

Master's Thesis
Opportunities for outsourcing
Infrastructure Asset Management activities
A mixed-method analysis of Dutch local road authorities

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MSc Thesis Civil Engineering & Management
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The background of the cover features a silhouette of a tractor against a sunset sky. The tractor is positioned in the lower half of the frame, with the sun low on the horizon to its left. The sky transitions from a bright orange near the sun to a darker orange and then to a black silhouette of the tractor and the ground. The overall composition is framed by a white and orange geometric design at the top and bottom.

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Preface

This report serves as my final academic record. I began my studies at Avans University of Applied Sciences in 's-Hertogenbosch, where I earned a bachelor's degree in civil engineering. I then attended the University of Twente to complete my pre-master's and master's degrees in civil engineering and management. In addition, to my study time in Enschede, I had a great time at the rowing association Euros, where I enjoyed the sport of rowing, made a lot of new friends, and developed myself in a variety of committees.

I would like to express my gratitude to Andreas Hartmann and Marc van Buiten from the university for their valuable supervision during this assignment. They were able to maintain my attention by consistently posing insightful questions. I would especially like to thank Bert Lankheet, my daily supervisor from Strukton, who was always there for me, helped me out in the late hours by reading over things, and provided me with a good debating partner during meetings. Additionally, I would like to thank Djim Witjes for helping me think through the research design before my study at Strukton and Jan Hendrik Fischer for his consistent feedback during the thesis assignment. Lastly, I would like to express sincere thanks to my girlfriend, family, friends from the rowing association, and friends from my hometown for their support during my more difficult moments and for attending to have coffee with me in the university library.

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Summary

SIGNIFICANCE This study investigates the relations between Infrastructure Asset Management (IAM) and the outsourcing strategies within Construction Organisation Forms (COFs) by Dutch Local Road Authorities (LRAs). It was completed from the point of view of contractor Strukton, who also served as study initiator. Based on this study, Strukton will be able to improve both its strategy and proposition when contending for governmental road maintenance contracts.

PROBLEM Many LRAs currently only outsource project executions to contractors and keep the management tasks in-house. Strukton stated that they are capable of carrying out a variety of IAM-activities, which means that many capabilities are untapped. However, since 2022, there have been sporadic requests for outsourcing management tasks and Strukton is therefore curious as to whether this trend is more frequently seen across other LRAs. Additionally, the contractor is interested in identifying which activities the LRAs currently face difficulties, in so they can focus on addressing these challenges during a collaboration.

METHOD The method was developed to encompass both the qualitative and quantitative aspects of the research problem. A combination of data collection techniques was utilised, leading to a mixed-methods approach. Through desk research, 375 outsourcing descriptions with an emphasis on road maintenance initiated by provinces, municipalities, and water boards from 2019-2023 were analysed. The case study strategy was selected for studying the present and desired state of IAM. This entailed conducting a comprehensive investigation through semi-structured interviews with twelve governmental cases. The last segment centres on Strukton's competencies and opportunities for enhancement which was mainly covered by a focus group discussion with employees of Strukton.

RESULTS During the analysed years, the most frequently used strategy was to outsource single operational activities by the use of discrete COFs. Notably, there has been an increase in framework COFs, constituting 25% in the years 2022 and 2023. The Western region, marked by higher urbanisation, exhibits a preference for Framework COFs and only provinces make use of integrated Performance Based Contracts (PBCs). Satisfaction with current strategies is mixed, with a desire for alternative approaches expressed by many LRAs. Motives for outsourcing include capacity constraints and a lack of in-house expertise. The study revealed disparities in IAM practises among LRAs, including variations in long-term planning, utilisation of CROW methodology, and preferences for delegating tasks to external parties. Certain authorities expressed a preference for increased collaboration, whereas others were inclined towards retaining tasks internally. The identified themes for improving IAM include providing feedback on policy objectives, implementing new inspection techniques, and enhancing the AM system. Strukton has multiple capabilities to capitalise on these areas of improvement, but can also elaborate several practices.

CONCLUSION The findings of this study suggest that the vast majority of Dutch LRAs continue to adhere to single discrete COFs for road rehabilitation. The RAW methodology is by far the most utilised, according to both desk research and case studies, with framework COFs gaining prominence in recent years. Given this information, it appears that it will be difficult for a contractor like Strukton to offer these authorities their expertise in IAM practices on a larger scale. Strukton believes that an integrated PBC is the most effective approach for applying their expertise to LRAs. Provinces are the only ones who prefer this integrated approach, so the contractor should focus on these kinds of authorities to apply their expertise throughout the partnership. Mutual trust and the understanding that tasks can be completed in unconventional ways are crucial for the remaining authorities. Both IAM participants can gain from collaboration if they recognise its potential benefits.

Samenvatting

BETEKENIS Deze studie onderzoekt de relaties tussen Infrastructuur Asset Management (IAM) en de uitbestedingsstrategieën binnen bouworganisatievormen (BOV's) van Nederlandse lokale overheden. Het is uitgevoerd vanuit het oogpunt van de Nederlandse aannemer Strukton, die ook als initiatiefnemer voor het onderzoek heeft gefungeerd. Op basis van dit onderzoek kan Strukton zowel haar strategie als propositie verbeteren binnen tenders voor wegonderhoudscontracten.

PROBLEEM Veel lokale overheden besteden momenteel alleen de projectuitvoering uit aan opdrachtnemers en houden ze de beheertaken intern. Strukton geeft aan dat zij in staat zijn diverse IAM-activiteiten uit te voeren, waardoor veel capaciteiten nu onbenut blijven. Sinds 2022 zijn er echter sporadisch verzoeken om het uitbesteden van beheertaken en Strukton is dan ook benieuwd of deze trend zich vaker voordoet bij andere lokale overheden. Bovendien is de aannemer geïnteresseerd in het identificeren van de activiteiten waarmee de overheden problemen hebben, zodat zij zich tijdens een samenwerking kunnen concentreren op het aanpakken van deze uitdagingen.

METHODE De methode werd ontwikkeld om zowel de kwalitatieve als de kwantitatieve aspecten van het onderzoeksprobleem aan te pakken. Er werd gebruik gemaakt van een combinatie van dataverzamelingstechnieken, wat leidde tot een gemixte methode benadering. Door middel van deskresearch werden 375 uitbestedingsbeschrijvingen geanalyseerd met de nadruk op wegonderhoud geïnitieerd door provincies, gemeenten en waterschappen in de periode 2019-2023. Voor het bestuderen van de huidige en gewenste staat van IAM is gekozen voor de casestudie strategie. Dit hield in dat er een uitgebreid onderzoek is uitgevoerd door middel van semigestructureerde interviews met twaalf overheden. In het laatste gedeelte stonden de competenties en verbetermogelijkheden van Strukton centraal. Dit is voornamelijk gedaan door middel van een focusgroep discussie met medewerkers van Strukton.

RESULTATEN Gedurende de geanalyseerde jaren was de meest gebruikte strategie het uitbesteden van afzonderlijke operationele activiteiten door gebruik te maken van discrete BOV's. Daarnaast is met name een toename van raamcontracten te zien, welke 25% uitmaakten in de jaren 2022 en 2023. De westelijke regio, gekenmerkt door een hogere verstedelijking, vertoont een voorkeur voor raamcontracten en alleen provincies maakten gebruik van geïntegreerde prestatiecontracten. De tevredenheid over de huidige strategieën is gemengd en veel lokale overheden willen een alternatieve aanpak. Motieven voor uitbesteding zijn onder andere capaciteitsbeperkingen en een gebrek aan interne expertise. Het onderzoek onthulde verschillen in IAM-praktijken tussen de overheden, waaronder verschillen in langetermijnplanning, gebruik van CROW-methodologie en voorkeuren voor het delegeren van taken aan externe partijen. Sommige instanties gaven de voorkeur aan meer samenwerking, terwijl andere geneigd waren om taken intern te houden. De geïdentificeerde thema's voor het verbeteren van IAM zijn het geven van feedback aan beleidsdoelstellingen, het implementeren van nieuwe inspectietechnieken en het verbeteren van het AM systeem. Strukton heeft meerdere mogelijkheden om op deze verbeterpunten in te spelen, maar kan ook diverse elementen uitbreiden.

CONCLUSIE De bevindingen van dit onderzoek suggereren dat de overgrote meerderheid van de Nederlandse lokale overheden blijven blijft vasthouden aan een discrete aanpak voor weg onderhoud. De RAW wordt verreweg het meest toegepast, zo blijkt uit zowel bureauonderzoek als uit casestudies, terwijl de laatste jaren raamcontracten aan populariteit hebben gewonnen. Op basis van deze informatie lijkt het voor een aannemer als Strukton moeilijk om de expertise van IAM op grotere schaal aan te bieden. Strukton is van mening dat een integraal prestatiecontract de meest effectieve aanpak is om haar expertise in te zetten. Echter, enkel provincies geven de voorkeur aan deze aanpak, dus de aannemer zou zich op dit soort overheden moeten richten om de haar expertise in te kunnen zetten. Wederzijds vertrouwen en het begrip dat taken op niet traditionele manier kunnen worden uitbesteed, zijn cruciaal voor de overige overheden. Beide partijen kunnen baat hebben bij samenwerking als ze de potentiële voordelen ervan inzien.

Acronyms

Acronym	Term
AI	Artificial Intelligence
AM	Asset Management
AMS	Asset Management System
AUS	Australia
BE	Belgium
CEDR	Conference of European Directors of Roads
COF	Construction Organisation Form
CROW	Centre for Regulation and Research in Ground, Water and Road Construction
D&C	Design & Construct
DC(F)M	Design, Construct, (Finance) & Maintain
E&C	Engineer & Construct
FI	Finland
GE	Germany
GIS	Geographic Information System
GPR	Ground-Penetrating Radar
HHNK	Waterboard Hollands Noorderkwartier
IAM	Infrastructure Asset management
iAMPro	Infrastructure Asset Management Professional
ISO	International Organisation for Standardisation
KPI	Key Performance Indicator
LIOR	Guideline of Public Space Design
LRA	Local Road Authority
NL	The Netherlands
NO	Norway
NRA	National Road Authority
PBC	Performance-Based Contract
PDCA	Plan, Do, Check & Act
PdM	Predictive Maintenance
PIM	Pavement information modelling
RAW	Rationalisation and Automation Soil-, Water- and Road Construction
RQ	Research Question
RWS	Rijkswaterstaat (Dutch National Roads and Waterways Agency)
SAMP	Strategic Asset Management Plan
SE	Sweden
UK	United Kingdom
US	United States

1

Introduction

Public assets are essential for the functioning of modern societies and play a crucial role in establishing infrastructure as a unified system. An effective and well-maintained infrastructure system is crucial for promoting economic growth and enhancing the overall quality of life (Chen & Bartle, 2017; Krop et al., 2008; Nyikos & Ermasova, 2022; Zeb, 2020). During the development of road networks, engineers first prioritised the design and building process to develop new and extend existing networks (Burrow et al., 2013). However, according to the World Bank, the majority of money invested in roads today goes towards maintenance rather than new infrastructure (du Preez, 2019). The importance of maintenance is that inadequately maintained roads hinder mobility and increase the frequency of accidents, resulting in substantial expenses in terms of human casualties and property damage (Burningham & Stankevich, 2005). In the Netherlands, the responsibility for road maintenance is distributed among various organisations. National Road Authorities (NRAs) primarily oversee the maintenance of highways, while the province is responsible for provincial roads and municipalities for local roads. Water boards can also oversee roadways, particularly those located on dykes. Maintaining road infrastructure can incur substantial costs, and numerous Local Road Authorities (LRAs) presently encounter financial limitations, more stringent laws, and ageing personnel. Despite this, these governments still have to fulfil objectives like road availability, sustainability, circularity, and quality optimisation. Given these factors, it is imperative to implement a more proactive and efficient maintenance strategy (Jolicoeur & Barrett, 2005).

Within road maintenance, operational tasks represent the physical maintenance efforts required to maintain optimal conditions. Four categories apply to these tasks: rehabilitation, winter maintenance, emergency repairs, and routine maintenance. Regular maintenance concentrates on short-term intervals to preserve asset conditions. It includes tasks such as grass cutting and drainage cleaning. Winter upkeep, which includes salting roads and shovelling snow, takes care of climate-related problems, while emergency repairs deal with things like potholes and broken lights right away. Longer-term, strategic planning guides the extensive work required for rehabilitation, which aims to improve performance and service life. Management activities, that are aligned with broader asset management practises, support these operational tasks and are mainly monitoring and planning. To make decisions about road conditions, risks, and necessary quality, monitoring comprises examining, documenting findings, modelling deterioration, and gathering data. Planning includes formulating intervention specifications, planning tasks, scheduling rehabilitations, and developing maintenance strategies (CEDR, 2015).

The International Organisation for Standardisation (ISO) describes asset management (AM) as activities within an organisation to realise the best value from assets. The concept entails evaluating and optimising costs, opportunities and risks concerning the desired asset performance, all to achieve the objectives of the organisation (Burrow et al., 2013; Fallah-Fini et al., 2015; ISO, 2014a). When the assets encompass infrastructure, such as roads, generally AM is mentioned as Infrastructure Asset Management (IAM) (Herder & Wijnia, 2012). Within the Netherlands, IAM has experienced substantial growth and gained significant acceptance among managers, although it has progressed from operational maintenance to a more tactical approach, it has not fully attained the strategic level (Wijnia & Herder, 2010).

Operational and management maintenance tasks can be outsourced from governmental organisations to private parties. If so, there are a few considerations that need to be taken into account to carry out the contract. Aside from the tasks, these include the volume, types and numbers of assets, payment methods, performance standards, length of the contract, geographical scope, and the Construction Organisation Form (COF). Although this and "contract form" are sometimes used interchangeably, in this study, "COF" is used. COFs are generally classified into three types. Discrete forms are usually short-term and used for planned activities with project character. For both planned and unforeseen activities completed over a given medium- to long-term time frame, framework forms are utilised. Lastly, integrated forms are employed for long-term, scheduled activities that repeat within a specific time frame (CEDR, 2015). Different countries have different levels of outsourcing that NRAs use for maintenance activities, particularly maintenance planning and monitoring (see table 1). According to the Conference of European Directors of Roads (CEDR), nations like the Netherlands, the United Kingdom, and Finland that have integrated COFs for routine maintenance exhibit the highest levels of integration and outsourcing. There is a corresponding increase in the transfer of planning and monitoring activities and new opportunities for contractors arise when they take on greater responsibility for maintaining assets in a region over an extended period (CEDR, 2017b).

Table 1 Level of maintenance outsourcing by NRAs
Source (CEDR, 2017b)

	Regular maintenance			Rehabilitation		
	Planning	Monitoring	Executing	Planning	Monitoring	Executing
Netherlands						
Belgium						
Germany						
United Kingdom						
United States						
Australia						
Finland						
Norway						
Sweden						

Legend

<i>Outsourcing level high</i>	
<i>Outsourcing level medium</i>	
<i>Outsourcing level low</i>	

This study was initiated by Strukton, a Dutch private contractor that specialises in infrastructure. They provide clients services including design, construction, and systems management. In addition, the contractor asserts that they have a wide range of capabilities in the field of IAM. They wanted to know if LRAs, like municipalities and provinces, are also following the NRA outsourcing trend. Also, within the Master's thesis of Pham (2017), it is noted that municipalities claim to implement AM. However, when questioned about the rationale behind certain activities and their resulting benefits, they are unable to provide a well-considered response. Further research into LRA's AM practises, as well as their outsourcing of AM activities to market parties, is also useful for future studies.

1.1 Problem statement

This research is conducted from the perspective of Strukton. They have stated that they are capable of carrying out a variety of IAM-activities. Their goal is to apply this knowledge to local authorities, like municipalities and provinces. However according to Strukton, many organisations of this type currently only contract out project executions to contractors and keep the comprehensive management tasks in-house. This kind of cooperation leaves some of Strukton's capabilities untapped. However, since 2022, there have been sporadic requests for management tasks to be outsourced by LRAs. Strukton is therefore curious as to whether this trend is more frequently seen across various LRAs, providing more opportunities to apply its full expertise. Additionally, Strukton is interested in identifying which activities the LRAs currently face difficulties, so they can create an effective proposition for future road maintenance tenders. Strukton also expects that in the future the responsibility for management tasks will shift more to the contractor because governments have less capacity (e.g. due to ageing personnel).

There were several underlying aspects to Strukton's problem. To begin, outsourcing IAM activities can be facilitated by selecting specific COFs. It was unknown which COFs were used by Dutch LRAs and whether there were opportunities to outsource IAM activities within them. Next to that, it was essential to determine whether LRAs were satisfied with the current applied COF or if they were looking for a different strategy. Furthermore, it was unclear what IAM activities LRAs were presently undertaking and what their future goals were in this regard. The study of Van der Lei et al. (2012) mentions that governmental organisations are encountering ageing workforces and challenges in attracting new employees, resulting in a gradual decline in internal expertise and capacity. Therefore it was expected that there would be a changing approach among LRAs. Finally, it was important to assess Strukton's present capabilities to determine whether any new developments were required to meet LRA requirements. The aforementioned aspects lead to the fundamental research problem, as shown in the fishbone diagram in figure 1. These aspects are Infrastructure Asset Management within Dutch Local Road Authorities, Construction Organisation Forms, and contractor Strukton.

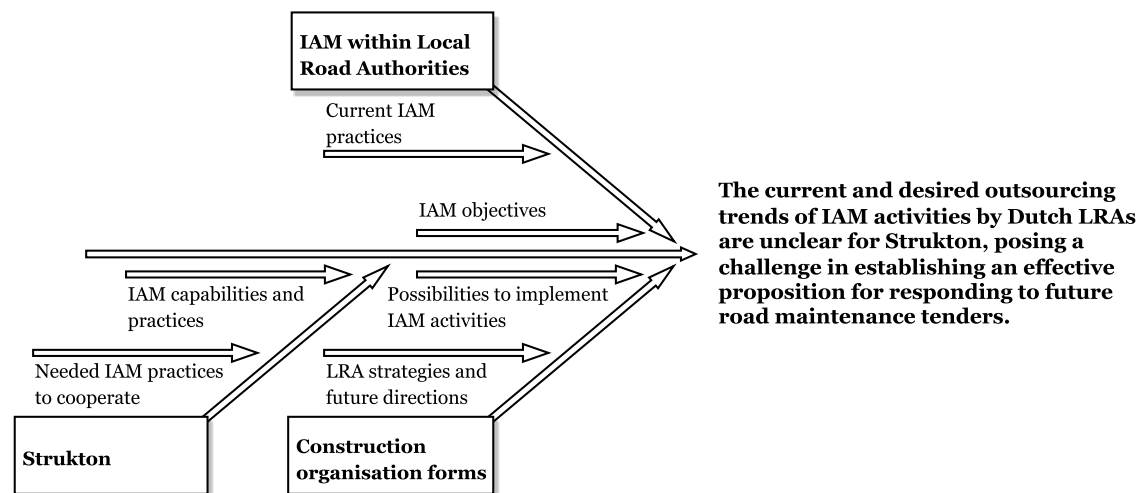


Figure 1 Fishbone diagram with underlying aspects of the research problem

1.2 Research objective and questions

The objective of this research was derived from the problem statement and the underlying aspects. The objective can be effectively expressed in a single sentence and out of this three research questions have been developed.

Research objective

Understanding the extent of IAM practices and the COFs used for road interventions within Dutch LRAs presents opportunities for Strukton to leverage and provide their expertise.

Research question 1

What are the current IAM outsourcing strategies employed by Dutch LRAs, given their current construction organisation forms?

Research question 2

What is the current state of infrastructure asset management in Dutch LRAs and which processes do they aim to improve?

