if there is a reason to do so?</li> <li>3. Is there an interim evaluation of the policy?</li> </ol>
Process	Planning
	<ol style="list-style-type: none"> <li>1. Is there a time planning used in the development of policy?</li> <li>2. How much time is needed for each step or phase of the policy process?</li> <li>3. What are the most important decision moments and intermediate products?</li> <li>4. How is the time schedule monitored?</li> </ol>

Process	<p>Communication</p> <ol style="list-style-type: none"> <li>1. What is the most suitable and optimal means of communication during policy development?</li> <li>2. Which means of communication are used and in which phase?</li> <li>3. Will everyone involved in the process be informed on time, about deadlines, etc.?</li> </ol>
Information	<p>Information</p> <ol style="list-style-type: none"> <li>1. Is information well distributed, internal and external?</li> <li>2. Which information is important in the manure policy?</li> <li>3. How is knowledge and information modeled and visualized?</li> <li>4. How is the information and knowledge provision for both the manure policy and the policy process?</li> <li>5. Have mechanisms been created in the process to share and disseminate information, and is there a provision for joint basic knowledge? (Does everyone have access to this information?)</li> </ol>

## A.7 Data

In the case study, documents, archival data and physical artifacts could be a major source of information. A policy development process will be studied. This policy is developed prior to the study, which meant that the data from this project was analyzed in retrospect. We will study process models as well as project specifications and reports. Most of the data can be found internally at the "Rijksportaal" or in the document management system (DoMus). Another source of information is the interviews. The interviews will be recorded so it can be used for further data analysis in Nvivo 12. The interviews will be transcribed and encoded in Nvivo and used to analyze and design a policy process model.

## A.8 Validity

The validity threats to the case study are internal and external threats. The internal validity can be threatened by incorrect facts and incorrect results from the interviews or documents. To counter this there will be held two interview session. On sessions to explore and elaborate on the policy process. The second session is to cross-check documentation found in the document management system and to validate the information from the first session. With respect to external validity, a threat is that one policy development dossier does not present all the policies developed. To deal with this a second dossier could be analyzed and compared to the main dossier.

## A.9 Schedule

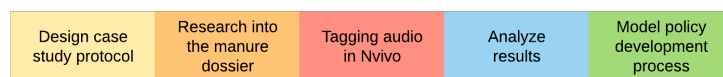


Figure 37: Case study schedule



# Appendix B

## Interaction between agents

### B.1 Interaction manure case

	<b>Committee of Experts Fertilizers Act (CDM)</b>
<b>Ministry of Agriculture, Nature and Food Quality</b>	At the request of the Ministry of Agriculture, Nature and Food Quality, the Committee can perform review(s) of scientific reports on aspects that are important for the Fertilizers Act.
<b>Ministry of Economic Affairs and Climate Policy</b>	The Committee has a formal role in advising the Ministry of Economic Affairs and Climate Policy on scientific issues substantiation of the manure and ammonia policy and about desired adjustments to assumptions, rules, standards, and fixed fees in the Fertilizers Act
<b>RIVM</b>	The Committee reviews the annual report of RIVM on the monitoring and implementation of derogation in the Netherlands.
<b>Team Manure</b>	Farmers must annually share their administration for the Agricultural Census and manure legislation with the RVO. The farmer can also apply for subsidies via RVO.
<b>RVO</b>	The Committee tests substances of co-fermentation materials based on the established protocol of RVO.
<b>NVWA</b>	The Committee answers questions about animal forfits and co-fermentation materials in the context of enforcement of the Fertilizers Act by the NVWA.
<b>WUR</b>	The Committee reviews the annual report of WUR on the monitoring and implementation of derogation in the Netherlands.
	<b>European Union - European Commission</b>
<b>Ministry of Agriculture, Nature and Food Quality</b>	The EU develops rules for all member states. This is translated into national policy per member state. In the field of Agriculture, Nature and Food Quality this is done by the Ministry of Agriculture, Nature and Food Quality.
<b>Ministry of Economic Affairs and Climate Policy</b>	The EU developed rules for all member states. This is translated into national policy per member state. In the area of climate policy, this is done by the Ministry of Economic Affairs and Climate Policy
<b>RVO</b>	The RVO is involved in various European programs. Their advisors give the EU advice when writing a project proposal about subjects such as food quality, climate and air quality and help find cooperation partners

<b>PBL</b>	The PBL carries out research both on its own initiative and at the request of external parties such as the European Commission. They conduct solicited and unsolicited research, independently and scientifically based.
<b>RIVM</b>	The European Union is offered an annual report on agricultural practice and water quality on grassland farms that may apply derogation by the RIVM.

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**Farmers**

<b>Ministry of Agriculture, Nature and Food Quality</b>	The farmers participate in sessions organized by the ministry to discuss the manure policy.
<b>Provinces</b>	Farmers depend on provinces and whether they issue nature permits for business expansion. In addition, they work under the Delta Plan on Agricultural Water Management together with the province and water boards to facilitate agricultural entrepreneurs.
<b>RIVM</b>	Approximately 350-400 farmers participate in the National Monitoring Network for Effects of Manure Policy monitored by the RIVM.
<b>RVO</b>	Farmers must annually share their administration for the Agricultural Census and manure legislation with the RVO. The farmer can also apply for subsidies via RVO.
<b>Water boards</b>	Under the Delta Plan on Agricultural Water Management, provinces and water boards work together to facilitate agricultural entrepreneurs and promote cooperation with the water boards. Among other things by starting area processes and sharing the knowledge and practical experience of other farmers.

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**House of Representatives**

<b>Ministry of Agriculture, Nature and Food Quality</b>	The House of Representatives assess the policies offered by the Ministries. They assess, ask critical questions and give advice about the policies. The House of Representatives debates about policy proposals and pass judgment.
<b>Ministry of Economic Affairs and Climate Policy</b>	The House of Representatives assess the policies offered by the Ministries. They assess, ask critical questions and give advice about the policies. The House of Representatives debates about policy proposals and pass judgment.

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**Interest groups**

<b>House of Representatives</b>	The interest groups have contact with members of the House of Representatives to convince them of their opinion, when they would like to influence the development of the policy.
<b>Ministry of Agriculture, Nature and Food Quality</b>	Interest groups try to put pressure on Ministries to shape policy so that it meets their interests.
<b>Ministry of Economic Affairs and Climate Policy</b>	Interest groups try to put pressure on Ministries to shape policy so that it meets their interests.
<b>Team Manure</b>	Interest groups participate in sessions organized by policymakers to deliver input for the manure policy.

<b>Farmers</b>	Intrest groups represent the interests of farmers in relation to the government policy.
	<b>Ministry of Agriculture, Nature and Food Quality</b>
<b>RVO</b>	The Ministry has outsourced part of the policy implementation to the RVO. Implementation of subsidy schemes and programs and policy support activities (such as policy advice) to RVO.
<b>RIVM</b>	The Ministry has outsourced part of the policy implementation to the RIVM. As a knowledge institute in the field of environmental issues, RIVM carries out policy-preparing and supporting research. In addition, RIVM supports environmental policy with a large number of (often legally established) regular tasks, such as monitoring and reporting obligations and substance assessments.
	<b>Ministry of Economic Affairs and Climate Policy</b>
<b>RVO</b>	The Ministry has outsourced part of the policy implementation to the RVO. Implementation of subsidy schemes and programs and policy support activities (such as policy advice) to RVO.
<b>RIVM</b>	The Ministry has outsourced part of the policy implementation to the RIVM. As a knowledge institute in the field of environmental issues, RIVM carries out policy-preparing and supporting research. In addition, RIVM supports environmental policy with a large number of (often legally established) regular tasks, such as monitoring and reporting obligations and substance assessments.
	<b>Ministry of Infrastructure and Water management</b>
<b>Ministry of Agriculture, Nature and Food Quality</b>	Has a partnership with the Ministry of Agriculture, Nature and Food Quality in the field of air quality
	<b>National Institute for Public Health and the Environment (RIVM)</b>
<b>Farmers</b>	The RIVM collaborates with farmers on project renewals. Such as the program "farmers and neighbors" which will focus on measuring air quality and farmers want more insight into their house emissions and the extent to which this contributes to concentrations in the living environment.
<b>Provinces</b>	RIVM is currently making regional environmental assessments in the field of air quality and noise. In the future RVIM will expand this with greenhouse gas emissions, odor and water quality. They do this in collaboration with the provinces.
<b>CBS</b>	RIVM and CBS are working together on the Compendium for the Living Environment, which is a website with facts and figures about the environment, nature and space in the Netherlands. Often these parties also work together on research.
<b>WUR</b>	Together with WUR, RIVM is mapping out for the government the effects of manure policy on business operations (WUR) and water quality (RIVM) on farm projects.