Research question 3

What opportunities and necessary developments should Strukton pursue to meet the IAM strategies of Dutch LRAs?

1.3 Scope and limitations

The focus of road maintenance and IAM is limited to the principles of road rehabilitation intervention activities and not daily maintenance such as sweeping, grass cutting, or winter upkeep. Also, there are likely to be many frameworks and procedures available for different areas of work, such as utilities and water management. However, these will be excluded. In addition, the analysis focuses exclusively on

evaluating provincial and local roads, without considering any adjacent infrastructure components like bridges and tunnels. This is because Strukton places a particular emphasis on this segment of the infrastructure industry.

Local governments in this study relate to the governmental organisations at the middle and lower levels. Initially, higher-level organisations such as Rijkswaterstaat (the state) will be excluded. Moreover, the governmental organisation needs to give high importance to the management of roads as a crucial component of its infrastructure. This results in that the focus will be directed towards municipalities, provinces, and water authorities. Another noteworthy factor is the emphasis on governments with whom Strukton has strong connections. The contact details were obtained from the study initiator, which facilitated the acquisition of cases for this study. It is expected that Strukton will soon collaborate with them.

In terms of the advice that will be given to Strukton, this will be on a strategic and tactical level rather than an operational level. The elaboration of the potential IAM principles or the development of comprehensive procurement plans will be required once the operational level has been reached, which is outside the scope of this study. The study will guide Strukton in the right direction in terms of where the contractor may implement improvements, and from there, operational thinking can be carried out.

2

Theoretical background

This chapter explains the theoretical foundations of infrastructure asset management (IAM) and construction organisation forms (COFs), which are the primary areas of investigation in this study. The first section covers IAM frameworks outlined in Dutch documents and global literature and assesses which framework offers the most extensive coverage of the essential elements of IAM. The second section is about COFs which refer to how the participants in a maintenance contract are assigned different tasks to complete. It is essential to gain an understanding of the various COFs that are utilised by the Dutch LRAs and by which it is possible to integrate IAM activities. This serves as a fundamental basis for the subsequent analysis and also guides Strukton regarding potential prospects for cooperation with local governments.

2.1 Infrastructure asset management

Asset management is a field that encompasses extensive research on theories, concepts, and frameworks. However, the ISO-55000 series has established itself as a standard for the adoption of AM systems. The series provides a comprehensive overview of the essential components that must be included in an AM system and establishes the necessary standards for its implementation. Adopting ISO 55000 is to establish uniformity in an organisation to improve the value of its activities (ISO, 2014a; Ruiter, 2015). Table 2 includes the specified essential components. This was used to assess how well (international) IAM frameworks conform to the specified requirements in the standardised norm. An overview of each framework documented in the international literature can be found in Appendix I.

Too (2010) conducted a research that defines five processes in IAM. Its primary emphasis lies in the management of information and the strategic selection of appropriate activities. Adey's (2019) study proposed a thorough framework that incorporates service-level objectives and the analysis and adjustment of the process. On the other hand, the establishment of a comprehensive IAM policy is somewhat lacking in this document. Cagle's (2003) model exhibits deficiencies in multiple aspects, specifically regarding the analysis and feedback of the entire process. This model primarily focuses on the adjustment of service needs and the allocation of essential resources. Additionally, the study conducted by Arif & Bayraktar (2012) lacks the same elements. The study conducted by Moon et al. (2009) misses sufficient coverage of comprehensive work planning. The studies conducted by Halfawy (2008) and Da Silva & De Souza (2022) are notable for their thoroughness, as they cover various stages and associated activities. Nevertheless, these frameworks lack in terms of policy and organisational context.

The 'CROW' provides yet another IAM framework. This is a Dutch institution that offers expertise and resources to enhance the development, construction, and management of infrastructure in the Netherlands. The organisation develops and manages various tools and platforms, including iAMPro, which enable the exchange of information and collaboration among participants in the infrastructure sector. iAMPro is an abbreviated form of "*Infrastructure Asset Management Professional*" and provides a thorough approach to AM. The framework seeks to optimise the usefulness and efficiency of AM practises in organisations by providing a standardised methodology and fostering collaboration and knowledge sharing among municipalities, provinces, and water agencies (CROW, 2023). The framework comprises six core processes and two supplementary processes, as depicted in figure 2. Appendix II contains a detailed explanation and analysis of each phase, including its underlying themes.

The iAMPro framework is centred around the Plan-Do-Check-Act (PDCA) methodology. The fundamental concept is that AM operates as a dynamic system that necessitates ongoing optimisation through continuous learning. The PDCA cycle entails stating goals, carrying out plans, assessing actions, and making any necessary adjustments (CROW, 2023). When the iAMPro model is placed along the ISO series, each theme and phase can be compared as seen in figure 3.

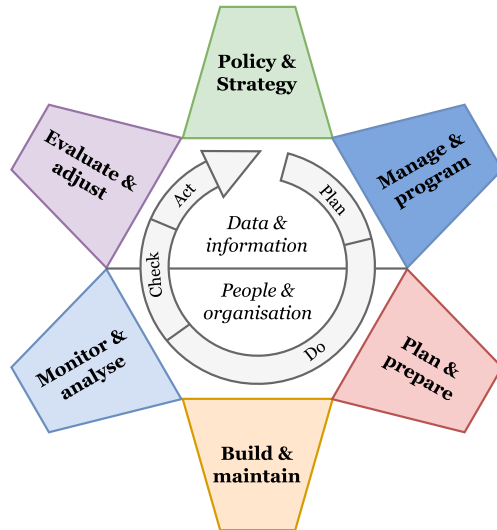


Figure 2 CROW iAMPro framework
Source (CROW, 2023)

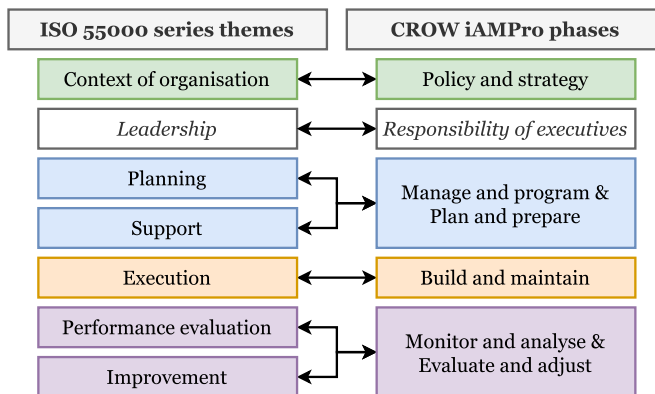


Figure 3 ISO series compared to iAMPro
Source (CROW, 2023; ISO, 2014b)

As partially stated in the introduction, IAM is defined by the CEDR as a process of management and operational tasks that are primarily broken down into planning, monitoring, and executing maintenance tasks. Although it can include a variety of interventions, such as routine maintenance and winter upkeep, the primary emphasis of this study is on both short- and long-term road rehabilitations. Strategic planning is essential for this, as is monitoring that places a focus on obtaining information and modelling asset deteriorations. Governmental organisations may contract out these tasks to private contractors. When doing this, several factors need to be taken into account, including elements such as task details, asset types, scope, and contract duration. However, the use of a specific COF is the main consideration for determining whether IAM activities can be included in the outsourcing contract. COFs are mainly divided into three categories: integrated, framework, and discrete forms (CEDR, 2015, 2017b) and these will be further discussed in section 2.2.

Table 2 Infrastructure asset management frameworks compared to key elements of ISO-55000

	CROW (2023)	Too (2010)	Adey (2019)	Cagle (2003)	Moon et al. (2009)	Halfawy (2008)	Da Silva & De Souza (2022)	Arif & Bayraktar (2012)
<i>Number of phases</i>	8	5	6	6	6	18	5	6
Stakeholder & Organisation context	✓		✓		✓			✓
Organisational plans and objectives	✓		✓	✓	✓	✓	✓	✓
IAM policy	✓				✓			
Asset portfolio	✓		✓	✓		✓	✓	✓
Strategic IAM plan & Objectives	✓		✓	✓		✓	✓	✓
IAM (short-term) plans	✓		✓	✓		✓	✓	✓
IAM system & required data	✓	✓	✓	✓	✓	✓	✓	✓
Implementation of activities	✓	✓	✓		✓	✓	✓	
Evaluation	✓		✓		✓	✓	✓	
Improvements/ feedback	✓		✓		✓	✓	✓	

2.2 Construction organisation forms

The primary emphasis on COFs in this study is linked to the tasks within road interventions. COFs show how participants' responsibilities are divided up during maintenance (intervention) contracts. Since IAM encompasses the management and operational duties associated with interventions, the selection of COF assumes a crucial role in determining how these processes are operated. The previous section focused extensively on IAM frameworks, revealing that the CROW iAMPro model is the most comprehensive. Unfortunately, there are such a large number of activities within this model that it is impractical to determine whether or not each of them can be outsourced. To streamline these responsibilities, the COF analysis concentrates solely on the fundamental tasks of Planning, Monitoring, and Executing, as outlined by CEDR (2015). A comparison of the iAMPro model and the CEDR can be found in the figure below. What can be seen is that the Plan & Prepare phase is split because the underlying activities are divided into both planning and executing (CEDR, 2015; CROW, 2023).

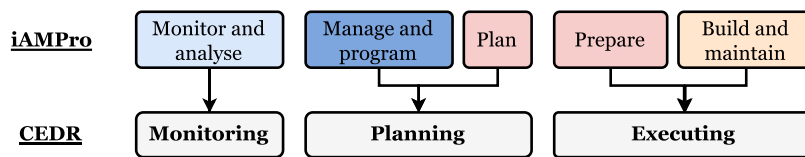


Figure 4 Comparison of the iAMPro model and the CEDR IAM tasks

According to the CEDR, there are three types of COF: discrete, framework, and integrated. These have a significant role in how IAM tasks and activities are distributed among clients and contractors. The research of CEDR (2017a) analysed this among several European NRAs and even the United States and Australia. Discrete COFs are typically short-term and meant for project-oriented, planned maintenance tasks like rehabilitations. Because of its distinct and limited characteristics, this kind of COF is frequently used for interventions like road resurfacing. Discrete is a traditional collaboration in which all parties' roles are well-defined. These COFS have typically been limited to interventions for specific assets within the NRAs, such as roads. However, a recent shift is evident, expanding it to simultaneous maintenance of multiple assets within a road section, such as activities on bridges and road pavement (CEDR, 2017a, 2017b). The various contracts investigated in the CEDR research can be seen in table 3. More specifically, every country's discrete COFs are included in this table. In all countries, the contractor is only acquired to execute the rehabilitations; each blue cell with a bold outline represents a stand-alone contract. Regular maintenance is also outsourced to a contractor in Sweden (SE) and Norway (NO), but it is a different agreement than for rehabilitations. The remaining activities, planning and monitoring, are carried out internally by the NRAs.

Table 3 Activities implemented by NRAs within discrete COFs
Source (CEDR, 2017a)
Legend Blue = Full responsibility contractor

DISCRETE COF Tasks	Activity	NL	BE	GE	UK	US	FI	NO	SE
Rehabilitation	Plan								
	Monitor								
	Execute								
Regular maintenance	Execute								
	Monitor								
	Plan								

Framework COFs are distinguished by their medium-to-long duration, which usually spans one to five years, and encompassing both planned and unplanned activities. These agreements, which frequently include unit costs and cover larger geographic areas, encourage strong communication between contractors and road authorities and produce consistently qualitative results. NRAs emphasise the importance of having solid relationships with contractors because they face difficulties in budgetary control and workload estimation. They use framework contracts as a tactical instrument to keep control and flexibility. Although they are used differently in different countries, frameworks are frequently used for the routine maintenance of individual assets. They can also be applied to rehabilitation projects or a combination of regular maintenance and rehabilitation (CEDR, 2017a, 2017b).

The contractor's partial responsibility is shown in green in table 4, in addition to their full responsibility. In the Netherlands, a COF was used, wherein the contractor was given partial responsibility for both the planning and the monitoring of rehabilitations in addition to the execution. In Finland, the contractor took on complete responsibility for all management and operational tasks associated with regular maintenance. Additionally, there were two Belgium contracts, one dealt with the combined maintenance and rehabilitation of installed assets, such as traffic lights.

Table 4 Activities implemented by NRAs within framework COFs
Source (CEDR, 2017a)
Legend **Blue** = Full responsibility contractor | **Green** = Partial responsibility contractor

FRAMEWORK Task	Activity	NL	BE 1	BE 2	GE	UK	US	FI
Rehabilitation	Plan							
	Monitor							
	Execute							
Regular maintenance	Execute							
	Monitor							
	Plan							

Integrated COFs cover a range of tasks and are used for planned activities that repeat within a given period. All operational and management tasks were traditionally covered by discrete and framework COFs, but over the past 20 years, there has been an increased trend towards integrated COFs. The degree of integration varies between NRAs about which activities and asset combinations. The fundamental reasoning is the same in all nations, namely the intention is to increase efficiency and lessen the workload for authorities. This by giving the responsibility of condition monitoring and intervention planning. Integrated COFs typically last up to 5 years but can last up to 15 years (CEDR, 2017a, 2017b). According to table 5, the NRAs do integrate a wide range of activities. For all regular maintenance-related activities, there was an agreement among the Netherlands, Germany, the United States, Finland, and Norway. Nevertheless, in a second contract, Finland and Sweden gave the contractor full control over the rehabilitations with the authority only handling quality control. In Australia and the UK, the contractor was partly in charge of rehabilitations but still in charge of all activities for regular maintenance.

Table 5 Activities implemented by NRAs within integrated COFs
Source (CEDR, 2017a)
Legend **Blue** = Full responsibility contractor | **Green** = Partial responsibility contractor

INTEGRATED Task	Activity	NL	GE	UK	US	AUS	FI 1	FI 2	NO	SE 1	SE 2
Rehabilitation	Plan										
	Monitor										
	Execute										
Regular maintenance	Execute										
	Monitor										
	Plan										

The degree of outsourcing of IAM activities is especially noticeable in the integrated COFs, as can be seen by comparing the variations in the tables. Regular maintenance is often the focus of this, but rehabilitation may also be included. Out of the ten integrated COFs, seven operated as a Performance-Based Contract (PBC). Two NRAs used service contracts that were mainly based on unit prices, but they also included performance requirements for the services. So, PBCs are very common when it comes to integrating IAM tasks in collaboration with market players, as is the case by the Dutch national authority Rijkswaterstaat (RWS). They combined several activities and assets into a single district-wide agreement with explicit service requirements. This includes a variety of additional road infrastructure like gutters, viaducts, bridges, and signs. Daily functionality is guaranteed by operational tasks, and system performance is supported by management activities. These management activities entail risk monitoring, data exchange with RWS, and keeping records (CEDR, 2017a).

The studies of the CEDR mention five main strategies for outsourcing maintenance and IAM which can be found in Appendix III. Strategy A means that all activities are in-house performed, while strategy E is to outsource all IAM activities. In strategies B through D, the road authority has to perform fewer and fewer tasks internally as more and more activities are outsourced to contractors. Single maintenance tasks are outsourced in B, multiple maintenance tasks are integrated in C, and asset management tasks are included in D. Every strategy shows the intended COF, with strategy E utilising a fully integrated COF (CEDR, 2017c). The next section dives further into the integrated PBCs.

2.2.1 Performance-Based Contracts

Governmental organisations are progressively utilising PBCs for maintenance purposes (PIANOo, 2020). The PBC approach transitions paying contractors based on their tasks towards compensating them for specific service outcomes. The method utilises well-defined performance indicators and provides flexibility in the execution of road maintenance work. PBC places a high importance on objectives that are focused on the future, the development of innovative thoughts, and preventive maintenance. The extent and comprehensiveness of it can vary, ranging from individual assets to entire regions (Alsharqawi et al., 2017; Queiroz et al., 2009). PBC stands out by transferring a substantial amount of responsibilities and risks from the agency to the contractor. It grants contractors increased independence in determining their actions, timing, and methodologies, provided they comply with the service level requirements outlined in the bidding documents. This enhanced flexibility fosters the adoption of cost-effective approaches and innovative technologies. The contractor assumes full responsibility for any shortcomings in management, including the prediction of asset deterioration, suitability, material specifications, planning for maintenance, and estimation of quantities. PBCs feature extended durations and can include both operational and management activities (Gericke et al., 2014; Queiroz et al., 2009).

PBC presents a range of advantages and disadvantages, the research of Hyman (2009) reports a list (see table 6). Besides, the study Al-Kathairi (2015) claims potential benefits which have been identified by multiple researchers. It describes that the primary benefits include cost reduction, increased innovation and productivity, and transfer of risk to the contractor.

Table 6 Potential advantages and disadvantages of performance-based contracts
Source (Alsharqawi et al., 2017; Hyman, 2009)

Advantages	Disadvantages
- Potential reduction in costs	- A more costly procurement process
- Transfer of risk to the contractor	- A longer procurement process
- Integrated and improved services	- A reduction in competition
- More innovation	- Uncertainty associated with long-term relationships
- Achieving economies of scale	- Obstacles in the process of mobilisation
- Enhanced AM	- Lack of agency control and flexibility to reallocate funds during long-term commitments
- Possibilities of benefiting from partnership	

Within the paper of Porter et al. (2014) and the report of Gericke et al. (2014) it is examined why PBC can facilitate IAM. Recurring questions arise during the process, including:

- What assets are owned and will be implemented in a contract?
- What service level is needed?
- What are the assets' conditions?
- Which interventions are needed for the lowest life-cycle costs?
- Which service delivery risks exist, and how can they be managed?

Although alternative COFs may accomplish many of these desired results deriving from the questions, the primary advantage of PBC is that it addresses all of them simultaneously. It compels a change in perspective and prompts consideration of the principles of effective AM (Gericke et al., 2014; Porter et al., 2014).

2.2.2 Frequent used COFs within the Netherlands

Because the study is focused on Dutch LRAs and so far only international NRAs have been discussed, this part delves deeper into the most widely used COFs in the Netherlands. According to Jansen (2009), PIANOo (2020) and TwynstraGudde (2018) three distinct categories can be found within Dutch COFs, Traditional, Integrated and Bouwteam. Traditional refers to a situation in which the contractor receives precise instructions from the client, this pertains to both Discrete and Framework COFs. In the Netherlands, integrated mostly also refers to the integration of multiple 'project phases' (Design, Construct, Finance, Maintain, and Operate). It does not necessarily mean integrating asset management tasks into the collaboration what is meant by the CEDR. When this is not the case, the COF is also discrete. Although these terms overlap, figure 5 shows that the majority of work in the Netherlands is still done traditionally and discrete. The Bouwteam agreement is separated due to its two-phases characteristics (Du Saar, 2022), this will be further discussed.

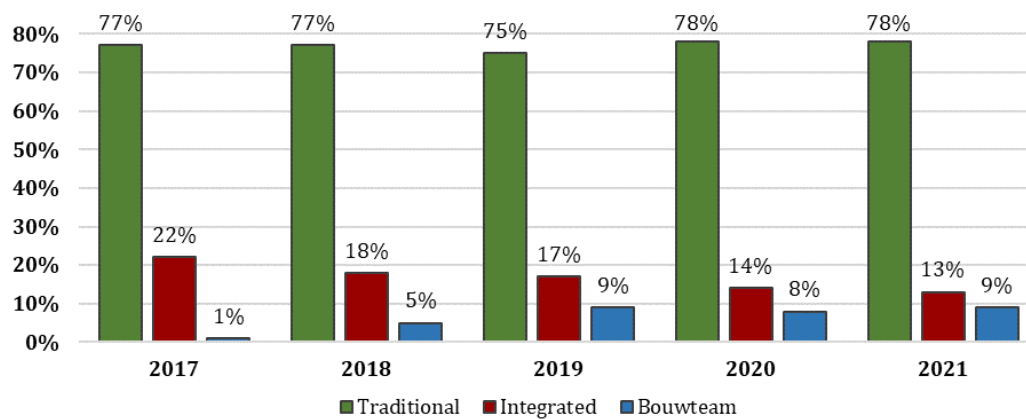


Figure 5 Distribution of COFs as % of total tenders within the Netherlands, 2017-2021

Source (Du Saar, 2022)

The most common approaches used in the Netherlands are RAW-systematics, Bouwteam, Engineer & Construct, Design & Construct, and Design, Construct & Maintain (PIANOo, 2020; TwynstraGudde, 2018).

RAW-systematics

The client takes responsibility for creating the design and work preparations, which are subsequently provided to the contractor relying on specific instructions. It is a discrete approach and a notable characteristic of this is that the procurer has the opportunity to exert significant influence over the process, the outcome, and consequently, the price (Jansen, 2009; PIANOo, 2020; Verkooijen & Drost, 2010). RAW can also be used as a framework COF and then the contractor agrees on fixed prices for non-project-specific work over a certain period. As a result, a statement of work is frequently included, comparable to the standard RAW systematics, but the specific quantities are not specified. The contractor operates within a defined regional area for a longer duration, allowing them to gain specific expertise and effectively oversee a variety of projects (PIANOo, 2020; Rijksoverheid, 2019b).

Bouwteam

A Bouwteam is a collaborative approach wherein a contractor and a client engage in close cooperation during the design phase to formulate and refine a plan or design. During the early phases of intervention projects, the contractor can take an advisory position, applying their expertise to collaboratively develop the most efficient design with the client. It is frequently called a two-phase approach because the Bouwteam phase is separated from the other phases. It can also be used as a systematics to do management activities to specify a discrete, framework and integrated COFs can be prepared through cooperation. Within a Bouwteam, only the preliminary tasks within an intervention project may be carried out, while a separate contractor is responsible for the actual execution (Jansen, 2009; Uzun, 2022; Verkooijen & Drost, 2010). An example of a Bouwteam structure is shown in the figure below.

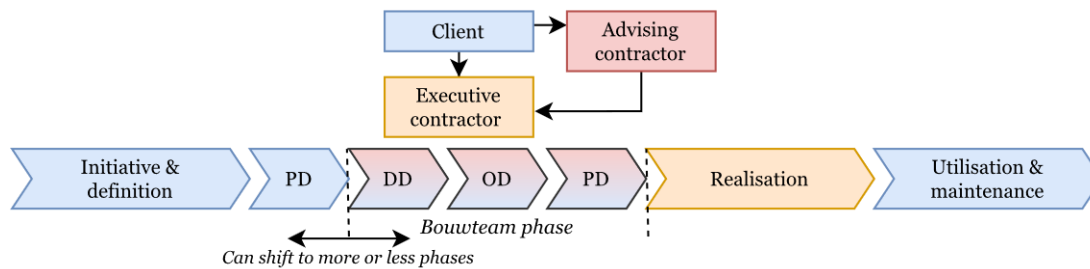


Figure 6 Schematic representation of Bouwteam
Source (SWECO, 2021; Uzun, 2022)

Engineer & Construct and Design & Construct

Engineer and Construct (E&C), also referred to as Engineer & Build, is a discrete approach where the contractor is responsible for the execution of the intervention and the work preparations. Design & Construct (D&C) entails the contractor having responsibility for both the design and execution of the project, following the specified requirements. This facilitates the optimisation, innovation, and coordination throughout the process. As part of the collaboration, the client is presented with intermediate results for their approval. Consequently, this leads to the consolidation of a single contract with the contractor (Jansen, 2009; Priemus, 2009; Sanchez et al., 2015; Verkooijen & Drost, 2010).

Design, Construct & Maintain

When a multi-year maintenance component is merged into the above-mentioned integrated forms, this leads to the development of the Design, Construct & Maintain (DCM) approach. This approach is utilised when there is a need for management measures and the outsourcing of long-term operations. Assigning the maintenance task to the contractor who is also accountable for the design offers the benefit of employing the "life-cycle" approach. When a market party is responsible for all three phases, it has the potential to result in innovative and easily maintainable solutions (Koppenjan et al., 2022; Lenferink et al., 2013; Verkooijen & Drost, 2010). Additionally, the option to assign financial responsibility to the contractor can be selected, leading to the implementation of DCFM. Nevertheless, this does not alter the accountability during different stages of the project.

These COF types include stand-alone interventions. The client's and contractor's responsibilities vary greatly from only the execution within RAW to including the design within a D&C. Maintenance tasks are specifically mentioned in a DCM agreement, but this is usually about stand-alone assets like bridges. Integration of management and operation tasks for one or more assets within a designated area is demonstrated in IAM, but this is not naturally addressed within these types. What trade-offs principals should make to arrive at a specific COF is further covered in the following section.

2.2.3 COF considerations

To determine the most suitable COF, the client must primarily establish a precise definition of their objectives with a specific focus on quality, cost, and time. The client should provide details on its ambitions, capacities, constraints, and the specific activities at hand. Although clients commonly opt for the traditional and discrete approaches, they should increase their knowledge of the available alternatives (Jansen, 2009). The advantages and disadvantages of each COF, that are mentioned previously, are outlined in Appendix III. In this appendix it is demonstrated that the allocation of duties, allocation of risks, and impact of the client differ significantly.

Various factors influence a client's decision to outsource activities to external organisations. In the past, authorities have overseen operational and management tasks by their staff. Nevertheless, recent developments such as policy adjustments, reduced resources, and budget constraints have led to an increased dependence on outsourcing (Schoenmaker & Verlaan, 2013). Table 7 presents a summary of the recurring motives found in the literature. Here, the main driver for cost reduction is the implementation of competitive tendering (Domberger, 1997; Leiren et al., 2016; Lindholst et al., 2018).

Table 7 Motives to choose for outsourcing

Outsourcing motives	Sources
Reduce overall costs	Domberger (1997); Hassanain & Al-Saadi (2005); Leiren et al. (2016); Lindholst et al. (2018); M. Zhang & Sun (2012);
Quality improvement / more innovation	Hassanain & Al-Saadi (2005); Wassenaar et al. (2013); M. Zhang & Sun (2012);
Obtaining expertise which is not available in-house	Hassanain & Al-Saadi (2005); Leiren et al. (2016); Schoute et al. (2018);
No in-house capacity / speed up the process	Hassanain & Al-Saadi (2005); Leiren et al. (2016); Lindholst et al. (2018); Wassenaar et al. (2013);

Each type of COF has a particular risk profile, which affects not only the client but also the contractor. The level of client engagement, which can range from directly controlling the project to merely accepting the results of it, is another factor that affects this profile. A graphical illustration of the differences in risk and influence that can be found across the various COFs can be found in figure 7a. According to Karsten (2009), it is possible to improve risk management and more effectively allocate responsibilities to the contractor if the design phase is integrated with any potential subsequent phases. The bundling of projects is a third dimension that can be taken into consideration in addition to the sharing of risks and the integration of different phases of the project (see figure 7b). Projects are typically bundled together throughout a multi-year collaboration, and this is especially true in the case of PBCs and framework collaborations.

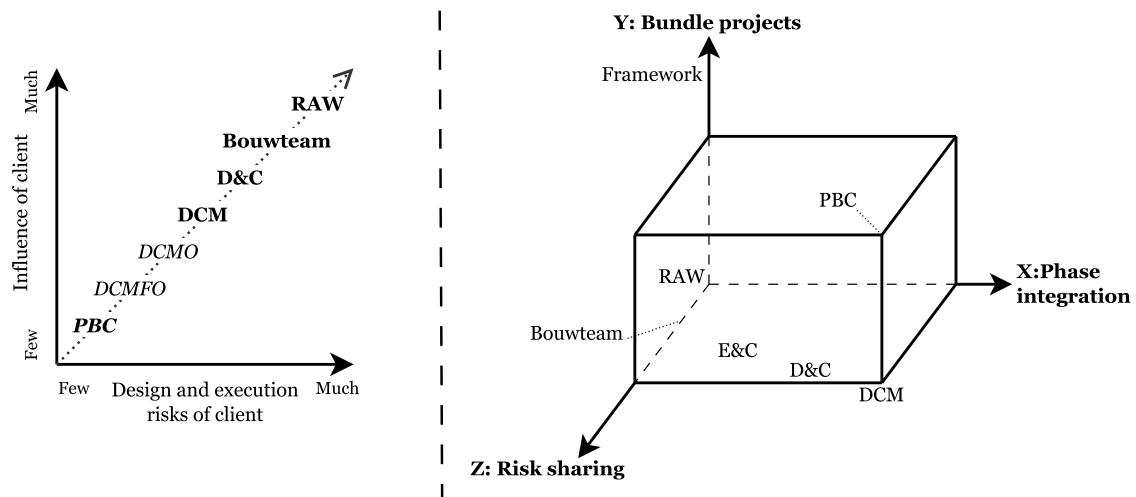


Figure 7 A: Influence and risks of the client | B: XYZ-axis of bundling, integration and risk sharing
Source (Karsten, 2009; Monumentenregie, 2013)

2.3 Theoretical framework

Synthesising the two primary components is important for the theoretical framework. Concerning IAM, the CROW's iAMPro model was found to be the most extensive compared to the ISO-standardised series, making it a proper framework for further study. While many of the frameworks found in the international literature are valid models, they all neglect a crucial step in the AM process. Given the extensive elaboration of various underlying themes and activities in the iAMPro model, it is viable to analyse the implementation of these activities in local governments. This high level of comprehension will enable in-depth investigation and it is acknowledgeable that the CROW maintains the greatest level of recognition within Dutch LRAs. However, the framework is too extensive to analyse all activities for implementation in certain COFs. Therefore, it is convenient that the CEDR consolidates the activities into planning, monitoring, and executing which are the main operational and management tasks within IAM.

The division of responsibilities between the client and contractor in maintenance contracts is determined by COFs. In IAM, the operational aspect oversees intervention execution, while the management aspect addresses planning and monitoring. These activities can be included in or excluded from discrete, framework, and integrated COFs, according to the CEDR. Discrete COFs are frequently utilised for planned maintenance activities like rehabilitations since they are usually short-term and project-oriented. Medium-to-long-term Framework COFs cover both planned and unplanned activities and promote effective communication between road authorities and contractors. When it comes to planned activities that repeat over a predetermined amount of time, integrated COFs are utilised for a variety of IAM tasks. The usage of the PBCs approach has been observed in most studied countries as an integrated form and has been on the rise for the last 20 years, also within the Dutch NRA. Nonetheless, the majority of COFs used in the Netherlands are framework or discrete which means that the main focus within these cooperations was on the execution of interventions.

The theoretical framework consists of these main elements, see figure 8. The framework serves as a conceptual guide that allows understanding, evaluation, and interpretation of the aspects of this study. The lines show a road authority's entire cycle of interconnected components. The policy and strategy of the client who owns the assets is where it all starts. The other components get started by assessing different trade-offs. Determining which IAM activities are integrated into the contract is necessary because decisions can affect the type of COF, namely discrete, framework, or integrated. The IAM cycle is centrally located and is divided into management and operational tasks. Monitoring and planning, with the corresponding iAMPro model phases, are further subdivided into management. From an operational perspective, the iAMPro model's Plan & Prepare and Build & Maintain phases are underlying. These belong in this group since its main objective is to plan, prepare, and execute interventions that comply with the model. Again, based on the client's strategies and capabilities, these components may be carried out internally or by a contractor. Evaluation is essential because it gives the policy and the IAM cycle feedback. The comprehensive approach to road maintenance can be guided by this model for both NRAs and LRAs.

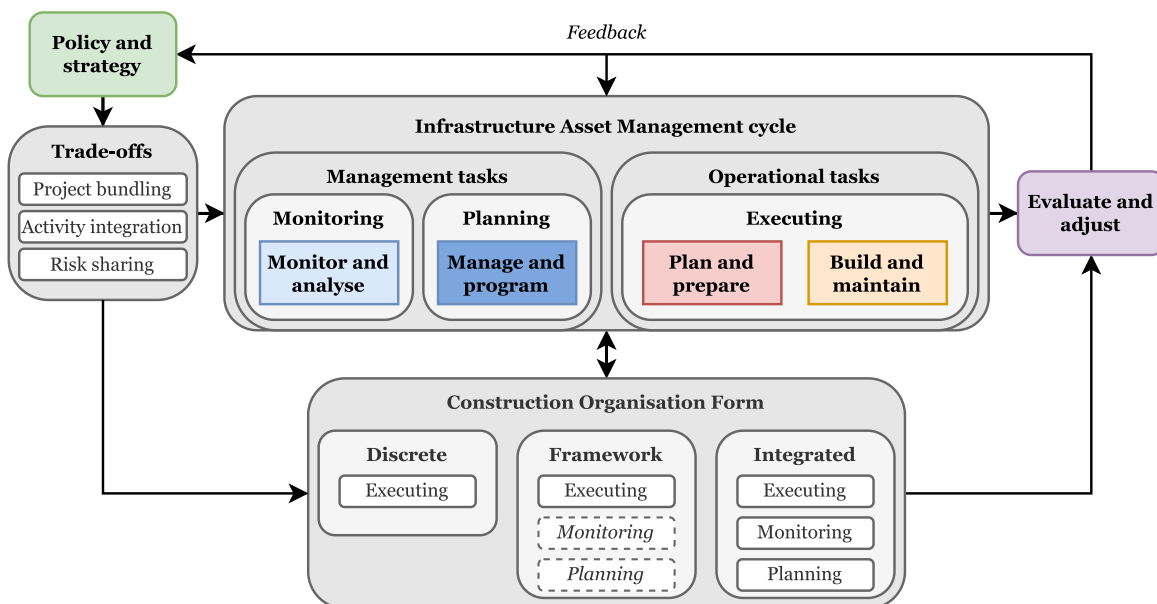


Figure 8 Theoretical framework

3

Research methodology

The study was conducted from Strukton's point of view to find out if there are any chances for Strukton to use and share its experience given the extent of IAM procedures and the COFs used for road interventions in Dutch Local Road Authorities. A mixed-method research approach that encompasses both breadth and depth has been selected to obtain a thorough understanding of the LRAs. Within this approach, the combination of qualitative and quantitative methods is integrated into the research (Molina-Azorin, 2016). The main sources of data in qualitative research include interviews, focus groups, observations, and document/material analysis (Jain, 2021; Leech & Onwuegbuzie, 2008). Quantitative research entails formal, objective, and systematic processes for gathering and analysing numerical data to identify patterns and make predictions (Mason, 2017), for example, desk research can be used to collect data from existing reports, statistics, and other resources (Chi, 2023).

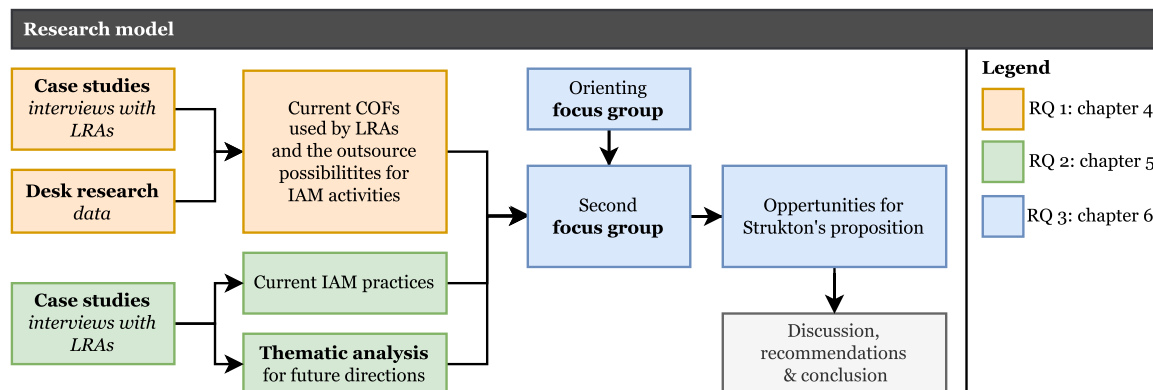


Figure 9 Research model

As illustrated in figure 9, the research model is divided based on the research questions. One or more research methods have been used for each sub-question; these are explained in sections 3.1 to 3.3. Insights into the current COFs used by Dutch LRAs and the possibilities of outsourcing IAM activities are requested within the first research question. The desk research method was the main tool used to learn about a large amount of LRAs. Furthermore, inquiries concerning this subject were made during the case study interviews, which were implemented within the results of this sub-question.

The second question relates to gaining an understanding of the current and desired practices of IAM on road maintenance within the LRAs. For this, it had been discussed with study initiator Strukton that it was possible to get contacts with LRAs they had partnered in the past. It was expected that 5-15 authorities wanted to cooperate in the study. The book of Verschuren & Doorewaard (2021) describes the case study as an in-depth research methodology with a relatively small number of research objects and labour-intensive research. This type of qualitative research seeks to investigate a topic or area of interest that is either new or has received little research attention. This method was intended to generate new insights into the LRAs as so-called cases (Fisher & Ziviani, 2004; Yin, 2018). By considering the authorities as stand-alone cases, the current situation of each case can be outlined, as well as future desires to improve their IAM practices.

The final question concentrates partly on the outcomes of the first two questions but also identifies future directions for Strukton. It focusses on the current IAM capabilities within Strukton and if there are areas of improvement they should focus on. For this, the focus group method was found as the most suitable in this situation. In such a discussion, the researcher facilitates an interactive session with a group of individuals, where their diverse personal experiences, beliefs, perceptions, and knowledge on a specific topic are shared, guided, monitored, and recorded (Gill et al., 2008; Nyumba et al., 2018; Powell & Single, 1996). During the sessions, the results from both research question outcomes were discussed and further elaborated into what it means for Strukton.

3.1 Desk research

During the desk research, a comprehensive review of road maintenance tender files from Strukton's data system was conducted. The amount of information that Strukton possesses regarding project enquiries, tender documents, and project specifications is extensive. It was quite curious to see which COFs were used most, and this information is required to answer the first research question. To obtain a comprehensive understanding, a five-year timeframe spanning from 2019 to 2023 was selected. This prompted a desk research of 375 tender documents from a total of 107 municipalities, 4 water boards, and 10 provinces. Within the documents, it was checked whether these were discrete, framework or integrated COFs. With these insights, it is possible to estimate whether there are opportunities for Strukton to offer their IAM practices or whether they are mostly focused on executions. Integrated COFs were further reviewed to see which specific tasks were outsourced.

3.2 Case study

For this methodology, 12 LRAs were analysed. In table 8, some information about the cases and a much broader introduction can be found in Appendix V where the cases are extensively explained in detail. It is worth noting that Utrecht has the highest population density and the highest road density. Of these two parameters, Hollands Kroon ranks as the least dense municipality, while provinces and the water board have even lower road densities. This is not surprising as they have a much larger area and do not have to manage all the municipal and state roads in their area. It was to be expected that among the municipalities, those with a high density have a more complex road network than those with a lower density and therefore face more complex problems in their IAM process.