	<b>Netherlands Environmental Assessment Agency (PBL)</b>
<b>Farmers</b>	PBL collaborates with farmers when necessary for their research reports.
<b>RIVM</b>	The PBL and RIVM work together on the Compendium for the Living Environment, which is a website with facts and figures about the environment, nature and space in the Netherlands. Often these parties also work together on research projects.
<b>CBS</b>	PBL and CBS work together on the Compendium for the Living Environment, which is a website with facts and figures about the environment, nature and space in the Netherlands. Often these parties also work together on research projects.
<b>Team Manure</b>	The PBL answers questions and gives advise to policy-makers when they are developing policy.
<b>WUR</b>	PBL and WUR are working together on the Compendium for the Living Environment, which is a website with facts and figures about the environment, nature and space in the Netherlands. Often these parties also work together on research projects.
	<b>Provinces</b>
<b>Farmers</b>	Provinces and farmers often work together in the field of agricultural innovation and nature conservation.
<b>Interest groups</b>	Provinces often have to deal with interest organisations when decisions are made within the province.
<b>Ministry of Agriculture, Nature and Food Quality</b>	The provinces regulate policy at the regional level and are responsible for translating national policy of the Ministry into regional policy.
<b>Ministry of Economic Affairs and Climate Policy</b>	The provinces regulate policy at the regional level and are responsible for translating national policy of the Ministry into regional policy.
<b>Water boards</b>	Under the Delta Plan on Agricultural Water Management, provinces and water boards work together to facilitate agricultural entrepreneurs and promote cooperation with the water boards. Among other things by starting area processes and sharing the knowledge and practical experience of other farmers.
	<b>Statistics Netherlands (CBS)</b>
<b>Ministry of Economic Affairs and Climate Policy</b>	The CBS performs the annual calculation of ammonia emissions from agriculture-using for the Ministry.
<b>PBL</b>	CBS and PBL are working together on the Compendium for the Living Environment, which is a website with facts and figures about the environment, nature and space in the Netherlands. Often these parties also work together on research projects.
<b>Team Manure</b>	It is important that policy-makers are supported in their work with the necessary data and insights. They often have to be produced in a targeted manner and CBS helps with this.

<b>WUR</b>	CBS and WUR work together on the Compendium for the Living Environment, which is a website with facts and figures about the environment, nature and space in the Netherlands. Often these parties also work together on research projects.
<b>RIVM</b>	CBS and RIVM work together on the Compendium for the Living Environment, which is a website with facts and figures about the environment, nature and space in the Netherlands. Often these parties also work together on research projects.
	<b>Supporting departments</b>
<b>Team manure</b>	Supports the manure team in collecting data, information and insights to develop the manure policy.
	<b>Team Manure</b>
<b>European Union - European Commission</b>	The team has consultations with the European Commission about policy the policy and the alternatives for the policy. This is necessary since the EC approves the policy or not.
<b>House of Representatives</b>	Questions to the minister from the House of Representatives are answered by the manure team. The manure team supports the minister in answering question posed by the House or Representatives.
<b>Supporting departments</b>	Supports the manure team in gaining insights about finance, legislation etc. that relates to the policy.
<b>RVO</b>	The manure team consults with RVO about policy and the feasibility of policy enforcement, while they are developing different alternatives for the policy.
<b>Interest groups</b>	The manure team organizes that interest groups provide input for the policy.
<b>Farmers</b>	The manure team involves farmers in policy development if applicable, this is done through meetings but also surveys.
<b>WUR</b>	The manure team asks the WUR for necessary data and insights to develop policy.
<b>PBL</b>	When developing a new policy, policy-makers make use of the evaluation about manure from PBL.
<b>RIVM</b>	The manure team asks RIVM for data, information and advice about manure in order to form the policy.
<b>CBS</b>	It is important that policy-makers are supported in their work with the necessary data and insights. They often have to be produced in a targeted manner and CBS helps with this.
	<b>Netherlands Commission for Environmental Assessment (NCEA)</b>
<b>Ministry of Agriculture, Nature and Food Quality</b>	The The Netherlands Commission for Environmental Assessment advises on the content of environmental impact reports. An environmental impact report maps out the environmental impact of a project before the Ministry takes a decision.
<b>Ministry of Economic Affairs and Climate Policy</b>	The The Netherlands Commission for Environmental Assessment advises on the content of environmental impact reports. An environmental impact report maps out the environmental impact of a project before the Ministry takes a decision.

	<b>The Netherlands Enterprise Agency (RVO)</b>
<b>European Union - European Commission</b>	The RVO is involved in various European programs. RVO advisors give advice when writing a project proposal and can help with find cooperation partners.
<b>Ministry of Agriculture, Nature and Food Quality</b>	RVO is partly responsible for implementing the manure policy. Implementation of subsidy schemes and programs and policy support activities. This is outsourced by the Ministry.
<b>NVWA</b>	The RVO serves as an advisory body for policy staff for manure to test whether the policy is enforceable. Together with NVWA, the RVO monitors compliance with the government's manure policy.
<b>Farmers</b>	The RVO monitors the annual administration of the farmers. They also provide subsidies to farmers.
<b>CDM</b>	RVO gives the CMD the task of testing substances and co-fermentation materials.
	<b>The Netherlands Food and Consumer Product Safety Authority (NVWA)</b>
<b>Team manure</b>	NVWA supports the manure team in answering questions and produces the necessary data and insights that are needed.
<b>RVO</b>	Together with RVO, the NVWA monitors the farmers compliance of the government's manure policy.
	<b>Wageningen University (WUR)</b>
<b>European Union - European Commission</b>	WUR is very active in the various research programs and a valued discussion partner for policy regarding research, agriculture, food, nature, fisheries and the environment specifically circular economy for the European Commission.
<b>CMD</b>	Delivers an annual report about the monitoring and implementation of the derogation in the Netherlands, this report is evaluated by the CMD.
<b>RIVM</b>	Together with RIVM, WUR is mapping out for the government the effects of manure policy on business operations (WUR) and water quality (RIVM) on farms.
<b>PBL</b>	WUR and PBL are working together on the Compendium for the Living Environment, which is a website with facts and figures about the environment, nature and space in the Netherlands. Often these parties also work together on research projects.
	<b>Water boards</b>
<b>Farmers and Provinces</b>	Under the Delta Plan on Agricultural Water Management, provinces and water boards work together to facilitate agricultural entrepreneurs and promote cooperation with the water boards. Among other things by starting area processes and sharing the knowledge and practical experience of other farmers.

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## B.2 Interaction undermining crime case

	<b>ICTU</b>
<b>Ministry of Justice and Security</b>	The ministry is the client of the ICTU foundation.
<b>Ministry of Interior and Kingdom Relations</b>	The ministry is the client of the ICTU foundation.
<b>Ministry of Finance</b>	The ministry is the client of the ICTU foundation.
<b>Municipalities</b>	ICTU helps with managing municipality projects.
	<b>Local companies</b>
<b>Municipalities</b>	Local companies and the municipalities coordinate about expertise and data that is needed to solve the formulates questions for data analyses.
	<b>Kadaster</b>
<b>Statistics Netherlands (CBS)</b>	The Statistics Netherlands coordinates with Kadaster about real estate fraud. The Kadaster has shared 6 billion data with the CBS to research real estate fraud.
	<b>Kamer van Koophandel</b>
<b>Statistics Netherlands (CBS)</b>	The Statistics Netherlands has received a lot of data from the Kamer van Koophandel out of their "Handelsregister".