Table 8 Case introduction table, numbers of 2022
Source (CBS, 2023; HHNK, 2023)

* = Density of residents ** = Density of roads

Nr	Case	Type	Region	Area [km ²]	Residents	Dens. 1* [res./km ²]	Roads [km]	Dens. 2** [km/km ²]
1	Hengelo	Municipality	North-East	62	81.476	1.339	500	8,1
2	Súdwest-Fryslân	Municipality	North-East	908	90.300	173	1.185	1,3
3	Hollands Kroon	Municipality	West	662	48.778	136	741	1,1
4	Breda	Municipality	South	129	184.702	1.469	974	7,6
5	Overijssel	Province	North-East	3.421	1.171.910	353	849	0,2
6	Dijk en Waard	Municipality	West	67	87.695	1.417	461	6,9
7	Utrecht	Municipality	West	99	361.699	3.857	1.067	10,8
8	Fryske Marren	Municipality	North-East	549	51.597	147	752	1,4
9	HHNK	Waterboard	West	1.966	1.182.758	601	420	0,2
10	Noord-Holland	Province	West	4.092	2.909.827	1.093	757	0,2
11	Tilburg	Municipality	South	128	224.459	1.783	1.102	8,6
12	Almelo	Municipality	North-East	69	73.115	1.089	506	7,3

The data was mainly collected through interviews and partly by a document analysis which are the two primary sources of data (Cuthill, 2002; Jain, 2021; Onwuegbuzie et al., 2014). The interviews were conducted in a semi-structured way which is extensively used to address complex research questions (Doody & Noonan, 2013; Gill et al., 2008). It ensures that the same topics are discussed in the interviews, but there is space for personal directions and interpretations (Alsaawi, 2014; de la Croix et al., 2018; Gill et al., 2008). The data collection within the case study interviews was done in six steps, see figure 10. This way helps with data collection creates an overview of all received answers, and finds theme-specific similarities. If there were relevant documents to be reviewed, such as policy documents, these have also been analysed mainly to get background information.

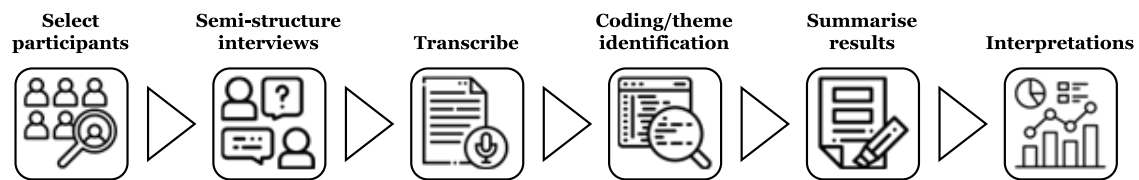


Figure 10 Phases within case study interviews

Source (Adeoye-Olatunde & Olenik, 2021; Braun & Clarke, 2006; Griffee, 2005)

When initiating the interview, a detailed explanation was sent to the intended participant. It was jointly checked whether that person was the right one and could answer all the questions. If the interviewee suggested that it would be more beneficial to talk with someone else, another participant was searched for. If it was considered practical to engage with multiple individuals or if it became clear during the interview that not all questions had been addressed, a subsequent interview was arranged. Within the cases of HHNK and Overijssel, the interviewee suggested the need to talk to an additional individual. During the interviews, the theoretical framework (with the iAMPro model) took centre stage. Initially, the current situation of IAM was discussed, which was divided into different phases. The current organisation form was included as a topic in one of the questions on IAM. The second part primarily focused on identifying the specific elements or processes that the local authority intended to expand, exploring potential areas for enhanced collaboration with contractors, and assessing their level of satisfaction with the current COF. The complete protocol is available in Appendix VI.

Furthermore, the interviews were conducted online through Teams to minimise travel time and enhance the interview options. Following the completion of a semi-structured interview, all of the content was transcribed in preparation for subsequent coding. This was done by the method of thematic analysis which is broadly described in the papers of Braun & Clarke (2006) and Nowell et al. (2017). The main steps are generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing results. The analysis has been done by the use of the program Atlas.ti which is a broadly used computer-assisted qualitative data analysis software (Paulus & Lester, 2016). It was expected that several themes would emerge from the thematic analysis that frequently returned in multiple interviews. From these important themes, the researcher returned to the raw data to see exactly what was said per case regarding these themes.

3.3 Focus group

The final question discusses the answers to the first two questions and indicates directions Strukton may go in the future. It specifically looks at Strukton's present IAM capabilities and finds possible areas for development. The focus group method was found to be the most appropriate strategy in this situation to address this. Focus groups are a valuable tool for understanding the collective opinions and deeper meanings associated with them on a particular subject (Gill et al., 2008; Powell & Single, 1996). A particular strength of the methodology is the possibility for participants to develop ideas and answers collectively (Smithson, 2000).

Two focus groups were organised for this study, one serving as an orientation session (before case study results) and the other as a follow-up session (after case study results). The purpose of the first one was to provide employees an opportunity to discuss their experiences within the broad framework of IAM. It was attended by a total of five persons from both Strukton and Unihorn which is a subsidiary and develops innovative concepts. However, the wide scope hindered the emergence of the subject's essence. The second focus group resulted in a more precise process due to the case study results. It was attended by four employees of Strukton which were mainly (AM) managers and a tender coordinator. The initial conversation focused on looking at the current state of IAM within the LRAs, followed by a discussion of future activities that the authorities would like to develop. This led to a lengthy conversation about what Strukton should, could, or should develop to respond to this. The topic of COFs and Strukton's desired future developments for joint IAM application at LRAs was also discussed.

4

IAM outsourcing strategies

This section presents the findings about the current outsourcing strategies by LRAs within the Netherlands. The majority of these findings were derived from extensive desk research, supplemented by the insights obtained from case studies. In particular, this chapter answers the first research question. The desk research encompasses data from projects conducted between 2019 and 2023, totalling 375 projects as can be seen in table 9 and the development over these years is visible in figure 11. The number of integrated COFs remains to be low, with only two requests in 2019 and 2022. Over time, the quantity of Framework COFs rose to a quarter of all requests in 2022 and 2023. This increase suggests a decline in Discrete COFs, but they still account for most of the requests made by LRAs to contractors. As a whole, the distribution is as follows: 79% discrete, 20% framework, and 1% integrated, see figure 13A.

Table 9 Discrete, Framework, and Integrated COFs used by LRAs (2019-2023)

COF	2019		2020		2021		2022		2023		Total	
Integrated	2	5%	0	0%	0	0%	2	3%	1	1%	5	1%
Framework	6	15%	19	18%	15	17%	16	25%	18	24%	74	20%
Discrete	32	80%	89	82%	73	83%	47	72%	55	74%	296	79%
	40		108		88		65		74		375	

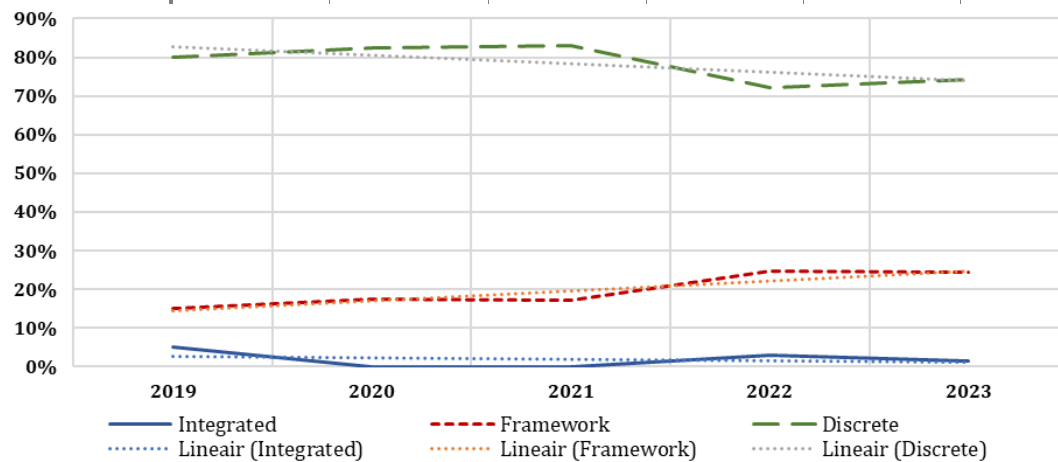


Figure 11 Distribution of COF types over 2019-2023

Additionally, it seemed that the choice of COF and the Dutch regions were related, this is illustrated in figure 12. The distinguishing factor of the west, in comparison to the other two regions, is its significantly greater degree of urbanisation. The data presented in table 8, of the case introduction, demonstrates that this region has a higher population density and a larger concentration of roads. In contrast to other regions, the western region employs a greater percentage of Frameworks, accounting for 28% instead of 16% and 18%. The amount of integrated COFs remains low in all three regions within the Netherlands.

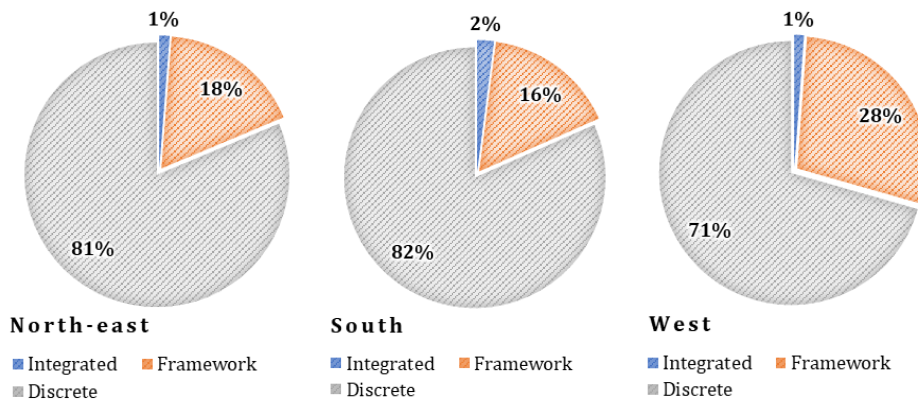


Figure 12 COF choices per region within the Netherlands

Within figure 13B it is visible which contract types were applied during the discrete collaboration. The great majority made use of the RAW systematics, which provides a detailed description of the rehabilitation work along with the necessary actions. Additionally, there were Bouwteams where the contractor and client worked together on the design and intervention preparations. There have been instances where the entire design process and rehabilitation preparations have been outsourced, respectively, under the Design and Construct (D&C) and Engineer and Construct (E&C) approaches. Concerning framework COFs, the RAW-framework systematics was constantly utilised, offering comprehensive descriptions of tasks without quantities and with unit prices. In some Framework agreements, the contractor was partly permitted to be responsible for the intervention planning, this will be covered in more detail later.

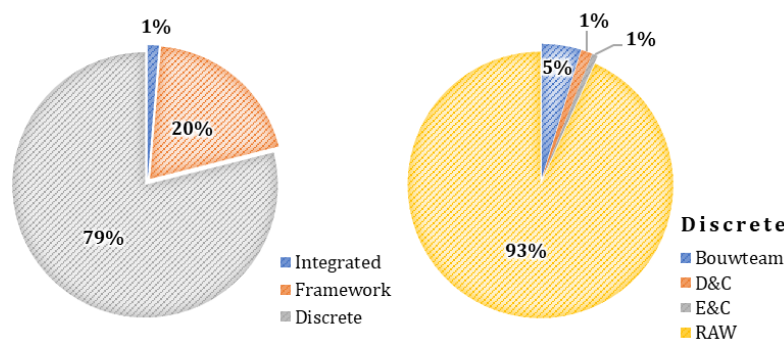


Figure 13 A: Total of COF types | B: Contract types within discrete COFs

Table 10 offers more information about the activities within the various COF types. It reveals that discrete COFs always involve standalone assignments with a project character for rehabilitation executions. There are two differences when it comes to framework COFs. First, requests have been made for rehabilitations over a multiple-year period, for maintenance tasks like surface replacements. Occasionally, it is stated that the contractor may assist with monitoring and planning. However, it is also commonly mentioned, that the client assigns periodised sub-tasks and is still in charge of planning and monitoring. There is also another type of framework in which the contractor is responsible for routine or daily maintenance in addition to the rehabilitations. In this case, planning may fall under the contractor's responsibility, although it is frequently mentioned that the client and contractor work together on this. Concerning the type of roads, asphalt roads are the most common, but concrete roads, elementary roads, and bike lanes may also be included.

Table 10 Activity integration within COFs

Legend Blue = Full responsibility contractor | Green = Partial responsibility contractor

Task	Activity	Discrete	Framework 1	Framework 2	Integrated 1	Integrated 2
Rehabilitation	Plan		Green	Green	Blue	Blue
	Monitor		Green	Green	Blue	Blue
	Execute	Blue	Green	Green	Blue	Blue
Regular maintenance	Execute			Green	Blue	Blue
	Monitor			Green	Blue	Blue
	Plan			Green	Blue	Blue

There are a total of five contracts that demonstrate an integrated approach. Three Bouwteam agreements combined monitoring and planning. This cooperation aimed to develop a multiyear planning for an upcoming Framework agreement. The management tasks in this case fell under the responsibility of the contractor, whereas the operational tasks were covered by a different contract. For example, the municipality of Almelo decided to outsource the planning for both minor and major asphalt maintenance. In terms of the contribution of the contractor in terms of IAM, it was specified to contribute to the maintenance cycle by developing processes related to performance, costs, risks, contract innovation, and AM roles (Gemeente Almelo, 2022a).

Further, two PBCs encompass the maintenance of many assets which are located within public spaces. The following management responsibilities for the contractor were mentioned within the agreement additionally to the operational tasks (Provincie Noord-Brabant, 2023; Provincie Zuid-Holland, 2022):

- Inspection and monitoring
- Recording, updating, and providing feedback on data
- Developing multi-year management and maintenance plans
- Offering advice on AM improvements
- Coordinating area maintenance activities
- Managing environmental aspects, such as soil investigation, inspections and monitoring
- Gathering extensive topographical data
- Communication by providing information to stakeholders.

The documents observed through desk research can be compared to the strategies mentioned in the theoretical background. Figure 15 shows that more than three-quarters of the time, strategy B was selected. With this method, AM tasks were prepared internally, and only standalone operational maintenance tasks were contracted out to the contractor. This applies to Framework COFs that only consisted of rehabilitations as well as all discrete COFs. Around twenty per cent used strategy C, which required the completion of standalone and integrated maintenance tasks. This was seen in Framework agreements where the contractor was in charge of daily, minor, or medium-sized maintenance tasks in addition to rehabilitations. In a minor amount of cases (integrated COFs), strategies D or E were selected. Wherein strategy D the contractor was responsible for only planning and monitoring, but in the PBC agreements all management and operational tasks were outsourced to the contractor.

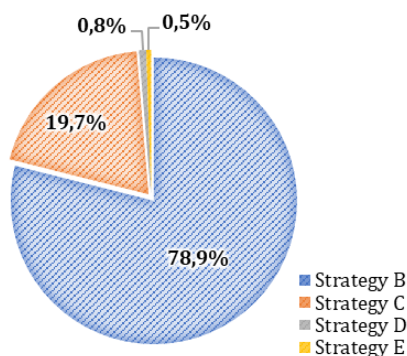


Figure 14 Used outsourcing strategies by LRAs

4.1 IAM outsourcing strategies within case studies

Within the case studies 9 cases indicated using framework agreements for minor and major maintenance, and using RAW for more complex and larger projects (see figure 15a). Some cases claim to perform all projects using the RAW systematics (discrete), while Noord-Holland states that they have so-called 'area contracts' (integrated). A series of six agreements with various PBC contractors ensure the maintenance of all seven regions within the province, these are referred to as PBCs. Within this, the contractor assumes the responsibility of planning, monitoring and executing maintenance for 10 years. Each contractor is responsible for their part of the province and they also need to ensure data

management. Presently, the province has incorporated into these PBCs all components located in public areas, including roads, sewers, and civil engineering structures.

"We have six contracts in seven areas. Those area-contracts include all elements of management, so the green spaces, the roads, the structures, everything and with that, a 10-year contract was awarded to the market." ... "All types of maintenance in within the contract." ... "The variable maintenance is also really coordinated with the contractor about when what is going to take place." ... "The contractors know the area, know the roads, have people there in the area. And yes, they take all the work at that time." – Interview Noord-Holland, 13 September 2023

When assessing the current COF, the interviewee was also questioned about their view on whether the current form is sufficient or if their organisation is seeking a different approach. Most indicated that they are seeking an alternative, refer to figure 15b. Only the governments of Noord-Holland and Utrecht expressed satisfaction with their strategy for area PBCs and framework agreements. Four cases mentioned that they encountered difficulties in identifying the optimal strategy suited to their specific demands. Similarly, four authorities said that they want to keep the management activities in-house and do not want to use integrated COFs. The two remaining cases show their openness to consider a longer-term COF with a contractor, which would enable the contractor to acquire knowledge about the assets and subsequently carry out work with greater efficiency. When comparing these prospective with the average road density and population (table 11), it becomes apparent that LRAs in regions with lower density tend to keep management activities in-house, while LRAs with higher density characteristics are more inclined towards framework or integrated COFs.

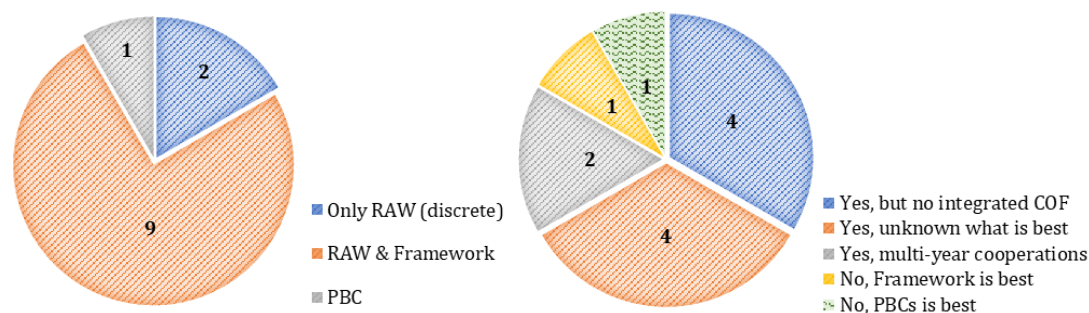


Figure 15 A: Current used COFs by the cases | B: Cases about the search for a new COF

Table 11 Future COF directions mentioned by cases including average densities

Future COF directions	Avg. Res. Dens. res./km ²	Avg. Road Dens. km/km ²
Yes, more multi-year cooperation	1436,0	8,0
Yes, unknown what is best	739,0	3,1
Yes, but no directing role	683,6	3,5

Only Noord-Holland makes use of integrated PBCs which means that all management and operational activities (planning, monitoring, and executing) are outsourced to the contractor. The other LRAs use a framework or discrete COFs, resulting in the authority itself being internally in charge of management tasks. The theoretical background indicated that there are multiple reasons for choosing a COF type that involves more outsourcing or in-house activities, this was also asked about within the case studies. Responses suggest that the primary motive for outsourcing activities is capacity, with over half of respondents also citing insufficient internal expertise as a factor. One particular case explicitly cited time pressure in certain projects as a potential factor.

4.2 Conclusion

This chapter presents the current outsourcing strategies that Dutch LRAs were using, based on case studies and desk research. There are many discrete COFs between 2019 and 2023, but in the last two years, the percentage of framework agreements has increased to 25%. With a maximum of two maintenance contracts annually, integrated COFs are limited. The Western region stands out in

particular because of its greater degree of urbanisation and its apparent preference for Framework COFs over other regions. For both discrete and framework COFs, RAW systematics are almost always selected, whereas PBC is used for integrated COFs where planning, managing, and executing activities are outsourced. Whereas a framework can vary and include multi-year rehabilitations with possible shared planning or monitoring responsibilities, the discrete approach always entails only standalone rehabilitation tasks. Overall, this indicates that category B was selected in the majority of cases, while 20% of cases were selected for category C.