	<b>Ministry of Finance / Belastingdienst</b>
<b>ICTU</b>	The Ministry has appointed ICTU, together with the other Ministries, as project manager that coordinates the City Deal "View of Undermining".
<b>Ministry of Interior and Kingdom Relations</b>	The ministry is the client of the ICTU foundation. The Ministry of Finance also works together with the Ministry of the Interior and Kingdom Relations on formulating frameworks and help with the coordination of the municipal projects. In addition, the ministries work together on the administrative decision-making if a problem/data analysis of the CBS shows that bottlenecks can be solved by amending laws and regulations.
<b>Ministry of Justice and Security</b>	The Ministry of Finance works together with the Ministry of Justice and Security on formulating frameworks and help with the coordination of the municipal projects. In addition, the ministries work together on the administrative decision-making if a problem/data analysis of the CBS shows that bottlenecks can be solved by amending laws and regulations.
<b>Municipalities</b>	The Ministry of Finance makes analysis capacity available for the municipalities to use. The capacity is based on which expertise is requested.
<b>Police</b>	The Belastingdienst cooperates with the police on investigations about undermining crime.
<b>Public Prosecutor's Office</b>	The Belastingdienst has an important cooperation relationship with the police and the Public Prosecution Service when it comes to financial investigations. If the Belastingdienst suspect tax fraud, this is submitted to the FIOD-ECD (the investigating authority of the Belastingdienst). The FIOD-ECD can then, in consultation with the Public Prosecution Service and start a criminal investigation.
<b>Regional Information and Expertise Centers</b>	The Belastingdienst work together with the RIECs and other partners on the fight against organized crime, they do this by sharing data and expertise on regional levels.
<b>Statistics Netherlands (CBS)</b>	The Belastingdienst provides data and expertise to the Statistics Netherlands for research.
	<b>Ministry of Justice and Security</b>
<b>ICTU</b>	The Ministry has appointed ICTU, together with the other Ministries, as project manager that coordinates the City Deal "View of Undermining".
<b>Ministry of Finance Belastingdienst</b>	The Ministry of Finance works together with the Ministry of Justice and Security and the Ministry of Interior and Kingdom Relations on formulating frameworks and help with the coordination of the municipal projects. In addition, the ministries work together on the administrative decision-making if a problem/data analysis of the CBS shows that bottlenecks can be solved by amending laws and regulations.








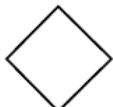

<b>Ministry of Interior and Kingdom Relations</b>	The Ministry of Justice and Security works together with the Ministry of Interior and Kingdom Relations and the Ministry of Finance on formulating frameworks and help with the coordination of the municipal projects. In addition, the ministries work together on the administrative decision-making if a problem/data analysis of the CBS shows that bottlenecks can be solved by amending laws and regulations.
<b>Ministry of Interior and Kingdom Relations</b>	
<b>ICTU</b>	The Ministry has appointed ICTU, together with the other Ministries, as project manager that coordinates the City Deal "View of Undermining".
<b>Ministry of Finance Belastingdienst</b>	The Ministry of Finance works together with the Ministry of Justice and Security and the Ministry of Justice and Security on formulating frameworks and help with the coordination of the municipal projects. In addition, the ministries work together on the administrative decision-making if a problem/data analysis of the CBS shows that bottlenecks can be solved by amending laws and regulations.
<b>Ministry of Justice and Security</b>	The Ministry of Interior and Kingdom Relations works together with the Ministry of Justice and Security and the Ministry of Finance on formulating frameworks and help with the coordination of the municipal projects. In addition, the ministries work together on the administrative decision-making if a problem/data analysis of the CBS shows that bottlenecks can be solved by amending laws and regulations.
<b>Municipalities</b>	
<b>Local companies</b>	The municipalities are continuously in conversation with local companies and whether they can contribute to the project. Local companies often provide data or expertise
<b>Kadaster</b>	The Kadaster has shared 6 billion in data to the project.
<b>Kamer van Koophandel</b>	The Kamer van Koophandel has shared data and expertise about land plots.
<b>Ministry of Finance and the Belastingdienst</b>	Focuses on partnerships with local companies for input of data from relevant parties to the relevant demand Municipalities are mapping out obstacles and solutions that can be input for policy principles and changes to laws and regulations. The Ministry uses this advice for further measures.
<b>Ministry of Interior and Kingdom Relations</b>	Municipalities are mapping out obstacles and solutions that can be input for policy principles and changes to laws and regulations. The Ministry uses this advice for further measures.
<b>Ministry of Justice and Security</b>	Municipalities are mapping out obstacles and solutions that can be input for policy principles and changes to laws and regulations. The Ministry uses this advice for further measures.
<b>Statistics Netherlands</b>	The municipalities and the CBS work together on the data analyses.
<b>Universities</b>	Drawing up the change agenda with the other participating municipalities. The municipalities seek cooperation with universities to be able to use their expertise and legal knowledge in implementation.

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	<b>National Information and Expertise Centers</b>
<b>Municipalities</b>	The NIEC is deployed where necessary to support the municipalities.
	<b>Police</b>
<b>Municipalities</b>	The police offers knowledge of the legislation aimed at the police approach and the provision of capacity and knowledge per municipality. In addition, information can be exchanged on the basis of the Police Data Act to detect criminal offenses, maintain public order and provide emergency assistance.
	<b>Public Prosecutor's Office</b>
<b>Police</b>	The police, together with the Public Prosecutor's Office and other investigative authorities, are responsible for the investigation and prosecution of suspects of criminal offenses. The Public Prosecutor's Office is leading and the police are conducting the investigation.
<b>Municipalities</b>	Use of their expertise in the area of the Judicial and Staff Information Act to form the change agenda in consultation with the municipalities.
<b>CBS</b>	Making relevant data available from the systems, insofar as these have not or cannot be made available by the Statistics Netherlands.
	<b>Regional Information and Expertise Centers</b>
<b>Municipalities</b>	The RIEC is deployed where necessary to support the municipalities.
	<b>Statistics Netherlands (CBS)</b>
<b>Local companies</b>	Local companies provides data and expertise to the municipalities for research.
<b>Kadaster</b>	The Kadaster records the name of the owner or user of a parcel. It also states where the parcel is located, what its dimensions are, what has been paid for and how the land from or near the parcel is used. The Kadaster is therefore a source of information for Statistics Netherlands when it comes to information about plots.
<b>Kamer van Koophandel</b>	The Kamer van Koophandel is an important source of data and is a partner in projects that can improve the business climate for the sake of advocacy, which is why they also share their data with CBS.
<b>Municipalities</b>	Collaborates in consultation with the municipalities on data analysis and makes data and analysis capacity available for this.
	<b>Universities</b>
<b>Municipalities</b>	Universities provide their expertise to municipalities based on the cases, phenomenon or questions.

## Appendix C

# Legend of the business process model

Symbol name	Symbol description	Figure
<b>Task</b>	The most basic level of an activity and cannot be broken down further.	
<b>Ad-hoc</b>	Is a sub-process to mark a segment in which the contained activities can be; executed in any order, executed several times, or skipped.	
<b>Sub-process</b>	Is a group of tasks that fit together particularly well.	
<b>Ad-hoc Loop</b>	An ad-hoc sub-process that iterates sequentially.	
<b>Parallel symbol</b>	Differs from other gateways because it is not dependent on conditions or events. Instead, parallel gateways are used to represent two concurrent tasks in a business flow.	
<b>Gateway</b>	Represents a decision moment.	
<b>Start event</b>	Signals the first step of a process.	


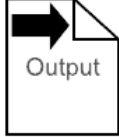
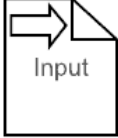
<b>End event</b>	Signals the final step in a process.	
<b>Data output</b>	Demonstrates information produced as the result of a business process.	
<b>Data input</b>	Represents data requirements that tasks in the business process depend on.	

Table 39: Explanation of the symbols used in the business process model

# Appendix D

## Concepts BPM

Aspect		BPM	Concept		
Behavioural aspect	<i>Event</i>	Start			
Behavioural aspect		Intermediate			
Behavioural aspect		End			
Behavioural aspect	<i>GateWay</i>	None			
Behavioural aspect		Complex			
Behavioural aspect		EventBased		ExclusiveEventBased	
Behavioural aspect				ParallelEventBased	
Behavioural aspect			Parallel		
Behavioural aspect			Inclusive		
Behavioural aspect	<i>ConnectingObjects</i>	Exclusive			
Behavioural aspect		SequenceFlow	Default	DefaultCondition	
Behavioural aspect			None		
Behavioural aspect			Conditional	Condition	None
Behavioural aspect					Until
Behavioural aspect					While
Behavioural aspect	Association			Loop	
Behavioural aspect	FlowNode				
Behavioural aspect	<i>CommunicationLink</i>	MessageFlow	Message		
Behavioural aspect		ConversationLink	Conversation	CallConversation	
Behavioural aspect			None		
Behavioural aspect	<i>Output</i>	NonDataObjectOutput	Single		
Behavioural aspect				Collection	
Informational aspect		DataObjectOutput	Single		
Informational aspect			Collection		
Informational aspect	InputSet				
Informational aspect	<i>Input</i>	NonDataObjectInput	Single		
Informational aspect				Collection	
Informational aspect		DataObjectInput	Single		
Informational aspect			Collection		
Informational aspect	OutputSet				
Informational aspect	DataStore				
Organizational aspect	<i>FlowObjectContainer(Actor)</i>	Lane			
Organizational aspect		Pool	BlackBox		
Organizational aspect			WhiteBox		
Functional aspect	<i>Activity</i>	Task	Manual		
Functional aspect				Automatic	
Functional aspect				Semi-Automic	
Functional aspect				None	
Functional aspect			Sub-process	Reusable	
Functional aspect				Embedded	NoneEventSubProcess
Functional aspect					EventSubProcess

Table 40: Concepts of the business process modelling method.

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# Policy development: A framework with Business Process Modelling and Agent-Based Modelling

Suzanne van Poelgeest<sup>[6154972]</sup>

Utrecht University 3584 ED Utrecht, The Netherlands [s.vanpoelgeest@uu.nl](mailto:s.vanpoelgeest@uu.nl)

**Abstract.** Business process modelling and agent-based modelling are two methods that could help to represent a policy development process. This research focuses on exploring if these two methods can give insights into the process, agents and data of a policy development process. The research will be conducted through two case studies at different Ministries. The case studies include interviews with policymakers. The case studies should lead to insights into the policy development process, the agents involved and how data is used and give an answer to the question if business process modelling and agent-based modelling can contribute to these insights.

**Keywords:** Policy development · Business Process Modelling · Agent-Based Modelling · Case studies · Framework · Meta-model

## 1 Introduction

Public policy does not only guide and determine present and future decisions but it is an attempt of an administrative organization, such as the government to purposefully influence a social issue. The link to politics lies in the process by which societies help figure out how to organize and regulate themselves. We are interested in investigating how public policy is actually developed in practice, by exploring if business process modelling and agent-based modelling can give us insights into the process, agents and data. Business process modelling is a way to graphically represent a company's business processes or workflows, as a means of identifying potential improvements. Agent-based modelling is a modelling and computational framework for simulating dynamic processes that involve autonomous agents. Such an agent has behaviours and these behaviours can be described by simple rules, and interaction with other agents.

Subjects during the study are policy makers, project managers and other functions related to the development of policy. For the first case study we interviewed subjects from the The Ministry of Economic Affairs and Climate Policy in collaboration with the Ministry of Agriculture, Nature and Food Quality. The second case study is imitated and performed at the Ministry of Justice and Security in collaboration with the Ministry of the Interior and Kingdom Relations and the Ministry of Finance.

The case studies are designed to answer the knowledge question: *"Can a combined approach of BPM and ABM give us better insight into the process,*

*data and agents around policy development?*”. During the research, the design science method is used. Design science is the design and investigation of artifacts in context. The artifacts of a research are designed to interact with a problem context in order to improve something in that context [1]. The design science method is part of the engineering cycle, that consists of five different steps: problem investigation, treatment design, treatment validation, treatment implementation and implementation evaluation. In a design science project, research is restricted to the first three tasks of the engineering cycle: problem investigation, treatment design, and treatment validation [1]. The problem investigation focuses on what public policy entails and what business process modelling and agent-based modelling is. As a part of treatment design the researcher designed a case study protocol that helps to understand how policy is development in the Ministries and if business process modelling and agent-based modelling can help to sketch an image of the policy development process, with its agents and the surrounding data. Based on the results of the cases studies a framework can be designed that points out when business process modelling and agent-based modelling can be used during the development of a policy. The framework is validated by policymakers. The last two steps of the engineering cycle are not part of this research but would normally focus on implementing the treatment in to practice and would look at the effects are of the implemented treatment. The rest of the paper is organized as follows: The second section discusses related works to the research. The case studies are described in the third section. Section four presents the observations of the of the case studies. The fifth section shows the framework based on the case studies. It discusses the limitations of the research. The sixth section describes the created meta-models. Followed by a conclusion of the research that identifies the most important findings and suggestions of future work.

## 2 Related works

This study revolves around three main subjects; policy development, business process modelling and agent based modelling. Publications about business process modelling and agent-based modelling in professional and scientific journals shows that there is limited amounts of research that makes a link between these two concepts and certainly not in the context of policy development. This section will explain shortly what the three different fields entail.

The first subject of researched is policy development. There is a difference between a policy and a public policy. A policy is often seen as a deliberate system of principles to guide decisions and achieve rational outcomes that are linked to procedure or protocols inside an organisation. The study of public policy is an important part of the field of political science. The link to politics lies in the process by which societies help figure out how to organize an regulate themselves. What makes this “political” is the location in the public sphere. Decisions are made by the public to address issues that affect people in communities. Public policies address problems that are public instead of private. A public policy does

not only guide and determine present and future decisions but it is an attempt of an administrative organization to purposefully influence a social issue. Many scholars have developed theories of how the public policy development process works, which has led to two dominant visions on policy development.

- The first vision focuses on analytically solving problems: The analytical vision assumes that policy is the product of deliberate choices. Policy stems from rational considerations of pros and cons. Forces and developments do not directly influence policy-making.
- The second vision is about power and distribution in policy-making: The political vision assumes that policy is the product of differences and contradictions in society. With the political vision, policy does not necessarily have to be well thought out, but there must be enough support from society [2].

Various theories have emerged from these visions, such as the Phase model, the Stream model, the Advocacy Coalition Framework (ACF) and the Diffusion theory. To determine if the policy development process has foundations in one or a combinations of these theories, case studies are conducted to create a business process model and identify agents. The objects of the research is to determine if the methods business process modelling (BPM) and agent-based modelling (ABM) can give us a better insight into the process, agents and data around policy development. The research should highlight when business process modelling can be used to describe the policy development process and when agent-based modelling is a good method to use.

Business process modelling is a method to graphical represent a company's business processes or workflows. Business process modelling is mostly used for model-based identification of process weaknesses, adopting best business practices, the design of a new business blueprint or end-user training [3] [4] [5]. The main goal of business process modelling is to improve the efficiency of the process. In a big organization, there is a good chance that different departments or teams do the same process differently. The popularity of business process orientation has yielded a number of techniques, languages and methodologies [6]. For this study, the Business Process Modelling Notation (BPMN) is used. The standard BPMN notation focuses on the workflow of a process, which is perfect to represent a business process within the Ministries.