Nine case studies showed that framework agreements are used for both minor and major maintenance, with discrete RAW being used for more complicated and large-scale projects. While some cases only use discrete COFs for all maintenance tasks, Noord-Holland has chosen to implement integrated PBCs that cover all asset maintenance for the next ten years. While most interviewees desired a different strategy, only those from Utrecht and Noord-Holland were satisfied with their framework contracts and PBCs. Four authorities favoured maintaining the management activities in-house, while four cases struggled to determine the best course of action. The two remaining cases demonstrated a willingness to explore longer-term partnerships with contractors.

The data for the years 2022 and 2023 indicates a decline in the discrete and a rise in framework COFs. This may be attributed to the local authorities' adoption of risk-sharing and project bundling strategies. Alternatively, this could indicate that governments in recent years have different reasons for outsourcing multiple activities to external parties. The case studies describe that the motives of the LRAs were primarily driven by capacity constraints and a lack of in-house expertise. It is noteworthy that the number of integrated COFs is extremely limited which suggests that local authorities may not want to fully outsource activities to contractors, but instead prefer to maintain their internal involvement. Further, the framework COFs are more commonly used in Western regions with higher rates of urbanisation, according to the desk research and case studies, and only provinces have used all fully integrated COFs. During the Strukton focus group, it was suggested that long-term collaboration is preferred, which means that these kinds of LRAs should be the main focus. With the help of these strategies, the contractor would be able to better coordinate the interventions, obtain a thorough understanding of the region, and perhaps prioritise sustainability, circularity, and optimisations in addition to facilitating planning.

5

Current IAM practices and areas of improvements

This chapter presents the findings related to the second research question by providing an understanding of the current IAM practises and the desired future directions within Dutch local governments. The findings are obtained through the analysis of the case study and are categorised into two sections, which are also determined by the interview protocol. The first section centres on the present situation and encompasses the introduction of a flowchart, which is supported with information. The second component entails a thematic analysis that delineates the specific areas in need of enhancement. Following that, a thorough examination of the three fundamental components is carried out to analyse the specific topics that were discussed during the interviews with these components.

5.1 Current IAM practices

Policy and Strategy

Not all governments describe having policy documents on road maintenance or IAM. However, they do indicate that they all have a memo on infrastructure capital assets that contains the (economic) depreciation periods for the assets. These periods are usually not very different from the technical lifespan and are therefore often used for the cyclic lifespan of roads. Nevertheless, five authorities indicate having a policy document that describes the strategy, goals, working methods and other important aspects for the upcoming four to five years.

Manage, program, monitor and analyse

Governments employ management systems to record information about roads, with regular inspections serving as the primary method of data input. It does vary how often these are done from annually, to every two years, to even continuous data input. The inspections utilise CROW systematics, which offers both fixed and variable data. Fixed data pertains to the government's administration of various elements, including geographical regions, asset lifespans, road segments, and pavement composition. The variable data encompasses various parameters that indicate the condition of the roads (CROW, 2019). The management system may incorporate complaints from residents and maintenance departments in certain instances.

"It is threefold, the inspections of course every two years. You have a distinction in that, say the real inspection systematics and then it shows where the inspector indicates minor maintenance." ... "Well the rest of the inspection results, so we are also going to put those into the 'measure test', we combine that with the knowledge of the field staff and with complaints from our reporting system. Fiction.nl is our reporting system." ... "We will then look based on the inspection results to see how we see that from two years ago, what is the degradation curve and what are we going to do now and what can wait a year." – Interview De Fryske Marren, 4 august 2023

The 'measure test' is a procedure employed by road managers to verify that proposed measures are following what is necessary. The process entails the selection of road sections for evaluation, performing a thorough on-site examination, and aligning measures with other plans and budgets. The manager chooses sections according to a short-term timetable ranging from 1 to 2 years and

subsequently assesses the planning, type of intervention, and extent. Modifications may be implemented as a result of divergences, synchronisation with other strategies, or external determinations (CROW, 2019). Except for Hollands Kroon, nearly all governments assert their commitment to this approach. However, Hollands Kroon prioritises personal observation of the current situation over the 'measure test' on objective data. The road quality standard is usually established at level-B, based on the CROW systematics. This guarantees that the suggested measures are following the actual execution. Based on this assessment, a maintenance schedule spanning 1 to 2 years is formulated, specifically targeting immediate maintenance needs. Nevertheless, numerous governments assert that they also formulate plans for the long term. The time frame can vary from 5, 8, 10, 20, or even 30 to 60 years ahead. The indication suggests that project plans are highly specific for up to 2 years, moderately specific for up to 5 years, and primarily based on the age of the roads for periods exceeding 5 years.

"You talk about year 1, which is this year you can do that planning and I often stay that way. But year 2 is already more difficult, because each road, the condition deterioration is different for each road. Some go faster, others go slower or something else comes in between." ... "So a multi-year maintenance planning, year 1 works pretty well but after that, it does get vague quickly." – Interview Hengelo, 6 July 2023

"Indeed, we also use the management system to generate planning and that is mainly that the inspections are read into it, and the basic planning is extracted." ... "With that basic planning, we then look at the roads that are high-risk for the next two years" ... "The maintenance plan that we have now you have to look at it as a period of five years. But the investment planning, so the replacements. I believe we are planning there now until 2040/2050. Where the next 10 years the plans are a bit more concrete." – Interview Utrecht, 3 August 2023

"1 to 2 years is the qualitative planning. That's based on the quality you have established and then you move towards cyclical planning. Yes, we can plan those 60 years forward now, But that is pure of this is my construction year and then every time in that cycle so that measure would occur." – Interview Almelo 28 September 2023

Numerous authorities state that they have trouble making long-term plans because they frequently are unsure of their exact goals at this point. Additionally, it is stated that the current management system does not support or enable the implementation of these plans. Unfortunately, other authorities suggest that this type of long-term planning, which primarily relies on cyclical maintenance and replacement cycles, is effective for communicating with both internal and external asset owners. Internal assets encompass infrastructure such as public sewer systems, civil engineering structures, and areas designated for greenery. External asset managers include utilities and housing corporations.

"Is planning also done together with external parties? - Yes, that is also my colleague who integrally coordinates with utility parties with housing corporations. All those kinds of stakeholders who influence the public space." – Interview Almelo, 28 September 2023

"There you can also see that we have so many things interlocking there. That planning together with external parties is almost impossible." ... "Those parties have much more of an already execution-oriented planning." ... "What they are sharing with us so far, then they are not looking very much further ahead than that." – Interview Utrecht, 3 August 2023

"There is a 'programming table' that jointly arrives at budgeting and project definitions. In doing so, we are programming projects up to about four years ahead." ... "The municipal programming of projects are discussed several times a year with the utility parties, we coordinate schedules as much as possible in this process." – Answered questionnaire Tilburg

Plan and Prepare

It appears that practically every government has standards for preparing the projects that are proposed, but there are variations in the available standards. For instance, a standard specification document (in Dutch: moederbestek) is indicated by almost all to have one. Breda, Utrecht, and De Fryske Marren have implemented a LIOR or HIOR, which stands for a guideline or handbook specifically designed to create public spaces. This document provides a detailed description of the design and implementation process for roads and other elements in public spaces.

"We have a standard programme of requirements and a master specification document indeed." ...
 "The programme of requirements was already a challenge to get it through the whole municipality. Handbook of designing public space, therefore, where indeed the urban planners are also a bit more involved, that is still very much in its infancy." – **Interview Breda, 27 July 2023**

"That is the LIOR, guideline for designing public space that also includes an element catalogue of well, what everything looks like, from benches, and wastebaskets to bus stops. And we have master specifications document." – **Interview De Frykse Marren, 4 August 2023**

Build and Maintain

As already mentioned in section 4.1, the current COF strategies were questioned by interviewees about their views on its sufficiency or if they are seeking a different approach. Most respondents are seeking an alternative COF, with only Noord-Holland and Utrecht satisfied with their strategy for area PBCs and framework agreements. Four cases are searching for a new COF but struggle to identify the optimal strategy. Similarly, four cases mention they are committed not to adopting a COF where the government exclusively takes on a managerial standing, such as within a PBC. Two remaining cases are open to considering a long-term COF with a contractor.

Evaluate and Adjust

In nearly all cases, when it comes to evaluating projects or the IAM process, they indicate that see do little to nothing. One instance demonstrates the evaluation of project delivery is done. The governments with certain policy plans indicate that they do evaluate these. Furthermore, there is a lack of adequate feedback from the implementation process to the AM system.

When all information provided by the interviewees is summarised and compared to the theoretical framework, the diagram within figure 16 emerges. It indicates that only a small number of authorities possess a policy plan, make use of incident reports, or subject them to evaluation. In addition, the AM system primarily relies on asset ages and inspections to determine maintenance needs for both the short and sometimes long term. This determination is made in conjunction with the CROW methodology and some programming measures such as anticipating external assets. Based on this planning, projects are formulated and thereafter executed by the use of different COFs.

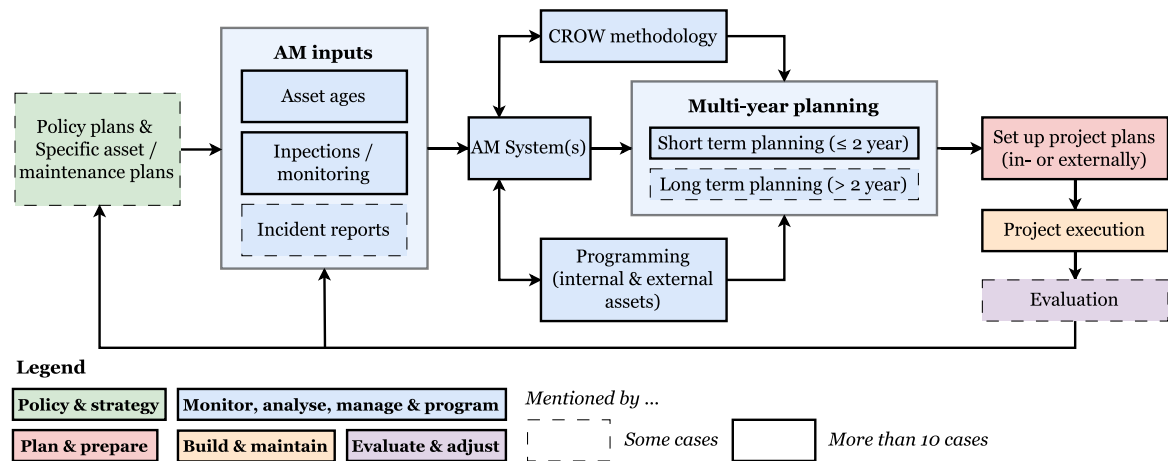


Figure 16 Current situation of the IAM process for road maintenance described by cases

5.2 Areas of improvement

In addition to the present circumstances, there was also an inquiry regarding the aspects that local governments would prefer to enhance or implement more extensively. Due to the semi-structured nature of the interviews, these answers were not solely elicited by a single question and therefore a thematic analysis was chosen. Within Appendix VIII, table 16, it can be seen that a total of 25 different answers were given, of which one was by far the most frequently mentioned - improving the AM system. Although many answers are overlapping due to this, it has been decided to set up a second table where these answers are grouped (see table 12).

The majority are only mentioned once or twice so they are not included in the further and more in-depth analysis. However, three of the themes are mentioned multiple times more and these are themes 2, 3, and 4. "Improve AM System" was mentioned most often in almost all cases. Planning projects, preparing budgets, creating multiple project alternatives, and combining multiple asset maintenance measures within a project all contribute to improving the Asset Management System (AMS). The second theme addresses the problem of providing feedback on the objectives stated in the policy plans after the projects are completed. Breda, Overijssel, and Utrecht mention that they have difficulties in demonstrating whether the objectives have been achieved within a given policy period of 4 to 5 years. The last theme centres on the development of new technologies for inspecting and monitoring roads within the areas of the local governments. Overijssel, Tilburg, and Noord-Holland indicated great interest in this topic. Today, visual inspections are mainly used to check the condition of roads. However, they indicated that innovative techniques exist to inspect roads more efficiently.

Table 12 Theme allocation out of the most mentioned answers

Nr.	Themes	Occur. (N=12)	Which cases
Theme 1	Improve IAM policies	1	1;
Theme 2	Improve Asset Management System	10	2;3;4;5;6; 7;8;9;10;12;
<i>Sub-theme 2.1</i>	<i>... to plan projects</i>	<i>10</i>	<i>2;3;4;5;6; 7;8;9;10;12</i>
<i>Sub-theme 2.2</i>	<i>... to create budgeting</i>	<i>4</i>	<i>2;3;5;9</i>
<i>Sub-theme 2.3</i>	<i>... to create multiple project alternatives</i>	<i>1</i>	<i>4;</i>
<i>Sub-theme 2.4</i>	<i>... combine multiple asset programmes</i>	<i>2</i>	<i>5;10;</i>
Theme 3	Feedback to policy objectives	3	4;5;7;
Theme 4	New techniques for inspection / monitoring	3	5;11;12;
Theme 5	Understand how other governments are implementing IAM	1	6;
Theme 6	Cost distribution on projects with combined asset projects	2	7;8;
Theme 7	Relationship between internal principal team and engineering team	2	7;9;
Theme 8	Involvement of citizens and other stakeholders	2	8;9;
Theme 9	Update road categorisation	1	9;
Theme 10	Reduce prep., admin. and mon. costs (VAT-costs)	1	10;
Theme 11	Improve the process of the construction phase	1	5;
Theme 12	Implementing circularity in projects	1	7;

Feedback to policy objectives

One of the mentioned components is the evaluation of policy objectives following the completion of projects. Projects are frequently driven by a distinct rationale and policy direction that the government aims to pursue. Therefore, regular feedback regarding the advancement made towards these goals, as well as the necessity for any modifications, is crucial. Have you successfully attained the objectives of increased sustainability or circularity through the projects you have implemented over the past four years? The government aims to enhance and solidify these goals or ambitions from the outset. Furthermore, it is important to make these goals more tangible and specific. Presently, they frequently establish numerous all-encompassing concepts such as circularity and sustainability as objectives, yet lack a precise understanding of exact formulations. Establishing concrete objectives is essential to effectively plan projects.

"When you have all these goals, especially in an area, generate concrete solutions, that's where things sometimes go wrong." ... "How can you put all those issues at play together in a comprehensive plan as a basis?" ... "That need is everywhere. And then it's often with politics at the 4 annual elections. Politicians like to show what we have achieved. And just how does your public space and redevelopment contribute to those governmental goals?" ... "What can you achieve, what can you do?" ... "Often it is then forgotten to give that feedback. Or that you don't monitor it at all." ... "Concrete goals Instead of all but loose statements." – Interview Breda, 27 July 2023

"So what is the effect? Of what, for example, a contractor has done for us? And then what is the effect? Did we achieve what we had thought of beforehand? Yes, we have a nice road, but is it sustainable? Does it contribute to climate adaptation? Is it circular, we don't do that evaluation." ... "But what is the effect then? Did it also have an effect that we took those interventions? Or not?"

And that's something we can pay even more attention to as a province, also together with market parties." – Interview Overijssel, 2 August 2023

According to the municipality of Utrecht, private contractors typically possess greater expertise in terms of execution, familiarity with materials, and inventive solutions. The goal is to enhance the involvement of external market participants to validate the selected maintenance measures for their effectiveness. This is also related to the theme because, in collaboration with the contractors, they can evaluate the objectives they have established and select the most optimal approach accordingly. This also enables expedited and more tangible feedback on the attainment of policy objectives.

"You already have an opportunity to go together with a contractor to review your maintenance measure. Whether what you are going to do is in line with elements such as circularity or sustainability."... "The contractor generally just has more knowledge of materials and, of course, most of the implementation knowledge lies with them. And you just want to make use of that, so there are indeed just a lot of opportunities for collaboration there." – Interview Utrecht, 3 August 2023

New techniques for inspection /monitoring

Additionally, there have been appeals from multiple cases for enhancements in the examination and monitoring of roads. Overijssel demonstrates a strong inclination towards adopting new methodologies and has actively pursued initiatives in this domain. There is a growing number of possibilities in the present time, particularly with the emergence of artificial intelligence (Mukherjee et al., 2021). The province expresses its desire to transition away from conventional inspection methods.

"I have intentions to also do a market consultation to do the inspections and measurements differently with all the new techniques that are out there, now with the AI and so on." ... "The smart techniques that are emerging now, which I am working on now. I put out annual inspections and measurements traditionally. I do ask to do it smartly, but little comes out of that yet." ... "So I want to get more out of intelligent techniques. So that you can predict even better based on the surveying techniques." – 2nd interview Overijssel, 11 September 2023

The municipality of Tilburg indicates that it is also interested in such new techniques and specifically indicates ground-penetrating radar (GPR) technologies. GPR has emerged as a highly efficient and reliable instrument for conducting road surveys and offering valuable insights into subsurface conditions. It involves the transmission and reception of brief electromagnetic pulses within a defined frequency spectrum. Within road engineering, GPR finds application in the examination of pavement layers, measurement of layer thickness, assessment of asphalt damage, as well as inspection of concrete structures (Benedetto et al., 2017).

"For inspections, we already use market players, for example, for asphalt roads, it is becoming increasingly interesting to use radar technology etc. So we are now also exploring this." – Answered questionnaire Tilburg

In the interview with the municipality of Almelo, it was mentioned that they would like to know the condition of their roads at an earlier stage. This will allow them to better predict when maintenance is needed, which is especially important for life-extending measures. This type of maintenance aims to slow down the ageing process and improve the condition of the road. It ensures that by doing preventive maintenance, over 10 to 20 years there will be significant savings in maintenance costs (Oosterhof Holman Infra, 2017).

"In the practical things make sure that we have a real grip on our area, that we know what it looks like outside, so that we can also, for example, the life-extending measures that we can carry out as soon as it is necessary and not when it is already too late. Because if you don't have a real insight into your area, then you go outside and see that it's poor but then you're already too late for the relatively more cost-effective measure." ... "Yes also the way of doing inspections could be better." ... "Having more data available, so you still get less failure costs." – Interview Almelo, 28 September 2023

Improve Asset Management System

The third aspect, which was also the most commonly mentioned, concerns the AM system. All governments stated that they possess some type of management system, yet the format of the system varies. A few indicate that they have one system covering all types of assets, while the majority indicate that they have several systems. The improvements they aspire to make in this area also vary reasonably across governing bodies. For example, Hollands Kroon suggests that the current system requires a lot of time and effort to update, load or request data.

"What I would like to see different is then, for example, the management system which is very laborious now. To me, that could be much simpler. Yes, it could save a lot of time if it's much more user-friendly and you can do much more with it. I can see opportunities for improvement in that." ... "In output but also in providing input. Making changes is very laborious, putting in a project that you can't just give that with an area. That all has to be done piece by piece now. It's just very laborious, you're clicking on boxes 100 times and filling in the same thing every time. That drives you crazy." – Interview Hollands Kroon, 19 July 2023

During the interview with the municipality of Breda, it was discussed that they would like to improve the system to produce better multi-year programmes. These are becoming increasingly important as they notice that the asset type 'roads' is shifting from leading to supporting when it concerns the initiation of integral projects. These are large projects where several asset types are maintained or improved at the same time. Breda suggests that this requires them to plan much further ahead so that it is easier to cooperate and coordinate with both internal and external assets. Additionally, they express a desire to create budgets based on management system data and present diverse maintenance scenarios.

"Above all, we need to get the data processing better and better in the way of that multi-year planning" ... "The management system task is very big, in terms of integral planning. But that desire is there. And what we see is that we very much want to develop towards a more automated asset management system. We still see quite a lot of actions, manually done things that can be programmed much more in a management application and we can still make great steps in that. For instance, we don't have fixed budgets from the multi-year planning yet. Well, That's still a real wish to get that out of that on that application. What is also a wish is to build in different filters so that you can present scenarios." ... "And where I also have a wish is really to facilitate that future manager. To help with the frequent client questions to request those from within this application conveniently in terms of information delivery." ... "The strategy we use to monitor that is after several years. Does it help what we do for maintenance measure here for ultimately fewer complaints in that district." – Interview Breda, 27 July 2023

Overijssel also indicated that it would like to improve the internal coordination of the various assets it manages. Specifically, they mentioned improving coordination between roads and civil engineering structures. The interviewee mentioned an example of a road maintenance project that was postponed for many months, or even more than a year because it was combined with the maintenance of a tunnel while it was still unclear what exactly was going on.