The second method used is agent-based modelling. Agent-based modelling is a modelling and computational framework for simulating dynamic processes that involve autonomous agents [7]. An autonomous agent can be both individual or collective entities such as organizations or groups [8]. Such an agent has behaviours and these behaviours can be described by simple rules, and interaction with other agents. Interaction with other agents influences their behaviour. By modelling agents individually, the effect of diversity that exists among agent can be observed. Also, the contribution of an individual to the system as a whole can be observed. The difference between these two methods is that business process modelling is good method to describe a process or workflow, but is limited in the description of agents. Agent-based modelling gives a better overview of the agents interaction and behavior, but is not the best method to use for process

management. In this research will be solemnly focus on modelling agents and not the simulation.

### 3 Case studies

The main goal of the research is to find out how a policy development process looks like and which agents are involved in the process. This first part of the research focuses on the so called problem investigation step out of the design cycle. To understand the policy development process and the agents linked to the process, a case study is executed. The case studies are based on researching the development of a policy in retrospect, which agents are involved in the policy and how data is used. These case studies have been imitated and performed at different Ministries for different policies. The first case study is about the manure policy and the second case study is about undermining crime. The case study contains interviews with policy-makers and these interviews are focused on four topics; a global description, the process, agents and information about the policy development process.

### 4 Manure case study

After the Second World War food security became important. Government and society decided that the green space should produce a lot of cheap food. The Netherlands became one of the largest agricultural exporters in the world, but more and more surplus was created at a European level. The enormous amounts of food produced by The Netherlands had one big disadvantage: the mineral efficiency decreased. Which meant damage to water, nature and landscape. A policy has been formed to combat this pollution. Over the years, the policy has been continually in motion, which ultimately led in 1995 to the Netherlands basing their policy on European directives. A policy has been formed to combat this pollution. Over the years, the policy has been continually in motion, which ultimately led in 1995 to the Netherlands basing their policy on European directives. We investigated the development of the most recent nitrate action programs, the fifth and sixth nitrate action programs that describe the manure policy from 2014 to 2021.

#### 4.1 Agents in the manure case

The interviews with policy-makers that developed the most recent nitrate action programs indicate that many different agents are involved in the process. These agents can be divided into internal and external agents whereby the internal agents consist of the Ministries itself, the departments within the Ministry, the manure team, but also supporting departments. The external agents are mainly research institutes and interest organizations. The interested organizations can be divided into regional and national organizations. In addition, water boards

are involved, the farmers but also the provincial government. The research institutes are, for example, Wageningen University, the Netherlands Environmental Assessment Agency (PBL), Statistics Netherlands (CBS), National Institute for Public Health and the Environment (RIVM), but The Netherlands Commission for Environmental Assessment (NCEA) is also involved. Figure 1 shows the agents in the manure case.

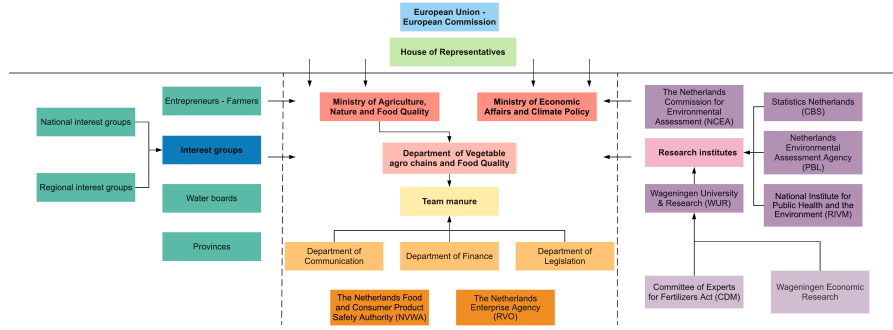
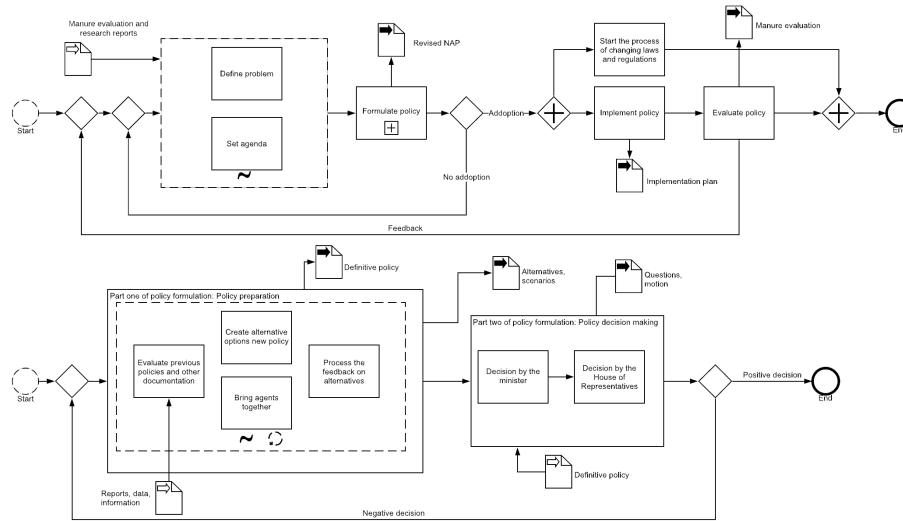


Fig. 1. The agents surrounding the manure policy.

#### 4.2 Process of the manure case

The policy development process can also be created based on the interviews, the business process model is show in Figure 2. The policymakers indicate that the process starts with a problem or a topic high on the political agenda. If the problem is clear, the policymakers will look again at the evaluation of the previous action program. Agents such as WUR, PBL, NCEA, RVO and NVWA provide a lot of information and data for the evaluation. In addition to the evaluation, other recommendations are also taken into account. These recommendations and results are all taken into account when designing various alternatives for the new policy. Policymakers engage in a dialogue with external agents to listen to their opinions and ideas. These dialogues are mostly with interest groups and farmers. These sessions help to shape the various alternatives for the new policy. Meetings with external agents are repeated until a policy has been formed that has sufficient support by the external agents, is scientifically substantiated and could win the support of the House of Representatives and European Commission. The Minister of Agriculture, Nature and Food Quality then decides if the policy is sufficient, presents it to the House of Representatives who then vote. If the decision for the policy is positive the policy will enter a new phase, otherwise the policy needs to be modified and will go to through the formulation phase again. When the policy is adopted by the House of Representatives the policy will be implemented and the process of changing the current laws and regulations will

start. These activities can run parallel to each other. The implementation of the policy lies largely, in the case of manure, by RVO and NVWA.



**Fig. 2.** Business Process Model of the manure policy development.

### 4.3 Undermining crime case study

The second case study has been performed at the Ministry of Justice and Security in collaboration with the Ministry of the Interior and Kingdom Relation and the Ministry of Finance. The Ministries has been seeing new forms of crime in the society. One of these new forms is organised crime. Organised crime is becoming more violent and criminals are active in multiple places such as residential areas, businesses and on the internet. The easiest way to explain undermining crime is as follows: The Dutch society is founded on a number of key domains, key persons or groups, key locations and key branches or organization. If these these key domains are the backbone of society and function well, the society functions well. But if one of these key domains is affected this means a deterioration of the stability of society. The responsibility to protect these social foundations is broadly divided. There are many different organizations or institutions in society whose task is to protect one (or more) of the key domains. The protection of the society can be done more efficient if data could be shared, in partnerships, between organisations. That is why the initiative has been launched to work towards "Undermining legislation". Undermining legislation is a collective name for several legislative proposals, all of which aim to strengthen the approach to undermining.

#### 4.4 Agents in the undermining crime case

To work towards this policy, several initiatives have been launched, such as the City Deal "View of Undermining". The City Deal "View of Undermining" is a strengthening and improvement of the approach to undermining crime by using methods such data analytics. For this research we interviewed people that are involved in this project. The City Deal "View of Undermining" builds on the experience of the investigation authorities, but makes it easy to do research through a collaboration between different agents. A large part of the participating agents are companies that provide data and expertise to conduct research. The policy focuses on tackling undermining crime, on a regional or municipal level. That is why the partnership has been set up in such a way that the municipalities are in the lead. There are five municipalities that have joined the first pilot on the undermining crime policy. These municipalities are Amsterdam, The Hague, Rotterdam, Tilburg and Utrecht. The municipalities are in contact with these local companies and also universities to carry out demand-oriented research. The universities have a role of experts in this partnership. They provide context to trends and findings that are found in data analyses conducted by the Statistics Netherlands in collaboration with the municipalities. The Regional Information and Expertise Centers (RIEC's) also help in the fight against undermining crime. The Netherlands is subdivided into ten RIEC's that work within regional borders. They collect information for ten security regions in the Netherlands, connect information, expertise and the powers of the various government agencies. The National Information and Expertise Center (LIEC) provides a link between the RIEC's and other national partners, so that the City Deal "View of Undermining" can not only use data that applies to the safety regions involved, but can also identify national trends. National parties that are part of the partnership are Kadaster and the Kamer van Koophandel. These organisations have delivered big amounts of data to the Statistics Netherlands in various areas to conduct research. The Belastingdienst is part of the Ministry of Finance and responsible for collecting government revenue. There are three Ministries that have an interest in reducing undermining crime. These ministries are the Ministry of Justice and Security, the Ministry of the Interior and Kingdom Relations and the Ministry of Finance. The Ministries are responsible in this project for guaranteeing the cohesion between the municipalities and their research by drawing up a framework. In addition, the Ministries have commissioned ICTU to provide organizational and functional project management for the City Deal "View of Undermining".



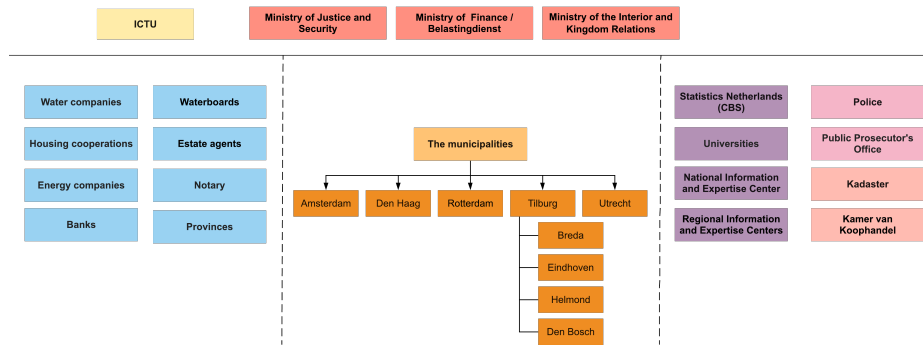


Fig. 3. Internal and external agents of the undermining crime policy.

#### 4.5 Process of undermining crime case

The development of the undermining crime policy, that falls within the City Deal "View of Undermining" is represented in this section. The process starts with a quarter-makers (kwartiermaker) phase. This phase is a preparation phase where the problem is defined and the planning and agenda is made for the activities that follow. Eventually a covenant with all the participating agents was formulated and signed. The official agents part of the covenant are the three Ministries with the Belastingdienst, the five municipalities, Statistics Netherlands, the Police and the Public Prosecution Office. To share data safely during the process the Ministries formulated a legal framework wherein they could work. After the framework had been formulated the data analyses started. Within the data analysis, research questions are asked that are suitable for pattern recognition. That is why this activity can also be worked out in a sub-process, as shown in Figure 5. To formulate an answer for the research questions, different local parties are required per question, which is why these agents are brought together per case. After the analysis the results are implemented, this could mean that the agents responsible for enforcement, such as the police continue with the results. The implementation needs to be evaluated and will function as input for further data analyses. Parallel to this the municipalities in collaboration with involved agents need to write down matters that hindered the process. This can be, for example, the laws and regulations that hindered the process or parties that are not yet connected to the program but should be. These matters are all bundled in a so called "change agenda". This agenda is the input for advice addressed to the Ministries that can set the process in motion to change laws and regulations.

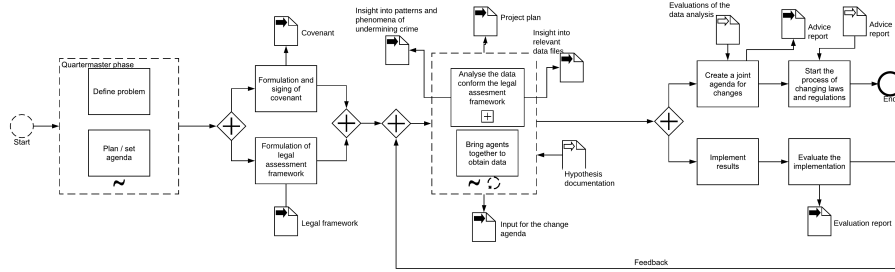


Fig. 4. Business process model of the undermining crime policy development.

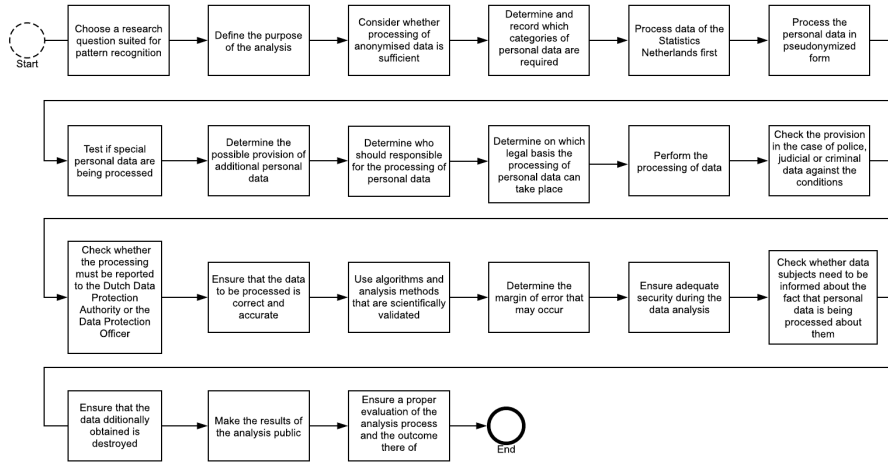


Fig. 5. Business process model of the undermining crime policy development.

## 5 Framework

### 5.1 Agents

The case study on manure and the case study on undermining crime show different observations and results. This makes sense since the nature of the cases are very different. In this chapter will we look at the differences and similarities of the cases. Some of these agents literally correspond, other agents have the same type of responsibilities or role in the development of policy. It is possible to categorize agents based on their similarities this leads to 4 categories:

1. Data and expertise institutions
2. The client
3. The agent that executes
4. Interest groups

	Manure case	Undermining crime case
Data and expertise institutions	Committee of Experts for Fertilizers Act (CDM) Netherlands commissions for the environmental assessment Netherlands Environmental Assessment Agency (PBL) Statistics Netherlands (CBS) The Netherlands Enterprise Agency (RVO) The Netherlands Food and Consumer Product Safety Authority (NVWA) Wageningen Economic Research	Universities Regional Information and Expertise Centers National Information and Expertise Center Kadaster Local companies Kamer van Koophandel Police Public Prosecutor's Office
The client	Ministry of Agriculture, Nature and Food Quality Ministry of Economic Affairs and Climate Policy National Institute for Public Health and the Environment (RIVM) European Union - European Commission House of Representatives	ICTU Ministry of Finance / Belastingdienst Ministry of Interior and Kingdom Relations Ministry of Justice and Security
Executive party	Team Manure Supporting departments	Municipalities Statistics Netherlands (CBS)
Interest groups	Entrepreneurs - Farmers Interest groups Provinces Water boards	

**Table 1.** Comparing and categorising agents.

## 5.2 Generalised policy development process

Because so many activities already match in the processes, we have looked at the possibility of merging the processes to create a process that could serve as a "global policy development process". This process is a combination of the activities of both processes.