"The process of coordination could sometimes be even better, and not just internally, but then it does involve external. Because how nice would it be if a municipality knows what the province is going to do and vice versa." ... "What I would also like to see better internally is our coordination between the major assets roads and civil engineering structures. That is of course a tricky point. We don't look closely at what other assets do we have there?" ... "Would the way of working together and working with a management system, does that need to be improved? Yes, that's where the key is." – Interview Overijssel, 2 August 2023

Multiple AM systems are used in the municipality of Dijk en Waard. The desire is to switch to a new single system in which all asset data can be processed and accessed. They would like to merge areas more easily to achieve joint maintenance planning.

"If there is some kind of management system where everything can be incorporated. And you could very simply coordinate everything with a push of a button. Then you could simply merge all the areas and all the planning, and have an entire departmental planning at once. That would be wonderful". – Interview Dijk en Waard, 3 August 2023

During the Utrecht interview, the topic of how a municipality wants to keep control of its asset data was discussed. The interviewee indicated that it seemed wise to him to keep control as a governmental organisation and to keep deciding what maintenance should be carried out. However, the interviewee also sees significant potential in collaborating closely with market parties to improve, for example, the management system.

"There is also room for improvement in the management system. It's just the more alignment you want to have, the longer you have to be able to look ahead so that you can already seek that interaction in time. And at the same time, you also want to keep that flexibility in it." ... "And what I point out, making your maintenance planning, even if you indicate that you just want to keep that to yourself as a property owner then you still have opportunities to work with the contractor as well." – Interview Utrecht, 3 August 2023

Other important elements in road maintenance nowadays are sustainability, circularity, climate adaption and responding to external initiatives such as a heating network. De Fryske Marren indicates that it would also like to respond proactively to these with a programming tool. It suggests that this may work well in collaboration with an external party.

"We are now searching a bit from a management perspective and from the overall challenges we face from sustainability, circularity, climate adaptation and reconstruction of neighbourhoods and districts. To have, say, an overall project overview for this, how to schedule better, with a kind of programming tool. And that could be done by an external party. I also think that the large projects should be transferred to the private sector." – Interview De Fryske Marren, 4 August 2023

Noord-Holland is improving its management system and wants to switch to predictive maintenance (PdM). Instead of traditional methods, PdM methods use real-time degradation monitoring to assess asset conditions and predict maintenance timing. Active PdM prevents asset failure, reducing downtime and costs. On road infrastructure, PdM uses various technologies to monitor and evaluate road conditions, identify defects and damage, and predict when repairs or maintenance are needed (Hassan et al., 2023). They also want to change programming into 10–15 km sections. This modification aims to facilitate the merging of maintenance projects, or as commonly referred to, 'making work with work'.

"We are working on a new Maintenance Management System, I do want to go to the next step to predictive maintenance. And as far as I'm concerned, that's a part that can and should. Programming will then no longer be by area. But on sections of 10, 15 km which makes it easier to make work with work." – Interview Noord-Holland, 13 September 2023

5.3 Conclusion

The first part of the case studies focused on examining the existing IAM practises within the 12 LRAs. These findings indicate that most of the mentioned activities are consistent across all cases, except for policy plans, utilisation of incident reports, long-term planning and conducting evaluations. The described activities align with the phases outlined in the theoretical framework. Regarding the AM system utilised, there are variations in its application. Several governments claim to possess a singular system, while others assert the possession of multiple systems. The systems exhibit variations in the types of assets, encompassing not only roads but also assets such as sewerage and civil structures. Further, one authority refrained from utilising the CROW methodology. The rationale for this decision stemmed from his belief that the test relying on objective data failed to accurately reflect the necessary actions, and instead placed greater importance on firsthand evaluation grounded in experience. Further, there is a significant disparity in the multiannual planning being conducted by the LRAs. Each individual claims to possess a planning, however, the time frame for these plans ranges from one year to sixty years. There is also a divergence of opinions regarding the effectiveness of planning for a period exceeding 2 years. Most authorities make use of discrete or framework COFs, while the province of Noord-Holland makes use of PBCs as discussed in the previous chapter. This interviewee believed that this should serve as a role model for other governments.

The further case findings uncover multiple IAM themes which the LRAs would like to improve. This includes developing specific policy objectives and providing feedback on them, implementing

innovative inspection and monitoring techniques, and enhancing AM data systems. These findings provide insight into the difficulties encountered by governments in their endeavours to uphold and enhance their IAM, as well as the potential for the contractor Strukton to capitalise on. When it comes to formulating and providing feedback on policy objectives, it is worth noting that many governments lack comprehensive policies. This suggests that while abstract and overly general concepts are labelled as objectives, it is not possible to ascertain whether contributions have been made to these objectives once projects have been finished. During the interviews, various potential approaches for implementing novel inspection techniques for the second element have been discussed. Techniques such as Ground Penetrating Radar and artificial intelligence are regarded as intriguing methodologies. Strukton can prioritise these types of innovations to effectively meet the government's goal of reducing the labour-intensive nature of inspections.

The third theme centres on enhancing the AM system, but there is a multitude of diverse desires. Planning asset activities is reportedly challenging, requiring significant labour and lacking usability. Furthermore, there is a desire to incorporate the development of budgetary guidelines from these activities into the AM system. Governments that express their intention to use multiple systems aim to consolidate them into a single system that incorporates various crucial assets. This integration could enable comprehensive planning and the generation of alternative initiatives. What has to be said is that the results of the case study are based on a single perspective, except for Overijssel, Breda, and HHNK, where multiple individuals were interviewed. It is possible that if other individuals are consulted in a specific situation, additional suggestions for enhancement may arise. Nevertheless, this study has demonstrated the recurring nature of these themes across multiple cases, indicating that they hold significant importance for Strukton's emphasis on future collaborations with LRAs.

6

Opportunities and directions for Strukton

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7

Discussion

Notable components from the results are briefly discussed in this section. According to Strukton, the best way to provide LRAs with IAM capabilities would be through PBCs. They go on to say that long-term framework agreements should be the bare minimum to support IAM if less integration is preferred. The findings, however, indicate that Dutch LRAs are mainly concerned with contracting out discrete COFs for individual interventions, like RAW agreements for particular tasks like resurfacing roads. This suggests a preference for only outsourcing operational aspects to the market and maintaining management activities in-house.

In contrast, a lot of the authorities that were interviewed mentioned internal ageing, staffing shortages, or a lack of knowledge. The concept of having internal capacities for activity management is contradicted by this. This may point to an upcoming change in how the market and government work together. Several authorities have expressed the need for a new approach to outsourcing, which could involve moving away from the traditional practice of outsourcing operational tasks to a more integrated partnership in which a contractor is contracted to handle both operational and management tasks. As a result, LRAs would have to assume a more coordinating role and concentrate more on supervision than on direct execution.

This change may lead to less government capacity and more reliance on market expertise, even though some LRAs have expressed reluctance. This could be because of the lack of familiarity. Both parties must acknowledge the need for a gradual transition if this trend persists. Adapting from traditional to integrated collaboration is a gradual process that takes time for LRAs and contractors to develop. LRAs may also aim to improve internal IAM knowledge and capabilities; even in these situations, involving market participants in a cooperative strategy, like a Bouwteam collaboration, might accelerate the progress. As they work together towards a Framework agreement for intervention execution, LRAs can benefit from the knowledge of the market and facilitate internal improvements.

Further, regarding the current IAM practices, the findings indicate that most of the mentioned activities are consistent across all cases, with the exception of policy plans, incident reports, long-term planning and conducting evaluations. LRAs may require specific guidance on best practices or specifications for the mentioned aspects. Concerning the AM system, there are variations in its application. Several LRA claim to possess a singular system, while others assert the possession of multiple systems. The systems exhibit variations in the types of assets, encompassing not only roads but also assets such as sewerage and civil structures. This study did not delve deeper into the system, such as analysing the preferred amount of assets and their characteristics, as it was beyond the scope. For Strukton, it will also be challenging to take over responsibilities related to a management system in the short term. Governments frequently have a multi-year collaboration with a particular system that they have purchased. Because of this, integrating Strukton's system or establishing communication with one of the numerous systems that the LRAs currently use is challenging.

One LRA refrained from utilising the CROW methodology. The rationale for this decision stemmed from his belief that the test relying on objective data failed to accurately reflect the necessary actions, and instead placed greater importance on firsthand evaluation grounded in experience. Hollands Kroon, as a rural municipality, is characterised by its low road density. During the interviews, it was observed

that rural municipalities exhibit a greater degree of conservatism when it comes to embracing innovations or expanding their IAM practises, in comparison to more urban governments. However, since the case studies primarily depended on the perspective of a single individual, interviewing others within the organisation might have provided different perspectives.

Within the limitations of the case studies, it can be said that the initially conducted interviews were less focused than the later ones. As a result, these can be considered less reliable. However, important elements were mentioned, resulting in the inclusion of these local authorities within the study. Concerning the focus groups, it can be said that the initial focus group was comparatively less impactful than the subsequent one. During the first session, the case study results had not yet been obtained. Therefore, the primary objective was to inquire about the potential opportunities for implementing IAM by Strukton. In this situation, the complete iAMPro methodology was used, resulting in a broad scope that ultimately limited its effectiveness. The second focus group took a significantly different approach, primarily focusing on the results of thematic analysis. This allowed for a comparison of the outcomes and an understanding of the contractor's possibilities. As a result, the decision was made to solely feature this focus group in the results section. In here, specific abilities and necessary enhancements were highlighted.

7.1 Recommendations for further research

Some aspects can be the subject of additional research. A recommendation is to conduct a more in-depth investigation into the regional variations in preferences regarding the outsourcing of work and desired COF preferences. This study observes that more urbanised areas exhibit a stronger inclination towards increased collaboration and contracting out to contractors. Nevertheless, conducting an extensive survey encompassing a large number of cases could provide additional value by offering a deeper understanding of the future goals and ambitions of government agencies. It is also possible to think about a study on how governments and contractors can move from a traditional model of collaboration to an integrated one. Adjusting to this new procedure will entail new responsibilities and will take time. Both parties will need to gradually adjust to this change as they are not prepared for it all at once.

Subsequent studies could also prioritise evaluating policy goals in IAM, particularly through partnerships with local authorities and contractors. It is crucial to find methods that can enhance the measurability of these objectives. This study shows potential for uncovering valuable approaches to align policy objectives with actual project results, leading to improved allocation of resources and the prevention of unnecessary capital expenditures. In addition, future studies might focus on further development of the optimal characteristics that should be present in an AM system. The selection of infrastructure asset types for integrated planning, the optimal planning duration, and the data necessary for comprehensive road maintenance planning are all factors that may be of interest.

8

Conclusion

The goal of this research was to provide Strukton with strategic advice on enhancing its strategy and proposition for future tenders. This is by clarifying the current infrastructure asset management processes in Dutch LRAs, as well as their future objectives and outsourcing strategies. However, the findings of this study suggest that the vast majority of Dutch LRAs continue to adhere to single discrete COFs for road rehabilitation. The RAW methodology is by far the most utilised, according to both desk research and case studies, with framework COFs gaining prominence in recent years. Given this information, it appears that it will be difficult for a contractor like Strukton to offer their expertise in IAM practices on a larger scale. Discrete COFs offer few opportunities because their primary focus is on contracting out only the execution task rather than including management tasks, which limits the opportunities for Strukton.

Unique opportunities do arise when performance-based contracts are outsourced to the market, as reported by the provinces Zuid-Holland and Noord-Brabant in 2023 and as explained by Noord-Holland in the interview. In the context of this integrated COF, it is expected that the client will outsource all three main IAM activities planning, monitoring, and executing. It appears that currently only provinces focus on this approach and a large number of local authorities, especially rural municipalities, have not yet embraced or are not willing to consider the idea of using this.

When Strukton finds itself in a position to improve IAM principles in collaboration with the LRAs, or when they will jointly implement them, the case studies have shown that it is best to focus on three primary themes:

- **Feedback to policy objectives:** Governments aim to establish explicit and measurable objectives for projects, enabling the assessment of their projects in achieving goals such as sustainability or circularity;
- **New techniques for inspection and monitoring:** There is an interest towards implementing innovative technologies, such as artificial intelligence and ground-penetrating radar, to enhance the inspection and monitoring of roads, ultimately resulting in more efficient determination of maintenance needs;
- **Improving the asset management system:** Numerous governments have expressed the requirement for a more user-friendly and efficient AM system. Their objective is to enhance their multi-year planning capabilities, budgeting, and the ability to present a wide range of maintenance scenarios;

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Strukton believes that an integrated PBC is the most effective approach for applying their expertise to LRAs. Nonetheless, a significant number of LRAs continue to prioritise internal management responsibilities while using discrete COFs to outsource only the operational tasks. Provinces are the only ones who prefer an integrated approach, so Strukton should focus on these kinds of LRAs to apply their expertise throughout the partnership. Mutual trust and the understanding that tasks can be completed in unconventional ways are crucial for the remaining authorities. Both IAM participants can gain from collaboration if they recognise its potential benefits. This study has shown what the current situation is within Dutch local authorities and where there are opportunities for contractor Strukton

to improve its proposition. Although there are few immediate options due to the traditional discrete strategies of the LRAs, there are opportunities in the future, as it shows that new strategies are being considered. For both Strukton and the local authorities, the research provide an insight into the various aspects at play in the field of infrastructure asset management and construction organisation forms.

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Appendices

Appendix I International asset management frameworks

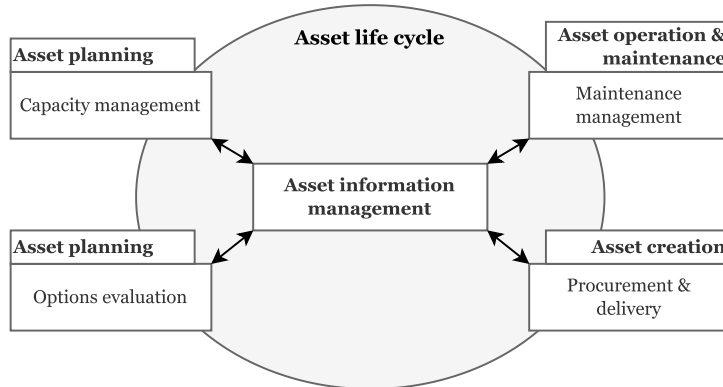


Figure 17 Strategic IAM processes
Source (Too, 2010)

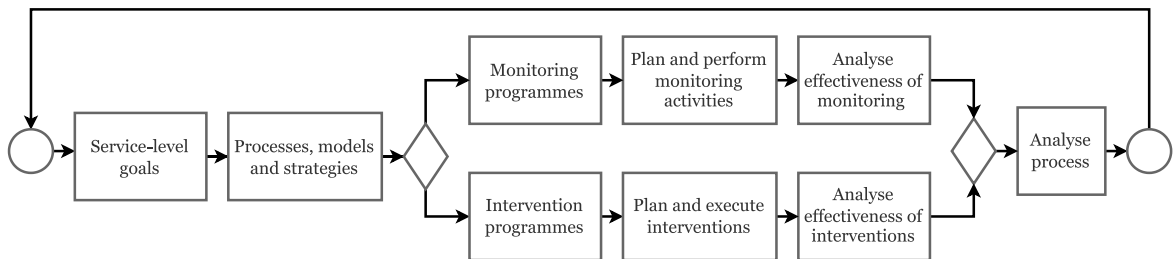


Figure 18 Road IAM processes
Source (Adey, 2019)

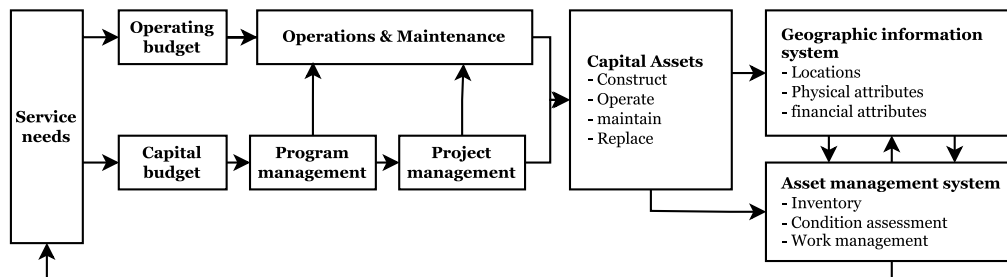


Figure 19 Asset management model
Source (Cagle, 2003)

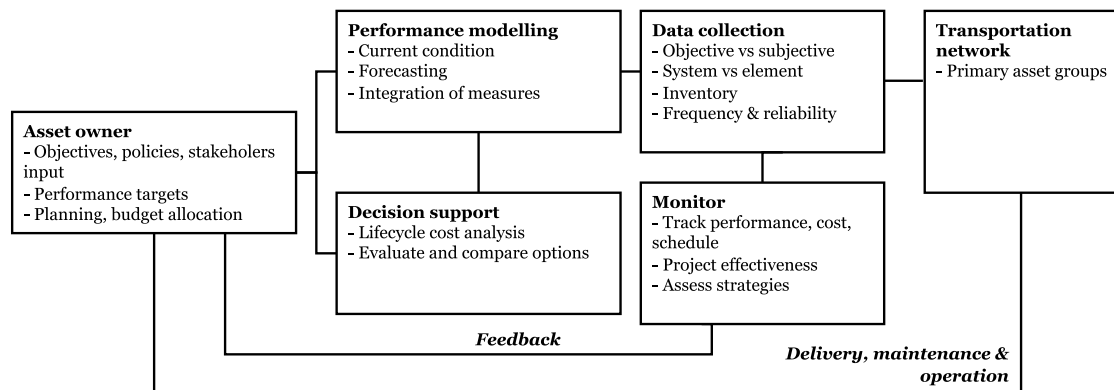


Figure 20 Example of Asset Management framework for a transportation network
Source (Moon et al., 2009)