The main processes are very similar, here you can find most of the tasks that occur in both processes. The sub-process that describes the formulation of the policy is more a combination of both processes. Since both process already had tasks that happened ad-hoc and in a loop so that it could be executed in any order, executed several times, or skipped these these tasks could be categorised together. As mentioned above the decision making part of the process is mandatory for the manure policy, but could be the future for the undermining crime policy development. The documentation around the general process is now renamed to more general terms so that the interpretation is not case dependent anymore. An evaluation report could now be for either the manure policy or the undermining crime policy.

The sub-process or tasks "analysing the data conform the framework(s)", does not return at all in the way in which the policy makers of the manure case make their policy. On the other hand, it is a key task within the undermining crime policy development process. That is why the decision is made to categorize the tasks and the underlying process as an ad hoc/ loop task. Processes that do execute data analysis in their policy development are therefore represented, but if a processes does not include this in their development, the step can be skipped. In addition, it is important to incorporate this task into the global process, because as indicated by the Ministries more data must used during the development of policy. The tasks of the sub-process will not be changed for the general policy development process.

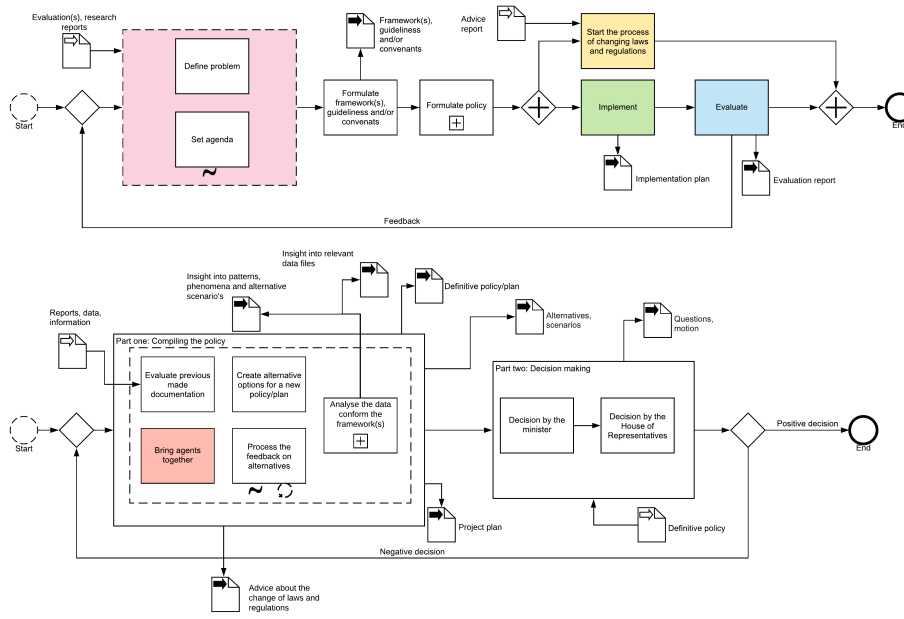


Fig. 6. General policy development process.

## 6 Meta-models

People make pictures, take measurements, draw up plans, orient on examples or build patterns. Be it in thought, with a pen, paper, other material or with the computer, whenever they want to understand or create a complex issue [9]. In other words they “use models all the time” [10]. In order to support a common understanding between stakeholders and to bridge the gap between the use of business process models and agent-based models we introduce two meta-models that lets users, model business process and their agents. A meta-model is a model of a model. Generating such meta-models is called metamodeling. From a theoretical perspective, it is vital to have a clear understanding of the semantics of the two approaches: business process modelling and agent-based modelling to describe their overlaps, differences and similarities. The semantics of the two approaches can be represented in meta-models. A meta- model describes the generic concepts that are identified and can be unified in a meta-model. A meta-model is an explicit model of the constructs and rules needed to build specific models within a domain of interest [11]. It defines the set of representational primitives with which to model.

Within the business process modeling method, there are several techniques and languages that can be used to visualize business process models. These techniques and languages and their syntax and semantics are well documented and make it possible for users to choose the right one given the situation. Not

only are there meta-models for every technique there are also meta-models that are technique or language independent. Several protocols and methods have also been formulated for agent-based modeling. These protocols and methods are only less clearly described than for the business process modeling method. This makes it harder for users to compare models or reuse them. The literature is mainly focused on how a conceptual model can be translated into a simulation, but does not focus on how a model is created.

**Meta-model BPM** There are a variation of business process modelling languages and techniques. Which makes comparing, analysing and improving business processes a notorious problem. Standardization has been discussed for over ten years, but still no standard is accepted. [11] tried to bridge this gap by proposing a meta-model that combines the seven biggest business process modelling languages. Translating these different techniques to one conceptual models makes it possible to systematically and objectively understand the potential contribution of each modelling method or technique. Heidari, Loucopoulos, Brazier, *et al.* [11] meta-model will be used as a basis for our meta-model to present business process modelling in a policy context. Figure 7 shows the meta-model of the business process modelling method created. The business process meta-model is universal and not dedicated to a single business process modelling language or technique.

Modelling a business process model, requires knowledge about the processes within an organization. The meta-model concepts make distinctions between different types of *Events*, *Gateways*, *Activity*, *ConnectingObjects*, *FlowNodes* and a *FlowObjectContainer*. An *events* for example can be a start event of the process but also the end. A *Gateway* can represent decision moments in the process or be used in diagrams both to separate flows and to recombine them. There are 5 types of gateways which are all used in different scenario's. A *Task* represents something the agent in the process does. Such as sending an email, or receiving a call. A *Activity* can either be a task or a sub-process. Here the task can be categorized into four different types and is a sub-process and way to explain a task in more detail. Now all activities must also be linked to each other and this happens with *ConnectingObjects*. The connecting objects can be a sequence flow, this is used between activities. But there is also a way to link a message to an activity and that is what a flow node represents. The last concept is the *FlowObjectContainer* this is a way to model agents in to the model with a lane and pool construction.

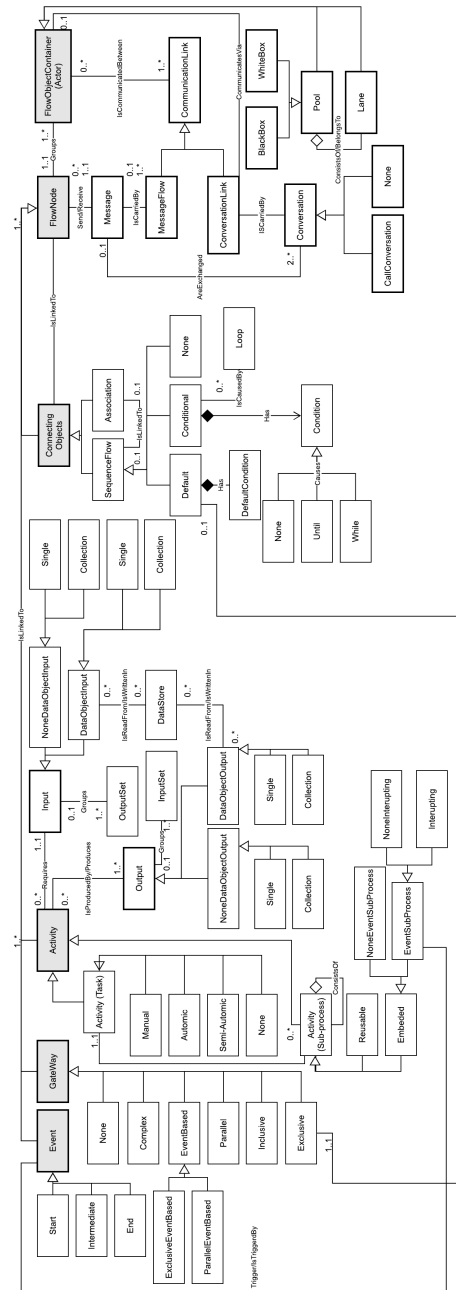


Fig. 7. Meta-model for business process modelling.

**Meta-model ABM** The agent-based modelling method has a similar problem as the business process modelling method. Literature describes different frameworks, approaches and methods to create agent-based models [12]–[14] here the focus is often on simulating agent-based models and not so much on creating the models themselves. In this research we focus solely on modeling agent-based models and not the simulation. For this reason, the framework of Ghorbani, Bots, Dignum, *et al.* [15] that proposes a conceptualisation framework for agent-based models and the work of Iba, Matsuzawa, and Aoyama [16] and Salgado and Gilbert [17] that try to apply meta-models in agent-based modelling are interesting. The conceptual model called: Modelling Agent systems based on Institutional Analysis (MAIA) from Ghorbani, Bots, Dignum, *et al.* [15] is a set of modelling concepts that is rich enough to capture a large range of complex social phenomena, but simple enough for modellers who are unfamiliar with software development. In addition, our model is inspired by the work of Scherer, Wimmer, and Markisic [18] and Hall and Virrantaus [19] and their work on conceptual modeling approach for agent-based models. Figure 8 presents our meta-model for agent-based modelling. Understanding how an agent-based model works is ultimately about understanding the behavior of the agents. The diagrams thus need to cover the agents and their environment. These agents can be divided into multiple categories of agents, we distinguish between *Biological agents*, *Institutional agents* and *Artificial agents*. Biological agents are for example a policy-maker or a project manager. The institutional agents are organizations such as a bank, government or the grocery shop. In certain domains, there may also be artificial agent types, such as software agents, embedded systems or robots. With respect to an institutional agent, one has to distinguish between external and internal agents. In the policy development process is the status as an internal or external agent of uttermost importance since it determines their contractual status, rights and duties. Regardless of the type of agent, has an agent goals and makes decisions based on these goals or perceptions. These decisions can change based on the current situation. The current situation in policy making can change decisions and actions. The media and politics for example can claim a topic of importance which can influence the agenda of a policymaker. Therefore, an agent assesses the current situation in order to make the (best possible) decision. These decisions lead to actions and depending on what kind of action if the action is an *ActionEvent* or *Non-ActionEvent*. An *Action-Event* is a thing done or an act that other agents can observe. However, there are also events which are not created by actions such as events created by natural forces, the *Non-ActionEvents*. The *ActionEvents* can be divided into events where there is only communication and an event where actions take place, the *CommunicationActionEvent* and *Non-CommunicationActionEvent*.

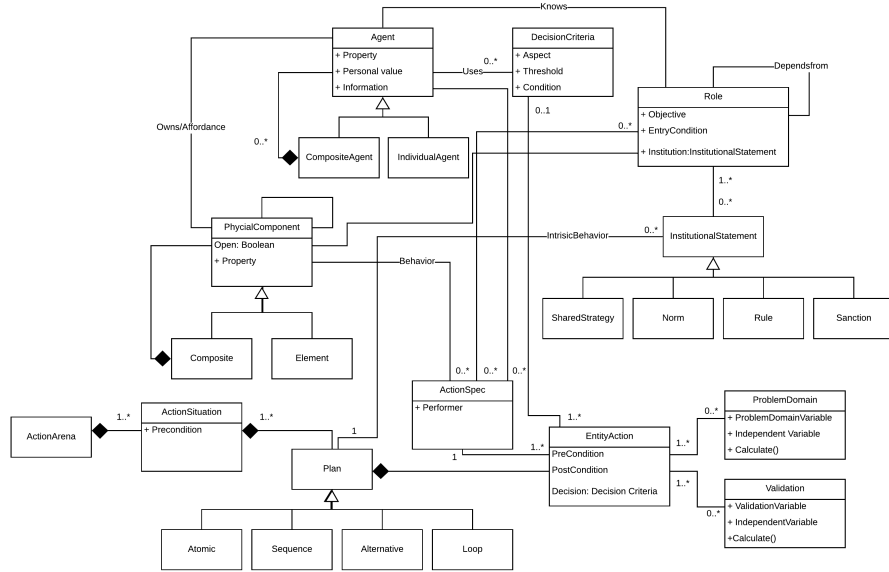


Fig. 8. Meta-model for agent-based modelling.

## 7 Conclusion

A combination of both methods have helped with understanding the policy development process. Both methods have played a different role in making the policy process easier to understand.

Business process modeling has contributed a lot to clarifying the policy development process and the documentation that is used. Due to interviews that where part of the case studies was it possible to visualise the policy development process into a business process model fro both case studies. The use of data within the policy process could only be visualized for one of the two policy processes that we investigated. The reason for this is because this policy was deliberately concerned with the use of data and had established a written process for it. The other policy relied very much on other organizations to provide the right data and information.

Agent-based modelling contributed a lot to recording the behavior and interactions of the agents that are part of the policy development process. The difficulty here lay in to translating these perceptions and interactions into a simple agent-based model, since there is little literature available that explains on a meta-model level how agent-based models should be visualized.

It has, however, been possible to compare the two case studies in order to be able to make more generalized statements about what the policy process looks like, which categories of agents appear in both cases and how data is used.



Precisely because our research revealed that there is almost no literature for metamodeling of agents, the research ultimately also focused on designing a meta-model for business process modeling and agent-based modeling, so that in the future an agent-based model can be created in a simple way.

### 7.1 Limitations

Due to the nature of the research questions and the limited amount of literature on the combination of business process modelling and agent-based modelling is this research mainly exploratory and does it not yield any statistically significant results. While the case studies were rigorously executed and validated, the results are limited to the case study sample size. It is therefore hard to say, considering the two case studies that have been done, if the produced generalises policy process also applies to other Ministries and other policy domains. Recommended is to also apply the results to other policy fields and Ministries.

As the saying goes, "No two people are the same". They differ along a wide range of factors, such in age, behaviour, gender, height, intelligence, and so forth. Eliminating such individual difference is not possible, but they do need to be taken into account. That is why we choose to stick with participants that had the same type of functions to interview about the policy development. During the case study, it is possible that the subjects' responses and behavior may impose a threat to construct validity as they might respond differently in an attempt to perform better to please the case study which can affect the outcome of the case study.

Another limitation is that we deliberately did not research the influence of policies that are linked to the chosen policies. This has been kept out of scope due through time constraints.

### 7.2 Future works

Although, we consider that the goal of this research has been accomplished, there are plenty of improvements that could be done in order to achieve better results. In the following sections we present, for each of the three fields policy development, business process modelling and agent-based modelling some of the open issues that deserve further research. There have been several studies focusing on business process modelling conceptualisation and standardisation in recent years. Also formulating a method or framework for agent-based modelling has gained attention. However, this is the first study to combine the two interest fields, with case studies and in the field of policy development.

In future research is validating the policy development process important. Executing case studies on different policies could provide us with and even better understanding of the policy development process. These case studies can be an extension of this research and used for the further development of the policy process. Moreover, it will be interesting to look at other policies and the process of these policies in other Ministries to compare the policy development process. In this way, threats regarding both the external validity and internal validity

of this research can be solved. Another interesting topic for research into policy development is how different types of policy influence each other.

Regarding the application of business process modelling, could future research provide a more detailed policy process. This was not possible for us due to time constraints, and the availability of interviewees.

Regarding the conceptualising of agent-based modelling is it important in the future to further develop the methods and frameworks that describe the forming of agent-based models. In addition, there should be more focus on conceptualizing and standardisation of the methods.

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