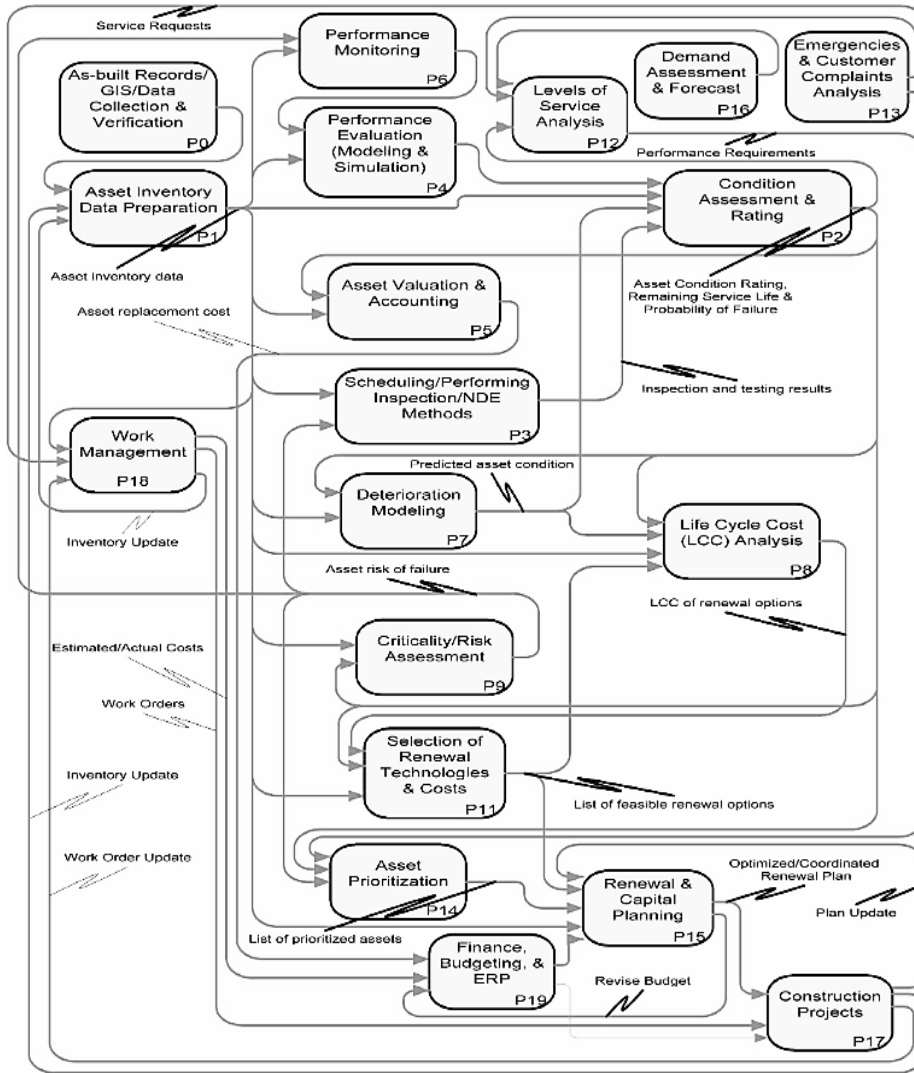


Figure 21 Structure and information flow of municipal infrastructure management
Source (Halfawy, 2008)

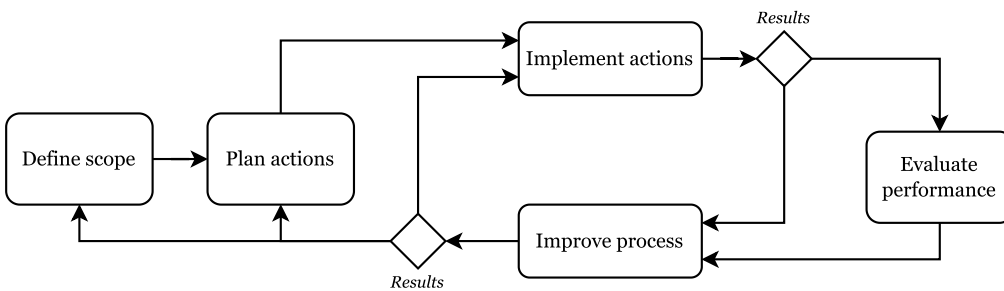


Figure 22 Proposed maintenance management framework for asset management
Source (Da Silva & De Souza, 2022)



Figure 23 Asset management framework
Source (Arif & Bayraktar, 2012)

Appendix II CROW iAMPro framework

Table 13 CROW iAMPro framework with phase description and main themes
Source (CROW, 2023)

Phase	Description	Themes
Policy and Strategy	Stakeholder interests play a significant role. These interests, along with the objectives of the organisation, are transformed into AM objectives. The strategic objectives are documented in the Strategic Asset Management Plan (SAMP). A policy plan outlines the specific strategies and actions that will be used to accomplish the goals.	<ul style="list-style-type: none"> - AM Scope - AM policy - Context - Stakeholders - Trends and developments - Assessment framework - AM objectives - Performance management - Asset overview - AM approach - Evaluation management - Communication and participation
Manage and Program	Programming refers to the development of a comprehensive and long-term plan for maintaining assets. The measures might be either one-time (such as replacements) or recurrent activities. To programme effectively, key information about the quantity and quality of the assets is needed. The process of managing these asset datasets is meant by the term 'manage'.	<ul style="list-style-type: none"> - AM Strategy - Technical developments - Legal frameworks - Policy frameworks - Standards and guidelines - Asset overview per discipline - Scenarios - Monitoring strategy - Long-term maintenance planning - Multi-year budget - Multi-year investment planning - AM activities programme - Communication and participation - Integral maintenance planning
Plan and Prepare	This step involves the elaboration of maintenance plans, restructuring, and design solutions, and involves short-term planning. Additionally, it encompasses the process of creating specifications, developing designs, and preparing contracts.	<ul style="list-style-type: none"> - Planning AM activities - Maintenance budget - Schedule of requirements - Implementation frameworks - Risk assessment - Contract management
Build and Maintain	This pertains to the execution of maintenance activities and the utilisation of already existing assets. The outcome is an initial operational implementation and monitoring strategy that addresses the inquiries of where, when, and what type of maintenance is required, at what levels of intervention, and with what degree of effectiveness.	<ul style="list-style-type: none"> - Work schedule - Licences - Work budgets - Stock control - Performance evaluation - Emergency plans - Implementation of activity - Supervision - Commissioning - Completion and accountability
Monitor and Analyse	This involves monitoring the performance of assets and evaluating the outcomes of activities. This entails examining the extent to which service levels are met and identifying the factors contributing to any deviations. Conditions are assessed by monitoring complaints, malfunctions, and inspections.	<ul style="list-style-type: none"> - Risk analysis - Inspection & monitoring - Performance analysis - Implementation analysis - Policy analysis - Complaint & incident analysis - Management of changes - Satisfaction survey
Evaluate and Adjust	In this context, an assessment is conducted on both the AM process and the system's operation. This encompasses the contentment of all parties involved. The asset owner fully or partially implements the recommendations provided in the reports.	<ul style="list-style-type: none"> - Performance evaluation - Process evaluation - Management of changes - Audits

People and Organisation	<i>Effective implementation of AM requires the collective adherence to the agreed-upon approach by all participants. The objective is to enhance work efficiency and optimise operations.</i>	<ul style="list-style-type: none"> - Team formation - Work culture - Capacity development - Competence development - Personnel activities - Management activities - Tasks, Responsibilities, Roles, Authorisations - Leadership
Data and Information	<i>Data and information play a key role in nearly every process step outlined previously. Undoubtedly, every process necessitates the support of information and its corresponding systems.</i>	<ul style="list-style-type: none"> - Plan information system - Defining information policy - Asset information standards - Performance standards - Information system requirements - Information transfer - Information management - Data collection

Appendix III Outsourcing strategies

Table 14 Outsourcing strategies within activities, suited COF and preferred duration
Source (CEDR, 2017c)

Strategy	Outsourced activities	In-house activities	Suited COF	Duration
Strategy A	No activities	All regular maintenance and rehabilitation tasks	-	-
Strategy B	Single maintenance tasks (e.g. pavement renewal) from separate contractors	All asset management tasks and single maintenance tasks (e.g. performance monitoring, road patching)	Discrete contracts & unit based framework contracts	1-3 years without extension
Strategy C	Single and integrated maintenance tasks (e.g. road patching) from separate contractors	All asset management tasks (e.g. performance monitoring, planning)	Framework and integrated contracts, usually appearance driven	4-6 years with possible extension
Strategy D	Single asset management tasks and all maintenance tasks (e.g. performance monitoring) from separate contractors	Single asset management tasks (e.g. maintenance planning)	Framework contracts for the performance monitoring and integrated contracts for the maintenance tasks	7-10 years with possible extension
Strategy E	All regular maintenance and rehabilitation tasks	No activities	Fully integrated	> 10 years

Appendix IV COF advantages and disadvantages

Table 15 Advantages and disadvantages of COFs from the client's perspective
Source (Buitenruimte, 2019; Gericke et al., 2014; van Amstel & Winkelmolen, 2017; Verkooijen & Drost, 2010)

COF	Advantages	Disadvantages
RAW	<ul style="list-style-type: none"> - The client has maximum influence results - Relative low costs - Many opportunities to exploit the market - Clear interpretation of requirements - Simple tendering procedure - Relatively quick for repeatable contracts 	<ul style="list-style-type: none"> - In-house expertise necessary - The coordination role remains with the client - No early input contractor knowledge - Completeness of documents necessary - No incentive to optimise for contractor - Time and cost uncertainty - Design risks and supervision at the client
Bouwteam	<ul style="list-style-type: none"> - Input of contractor expertise - Better budget control - The client's influence on the project remains strong - Possible time savings - Clear interpretation of requirements - Simple staged tendering procedure 	<ul style="list-style-type: none"> - Coordination and steering capacity required from the client - Potential unclear responsibilities and liabilities - Time and cost uncertainty - No timely input of knowledge of execution - Many risks remain with the principal - Contractor tends to emphasise make ability
E&C	<ul style="list-style-type: none"> - Time and cost are more certain - Lower preparation costs - Shorter preparation time - The client has a high influence on the final product - No detailed control on-site for the client 	<ul style="list-style-type: none"> - Design responsibility remains with the client - Risks remain with the client - Little use of contractor's knowledge - Creativity on behalf of client limited - Choices less easy to justify politically
D&C	<ul style="list-style-type: none"> - Time and cost certainty - Early insight into total costs - Lower preparation costs - Design risks away from the client - No detailed control on-site for the client - Good opportunities to exploit the market - Own expertise less necessary - Timely input of knowledge of the contractor 	<ul style="list-style-type: none"> - The client has less influence on the final product - Staggered tendering procedure - Broad expertise required to assess tenders - Contractor inclined to trade-off on process/quality - (Scope) changes after contract formation are usually costly
DCM	<ul style="list-style-type: none"> - Design risks away from the client - One contract partner - Time and cost certainty - Early insight into total costs - Lower preparation costs - Fewer administrative costs in the management phase - No need for detailed checks on-site - Impulse for quality - Possibilities to use market knowledge - In-house expertise is less necessary 	<ul style="list-style-type: none"> - Long-term contract commitment - Adjustment after the contract moment is difficult - The client has less influence on the final product - Relatively high tender costs - Stepped tender procedure - Relatively unknown patterns and legal context
PBC	<ul style="list-style-type: none"> - Potential reduction in costs - Improved level of service - The transfer of risk to the contractor - Securing an appropriate level of multi-year financing - More innovation - More integrated services - Enhanced AM on the part of both the PBC contractor and agency - Ability to reap the benefits of partnering - Expedited implementation of works 	<ul style="list-style-type: none"> - A more costly procurement process - Increased complexity - Potentially a longer procurement process - Increased Cost of Data - A reduction in competition - Uncertainty - Potential loss of agency control and flexibility - Shift in Control of Decisions

Appendix V Case introductions

Hengelo

The municipality of Hengelo is located in the eastern part of the Netherlands. In addition to the city of Hengelo, it also includes the village of Beckum and the hamlets of Woolde and Oele. The municipality has a maintenance policy for its roads based on the national CROW guidelines. This approach includes planned maintenance, road repairs and reactive measures based on reports from citizens. In Hengelo, there is no overdue maintenance of pavements. A multi-annual plan is drawn up each year, covering various aspects such as pavements, lighting, structures and green areas. The available budgets are sufficient to ensure that the roads meet the national CROW guidelines. The maintenance process includes both short-cycle maintenance and major maintenance. Major maintenance is contracted out separately, while cyclical maintenance is carried out by an in-house maintenance team. No separate annual reservations are made for road maintenance. Instead, future replacements are included in the annual budget to ensure maintenance and replacement for the coming years (Gemeente Hengelo, 2022).

Súdwest-Fryslân

The municipality of Súdwest-Fryslân is located in the northern province of Friesland. In terms of area, it is the largest municipality in the Netherlands with 6 cities and 83 villages, but it is one of the less densely populated areas. In terms of maintenance, it applies risk-based management based on the CROW methodology and aims to maintain the basic physical structure. The current state of repair shows that the maintenance of pavement elements such as footpaths is particularly overdue. In the past, progress has been made in the maintenance of asphalt roads. The structural maintenance budget was almost sufficient for road maintenance, but there was a separate budget for minor traffic modifications. The maintenance budget will be increased to compensate for the expansion of the area and price increases. The 2023 programme includes several integrated works as well as major road maintenance in several locations. The aim is to gradually reduce the backlog of elements and asphalt roads and to reach an average base level for 10-15 years (Gemeente Súdwest-Fryslân, 2022).

Hollands Kroon

Hollands Kroon is a municipality in the northwest of the Netherlands, situated near the Afsluitdijk. Its principal town is Anna Paulowna and it also encompasses 35 villages and hamlets. It is a rural municipality with a noteworthy farming community that engages in cattle breeding and agriculture. Pavement maintenance is generally done at the agreed quality level. Regular inspections take place to detect any defects, after which appropriate maintenance is carried out. It comprises three main aspects: cleaning, repairing and replacing. Full pavement replacement should only be considered when there is a need to replace the underlying sewerage system or when the pavement itself requires immediate replacement. Repair work can vary from minor maintenance tasks such as fixing loose tiles to major maintenance tasks such as replacing asphalt layers. Due to various developments, the life-extending approach to infrastructure has been postponed for several years on some roads (Gemeente Hollands Kroon, 2022a, 2022b).

Breda

The municipality of Breda is located in one of the southern provinces of the country. It encompasses the residential areas of Breda, Prinsenbeek, Bavel, Teteringen and Ulvenhout. For pavements, the local authority is responsible for around 10 million square metres and maintains them at an average level of B-. Progress seemed to be made in catching up with overdue maintenance until 2020 when inspections showed a negative trend due to dry years, a preference for asphalt pavements, and a limited maintenance approach. In 2021, €3.2 million was allocated to catch up, and an approach is proposed when the capital assets policy framework is reviewed in 2022-2023. Maintaining public areas involves various tasks. Minor maintenance is carried out to address serious damage on a small part of a road section, such as a pothole, to prevent early major maintenance. Major maintenance includes planned measures to prevent rapid road deterioration and aims to achieve the road's technical lifespan. Minor maintenance is carried out to address serious damage on a small part of a road section, such as a pothole, to prevent early major maintenance. Cyclical maintenance involves repetitive actions, such as cleaning and sweeping, to maintain a tidy appearance. Maintenance also directly relates to the

replacement of the entire pavement construction in the case of asphalt roads. In Breda, management and maintenance are carried out at a basic level (Gemeente Breda, 2014, 2022).

Dijk en Waard

The municipalities of Heerhugowaard and Langedijk were merged into the municipality of Dijk en Waard in 2022. The city of Heerhugowaard and 15 villages and hamlets make up the new municipality in the province of Noord-Holland. Dijk en Waard will also be responsible for the day-to-day maintenance, major maintenance and replacement of capital assets, including roads. The importance of maintenance quality cannot be overstated, given that it directly impacts how public spaces are experienced by residents. Heerhugowaard and Langedijk took different approaches to major maintenance—Heerhugowaard allocated funds annually, while Langedijk maintained a separate reserve budget. Dijk and Waard harmonised these approaches, resulting in a single method. The Multi-Year Investment Plan (MIP) encompasses not only maintenance but also new and replacement investments (Gemeente Dijk en Waard, 2022).

Utrecht

The fourth largest municipality in the Netherlands is the centrally located Utrecht, and in addition to the main city, it also includes the villages of De Meern, Haarzuilens and Vleuten. Utrecht is part of the metropolitan area known as the Randstad and is one of the oldest cities in the Netherlands. The preservation of public spaces is of utmost importance, and thus, maintaining capital assets is vital. Regular inspections are conducted to assess the overall condition. To increase operational efficiency and minimise disruption to residents, maintenance activities are coordinated across different neighbourhoods and programmes. The goal in the municipality of Utrecht is to ensure a consistent standard of quality for the entire public space, which is evaluated using the CROW method. The target level is set at level B, with "A" accents implemented at specific locations, to achieve a uniform level of quality. It is crucial to maintain maintenance levels at level C or above to prevent capital depreciation. While a small part of Utrecht's overall area experiences overdue maintenance, the costs associated with this are considerable. There are ongoing initiatives to systematically eliminate such overdue maintenance within a decade. This all will be executed based on the city's accessibility, regeneration plans and financial resources available, in line with the guidelines stated by the Budget and Accountability Order (BBV) (Gemeente Utrecht, 2020, 2022).

De Fryske Marren

De Fryske Marren was formed by the merger of three municipalities and is also part of a fourth municipality in the province of Friesland. The municipality has 51 official places of which Joure is the largest city. The name refers to the many lakes in the municipality. The municipality has made significant investments in capital assets, including roads, sewers, green spaces and waterways. The maintenance programme includes activities ranging from day-to-day routine maintenance to major rehabilitation works, with the main aim of extending the life of the assets. The current condition of these assets is systematically assessed through visual inspections, following the methodology described in the CROW guidelines, and repeated every two years. The Road Policy Plan for 2020-2024 focuses on new challenges and developments in road management. The municipality aims to maintain the roads following the standards set out in the CROW guidelines at level B (De Fryske Marren, 2022).

Tilburg

Tilburg is the seventh largest municipality in the Netherlands, encompassing the city of the same name in addition to Berkel-Enschot, Udenhout, and Biezenmortel. The municipality has an established quality standard of level C for road pavements across all functional areas. Proposed policies aim to upgrade the quality level of pavements near social facilities from level C to level B. An early 2021 inspection revealed that the majority of pavements (90%) achieved grade B or above, with only 1% at grade C, and 9% at grade D. Asphalt and concrete pavements perform better than element pavements, especially in residential and commercial areas. Root pressure causes a lot of unevenness in residential areas. So far, more than 220,000 m² of D-level have been addressed, and in the coming years, about 350,000 m² more will be improved through planned projects within the Multi-Year Urban Development Investment Plan (Gemeente Tilburg, 2022).

Almelo

Located in the Twente region of the Overijssel province, the municipality of Almelo comprises the city as well as Aadorp, Bornerbroek, and Mariaparochie cores. Beginning in 2023, the municipality plans to adopt a flexible road management approach to accommodate evolving standards and requirements. This approach will be based on the legal minimum as prescribed in the national CROW guidelines and will focus on cost, safety, functionality, capital preservation and reuse. The paved area encompasses 4.7 million square metres and comprises 50% element pavement, 49% asphalt pavement, and 1% concrete pavement. There is no specific policy for technical maintenance. The municipality conducts a two-year assessment of the road quality. The basic level of quality remains the central starting point, with improvements expected as a result of additional major maintenance and replacement efforts. There are several key areas of focus, such as addressing significant maintenance backlogs, carrying out district-based minor maintenance, and incorporating sustainability, liveability and climate considerations (Gemeente Almelo, 2022b).

Overijssel

Overijssel is an eastern province of the Netherlands, with Zwolle as its capital and Enschede as the city with the highest population. The province has the responsibility of maintaining the provincial infrastructure, which includes roads, artworks and waterways. The policy is aimed at achieving a 'basic' level of maintenance quality, as defined by CROW, with a concentrated focus on innovation, circularity, climate change and sustainability. The infrastructure undergoes regular inspections, and roads have a life cycle that requires major maintenance or complete replacement. The task of replacing the infrastructure for the upcoming years is substantial due to the end of life of much infrastructure. The Maintenance Plan for Infrastructure Capital Assets (BIK) has been recently updated and submitted to the Provincial Council at the end of 2022 (Provincie Overijssel, 2022).

Noord-Holland

In the northwest of the Netherlands lies the province of Noord-Holland, home to the capital of the Netherlands, Amsterdam. In addition to the mainland part of the province, it also includes one of the Wadden Islands, Texel. In 2023, the province of Noord-Holland is taking steps to manage its provincial infrastructure more professionally and efficiently. Decisions on policy changes and trends will be made annually in line with the Infrastructure Capital Assets Note. AM will be further developed and aligned with broader sustainability goals such as biodiversity and climate change. Infrastructure management is area-based, using area contracts for both fixed and variable maintenance. The Integrated Multi-Year Programme Infrastructure (IMPI) provides insight into investment needs. Fixed and variable maintenance is carried out by area contractors in the province of Noord-Holland (Provincie Noord-Holland, 2022).

Hoogheemraadschap Hollands Noorderkwartier (HHNK)

Hoogheemraadschap Hollands Noorderkwartier (HHNK) is one of the five water boards in the Netherlands responsible for managing roads. It was formed in 2003 after several water boards merged. Its area is almost the same as the province of Noord-Holland, but the Noordzeekanaal forms the transition to the Rijnland and AGV water boards. At present, HHNK is in the process of transferring road management responsibilities to the municipalities within its area. The complete transfer is projected to conclude by approximately 2025. Three fundamental principles govern road maintenance within the water board, namely road safety, collaboration with other road authorities, and transparent accountability. Furthermore, the working method is divided into exploration, analysis, preparation of alternatives, implementation of decisions and evaluation (Waterschap HHNK, 2019, 2022).

Appendix VI Case study interview protocol

Date:

Interviewee:

- **Introduction**
- **Explanation of thesis research**

QUESTIONS CURRENT SITUATION IAM CONCERNING ROAD MAINTENANCE

- Could you briefly describe (from initiative to evaluation) how road management is currently defined, contracted/contracted and implemented?

Policy and strategy:

- Is there currently a policy on roads or in combination with other types of assets?
- Do you think there is a clear strategy for road management?
- Are there concrete quality levels that roads/paving should meet? How has this been determined?
- Are there enough financial resources to keep the municipality up to standard?
- In your opinion, does "old-fashioned road management" still exist or are other interests involved in almost every project?

Managing and programming & Monitoring and analysing

- Is a management system used?
 - o *Is this an external or internal system?*
 - o *Are there multiple systems for the various assets or is everything in 1 system?*
- Are technical data properly maintained and updated in the management system on time?
- What is done to monitor and analyse the roads? Annual inspections or otherwise?
- Is maintenance (partly) planned based on objective system data?
- Is (long-term) planning done for road management?
 - o *How is this established?*
 - o *Are schedules coordinated with other assets for possible integral projects?*
- Does road maintenance often coincide with other maintenance activities (sewerage, green, etc.)?
 - o *What asset type then triggers the project initiative?*
 - o *How is the coordination with external assets (NUTS companies)?*
- Is there programming and/or prioritisation? On what basis?

Planning and preparation

- Which elements within the preparation process do you currently outsource?
 - o *Or do you do a lot internally because there is an internal engineering office?*
- What are currently the main reasons within your organisation for outsourcing work?
 - o *Because of capacity? External expertise that is lacking internally? Or is there another reason?*
 - o *What work is this mainly?*
- Are there standards for PoA, fixtures, specifications, etc.?

Construction and maintenance

- What methods of tendering are used in road management and any integral projects?
 - o *In your opinion, is this way of tendering the best way?*

Evaluate and adjust

- Are the projects and processes evaluated?
- Is the policy evaluated and adjusted?
- Are standards (specifications etc.) adjusted based on evaluations?

QUESTIONS OPPORTUNITIES FOR EXPANSION & POSSIBILITIES FOR COOPERATION

- Which elements/processes within road management would you like to extend?
 - o *Where is there room for improvement to achieve more proactive road management?*
- In which elements/processes do you see opportunities for greater cooperation with market parties?
 - o *Why these elements?*
 - o *What impact will this cooperation have?*
- Is your organisation familiar with the opportunities that market parties can offer in road management?
- Is any thought being given to using a different type of procurement form for road management?
 - o *What new type of tendering fits the new type of collaboration?*
- What role (in a collaboration) does your government want to adopt, should elements be outsourced to a market player?
- Is the confidence there among market players to outsource such elements?

Appendix VII Results case studies current situation section

	1	2	3
Cases	Hengelo	Súdwest-Fryslân	Hollands Kroon
Policy plans / maintenance plans	<ul style="list-style-type: none"> • Geen 	<ul style="list-style-type: none"> • AM-beleid en wegenbeheerbeleid 	<ul style="list-style-type: none"> • Integraal beheerplan openbare ruimte
Input for AMS Inspections, age, etc.	<ul style="list-style-type: none"> • Jaarlijkse inspecties 	<ul style="list-style-type: none"> • Elke 2 jaar inspectie 	<ul style="list-style-type: none"> • Aan de hand van persoonlijke inspectie een eigen planning maken • Om het jaar inspecteren • 1x per jaar zelf door areaal rijden • Meldingen ook
AM System		<ul style="list-style-type: none"> • Geovisia, van Data quint • Beheersysteem levert geen planning of begroting, enkel ruwe data, verhardingstype en jaartal 	<ul style="list-style-type: none"> • Switchen van beheersysteem is moeilijk • Beheersysteem wordt gebruikt om op eigenwaarneming te analyseren of een weg onderhouden moet worden • Obsurv van Sweco Voor alles • Beheersysteem werkt niet integraal, het zijn losse planningen • Excel met alle wegen binnen areaal
CROW method		<ul style="list-style-type: none"> • Diverse KPI's die asset niveau bepalen 	<ul style="list-style-type: none"> • CROW methodiek planning draaien uit beheerpakket is omslachtig • Maatregeltoets doen wij niet, kijken zelf buiten
Multiple year plannings	<ul style="list-style-type: none"> • Slechts 1 jaar vooruit 	<ul style="list-style-type: none"> • 30 jaar vooruit, wordt elke 5 jaar herzien • Per vakgroep/asset een planning 	<ul style="list-style-type: none"> • Planning uit beheersysteem niet werkbaar • Veel data in beheersysteem, maar slecht bruikbaar • Eigen Excel met de planning met interventiecyclusen voor de komende 15/20 jaar
Programming	<ul style="list-style-type: none"> • Wegonderhoud wordt geleid door andere programmas • Als gemeente niet meer in de lead 	<ul style="list-style-type: none"> • Asfaltvervanging alleen met riool • Elementen ook mits riool nog 30 jaar meegaat. • Wegen in de lead • Afstemmen samen met verschillende vakgroepen per asset 	<ul style="list-style-type: none"> • Riool afstemmen met wegen • Groen speelt in op wegen • werk met werk maken • Vaak op basis van riool
Short-term exec. Planning			<ul style="list-style-type: none"> • Onderhoudsprogramma per jaar
Set up project plans In or extern	<ul style="list-style-type: none"> • Capaciteit, Voor innovatieve oplossingen, Externe expertise, tijdsdruk 	<ul style="list-style-type: none"> • Handboeken en moederbestek 	<ul style="list-style-type: none"> • Extern
Project execution		<ul style="list-style-type: none"> • Bestek en raamovereenkomsten 	<ul style="list-style-type: none"> • klein onderhoud wordt gedaan met raamcontract • RAW-bestek voor aparte werken
Evaluation			<ul style="list-style-type: none"> • Geen formeel evaluatie moment, maar wordt wel informeel gekeken wat beter kan

	4	5	6
Cases	Breda	Overijssel (Province)	Dijk en Waard
Policy plans / maintenance plans	<ul style="list-style-type: none"> •Hebben 3 peilers: 1.Beleid (meerjaren doorloop) 2. Werkplan: Doorkijk van 5-10 jaar (ook voor samenwerking). 3. Operationeel (weginspecties, wat je in het aankomend jaar gaat doen) •Beheervisie 	<ul style="list-style-type: none"> •Beheer nota infrastructurele capitaal goederen 	<ul style="list-style-type: none"> •Wijkenplanning wel, wegbeheer weet ik niet
Input for AMS Inspections, age, etc.	<ul style="list-style-type: none"> •een keer per 2 jaar wegininspectie > elk jaar de helft van de stad 	<ul style="list-style-type: none"> •Data vanuit inspecties naar de beheersystemen •2x per week wordt er gecontroleerd op schades 	<ul style="list-style-type: none"> •Inspecties inlezen in beheersysteem
AM System	<ul style="list-style-type: none"> •Aparte systemen per asset •AMSs werken niet samen 	<ul style="list-style-type: none"> •beheersysteem voor alle assets 	<ul style="list-style-type: none"> •GISIB •Meerdere systemen
CROW method	<ul style="list-style-type: none"> •Meerjarenplanning vanuit maatregelentoets. 	<ul style="list-style-type: none"> •CROW normen (niveau B) 	<ul style="list-style-type: none"> •Niveaus van de CROW > Niveau B
Multple year plannings	<ul style="list-style-type: none"> •opgave voor de komende 10 jaar •Worden verschillende plannings gemaakt per discipline 	<ul style="list-style-type: none"> •Beheercyclus van 12 tot 15 jaar voor wegen •4-5 jaren planning met concretere onderhoudsplanung 	<ul style="list-style-type: none"> • via 1. wijkenplanning 2. op basis van inspecties en 3. reconstructies (meerjareninvesteringsplan) •cyclusplanning, jaarlijkse planning, wijkenplanning lopen door elkaar heen •Vanuit beheersysteem plannen > onderhoudsjaar 1-2 voor accuut onderhoud. En onderhoudsjaar van 3-5 jaar voor de minder urgente projecten
Programming	<ul style="list-style-type: none"> •vanuit 10 jaren planning met partners samen zitten kijken of je werk met werk kunt maken •integrale overlegtafel •Wegprojecten aanleiding om riool reconstructie of verkeersreconstructie aan te pakken •Enorm groot deel van de projecten hangt samen met een andere asset/invloeden 	<ul style="list-style-type: none"> •Geprogrammeerd op basis van leeftijd voor de komende 4-5 jaar •Wegen zijn leidend, die bepalen wanneer er ergens onderhoud of beheer komt 	<ul style="list-style-type: none"> •Vooral inspelen op riool •Een keer in de 4 weken een overleg met de belangrijke assets/beheerders •veiligheid en schades
Short-term exec. Planning		<ul style="list-style-type: none"> •Vanuit het meerjarenplanning wordt een jaarlijks uitvoeringsplan gemaakt voor het aankomende jaar 	
Set up project plans In or extern	<ul style="list-style-type: none"> •Leidraad voor specificaties, LIOR Leidraad inrichting openbare ruimte •We hebben standaard PvE en moederbestek 	<ul style="list-style-type: none"> • PvE stellen we zelf op. Daarna wordt alles extern gedaan •moederbestek, standaard details 	<ul style="list-style-type: none"> •Hele grote projecten worden voornamelijk uitbesteed. •HIOR handboek inrichting openbare ruimte •Moederbestek
Project execution	<ul style="list-style-type: none"> •RAW-bestek en raamovereenkomst. Ook wel eens bouwteams of UAV-GC. 	<ul style="list-style-type: none"> •Voornamelijk RAW-bestek, soms UAV-GC en bouwteams 	<ul style="list-style-type: none"> •Elementen onderhoud en groot wegonderhoud in raamovereenkomsten. RAW-bestek daarnaast voor overige projecten. En proberen bouwteams.
Evaluation	<ul style="list-style-type: none"> •Evalueren wel op het beleid 	<ul style="list-style-type: none"> •no 	<ul style="list-style-type: none"> •Ooit wel gedaan met past performance. Maar dat is niet helemaal eerlijk en heb je niks aan

	7	8	9
Cases	Utrecht	De Fryske Marren	HHNK (Waterboard)
Policy plans / maintenance plans	<ul style="list-style-type: none"> •4 jaar geleden is een nota borg geschreven. een herziening van de capitaal goederen 	<ul style="list-style-type: none"> •Beleidsplan voor wegbeheer •Geen integraal openbare ruimte plan of nota capitaal goederen. 	<ul style="list-style-type: none"> •Wegenbeleidsplan van 2012 tot 2017. Maar geen nieuw beleidsplan door de wegenoverdracht
Input for AMS Inspections, age, etc.	<ul style="list-style-type: none"> •inspecties 	<ul style="list-style-type: none"> •1x in de 2jaar visuele CROW inspectie •Op basis van bovengrondse waarnemingen en klachten wordt er ingespeeld op riolering •2 jaarlijkse inspecties. (beheersystematiek en klein onderhoud inspecties). Maatregeltoets, combineren met de kennis van buitendienst en klachten van de buitendienst. Vanuit inspecties en resultaten kijken wat we echt moeten doen en wat kan wachten 	<ul style="list-style-type: none"> •Jaarlijkse inspecties
AM System	<ul style="list-style-type: none"> •We gaan over van Gisib naar iAsset •beheersysteem voor alle assets 	<ul style="list-style-type: none"> •Geovisia •Het genereren van planningen wordt uitbesteed 	<ul style="list-style-type: none"> •Beheersysteem omvat alle onderhoudscyclussen •Iasset
CROW method	<ul style="list-style-type: none"> •CROW maatregeltoets geeft risico's voor de wegenplanning •Inspecties in beheersysteem > Systematiek CROW > Maatregelen toets > 2 jaren basisplanning 	<ul style="list-style-type: none"> •Hebben gedifferentieerd onderhoudsniveau van de CROW. A-B-C-D niveaus van de CROW gebruiken 	<ul style="list-style-type: none"> •CROW maatregelen toets gehanteerd
Multiple year plannings	<ul style="list-style-type: none"> •wegbeheer vanuit 3 sporen. 1. Vanuit inspecties (hoofdwegen elk jaar, en de rest 1x in de 2 jaar) 2. Meldingen voor klein onderhoud (lost de interne dienst op, maar die kunnen ook groot onderhoud aanklaarten). 3. Vanuit de vervaningsplanning •Vervaningsplanning is tot 2040/2050 waarbij de komende 10 jaar redelijk concreet zijn en daarna is het voornaemlijk op leeftijd •MIP, is en periode van 5 jaar 	<ul style="list-style-type: none"> •Beheer programmering 10 jaar vooruit, en een concretere 4 jaren planning waarop integrale projecten ook op worden gebaseerd 	<ul style="list-style-type: none"> •Wegen die matig zijn op een 5 jaren planning •concrete planning 1-2 jaar vooruit •beheersysteem zorgt voor theoretische planning. Zelf maken we praktische planning •Theorie en praktijk wijkt niet veel af, maar theoretisch zegt niet exact wat je moet doen
Programming	<ul style="list-style-type: none"> •Groen speelt ook vaker in met wegwerkzaamheden •Op basis van een 5 jaren planning van alle assets gaan we kijken of we werk met werk kunnen maken •Riolering aanleiding voor wegvervangingen •Bereikbaarheid en veiligheid 	<ul style="list-style-type: none"> •Capaciteit van intern ing bureau is leidend voor het uitvoeren/wegzetten van projecten •1x per jaar samen met andere assets kijken of we kunnen combineren •Samenwerken met externe assetbeheerders gaat eigenlijk niet •Momteel geen integrale planning •Op klachten •bereikbaarheid 	<ul style="list-style-type: none"> •Bereikbaarheid en veiligheid staan op 1 •Onderhoud afstemmen ook op andere projecten. werk met werk maken •Ja hebben volop integrale projecten waarin Dijkversterking leidend is
Short term exec. Planning	<ul style="list-style-type: none"> •Inspecties in beheersysteem > Systematiek CROW > Maatregelen toets > 2 jaren basisplanning 	<ul style="list-style-type: none"> •Waarvan de eerste 2 jaar concreet is vanuit de CROW beheersystematiek •Vanuit de programmeringsplanning komt de uitvoeringsplanning voorhhet komende jaar 	
Set up project plans In or extern	<ul style="list-style-type: none"> •HIOR •Moederbestek 	<ul style="list-style-type: none"> •LIOR •Moederbestek •PvE geen standaard, zijn we wel mee bezig 	
Project execution	<ul style="list-style-type: none"> •Meeste onderhoud via raamovereenkomsten van 2 jaar. Integrale herinrichting via RAW-bestek. 	<ul style="list-style-type: none"> •Groot onderhoud via raamovereenkomst. Grote integrale projecten via RAW-bestek. Proberen meer UAV-GC toe te pakken. 	<ul style="list-style-type: none"> •Integrale projecten via RAW-bestek •Onderhoud via raamcontract
Evaluation	<ul style="list-style-type: none"> •Nee doen we niet 	<ul style="list-style-type: none"> •Echt evalueren doen we niet 	<ul style="list-style-type: none"> •Oplevering wordt gecheckt. Verder niet geëvalueerd

	10	11	12
Cases	Noord-Holland (Province)	Tilburg	Almelo
Policy plans / maintenance plans	<ul style="list-style-type: none"> •Nota infrastructurale kapitaalgoederen is het beleid. Wordt elke 4 jaar vastgesteld •Processen in het beheer zijn beschreven. Ook guidelines en inkooptechnische hebben we contracten 	<ul style="list-style-type: none"> •Er is een sectoraal beleidsplan wegen 2022-2025 en een integraal beleidsplan openbare ruimte 2023-2026. 	<ul style="list-style-type: none"> Nee, Enkel nota kapitaalgoederen • We willen richting een SAMP
Input for AMS Inspections, age, etc.	<ul style="list-style-type: none"> •Input: inspecties, dagelijkse controles etc. •De aannemers in de gebieden zorgen voor de data, staat in het contract 	<ul style="list-style-type: none"> •inspecties, onderzoeken •De gegevens uit deze inspecties en onderzoeken zijn belangrijke input voor de programmering van sectorale onderhoudsmaatregelen •1 x per 2 jaar een globale wegininspectie van het gehele areaal (incl. inspectie klein onderhoud), 1 x per jaar een inspectie van de asfaltwegen op de hoofdstructuur, op specifieke locaties gerichte wegininspecties, asfaltonderzoeken etc. 	<ul style="list-style-type: none"> • 2 jaarlijkse inspecties, willen ook meldingen erin gaan verwerken • Basis topografie > areaal gegevens, welke assets heb je. Daarnaast komen de wegininspecties die laten zien wat de kwaliteit is. Willen in de toekomst ook meldingen eraan koppelen.
AM System	<ul style="list-style-type: none"> •momenteel GISIB • Zijn aan het kijken voor een nieuw BMS We willen meer elementen uit het BMS halen en dat lukt nu niet optimaal 	<ul style="list-style-type: none"> •voor verhardingen gebruiken we Obsurv van Sweco. •Er zijn meerder systemen voor de diverse assets. Alle assets zijn simpelweg niet onder te brengen in één systeem. 	<ul style="list-style-type: none"> • GBI is bevroren omdat in transitie zijn. Alle informatie is omgezet naar IMBOR voor de registratie. • zijn overgeschakeld naar een Basis ObjectenRegistratie waarin alle assets met alle basis data worden gekoppeld • Doel is om nu de markt te gebruiken om data op een hoger niveau te krijgen
CROW method	<ul style="list-style-type: none"> •In lijn met CROW. Hebben categorie D. 	<ul style="list-style-type: none"> •Ja, de stad is ingedeeld in zgn. functiegebieden. Samen met de gemeenteraad zijn aan alle functiegebieden een kwaliteitsniveau gekoppeld. 	<ul style="list-style-type: none"> • CROW is leidend is kwaliteit bepaling. • Veel niveau Basis van uit CROW en IBOR-model. Gericht op schoon, heel en veilig
Multiple year plannings	<ul style="list-style-type: none"> •Planning liggen voor 8 jaar vooruit. naarmate de tijd dichterbijkomt is het meer gedetailleerd •Planningen zijn volledig gebaseerd op data maar er moet altijd gecheckt worden wat er exact moet gebeuren 	<ul style="list-style-type: none"> •Vanuit deze integrale afstemming komen we tot een meerjarig programma voor de openbare ruimte. •op basis van gegevens uit de verschillende inspecties hebben we al globale plannings liggen tot 2030. 	<ul style="list-style-type: none"> • Standaard systematiek, maatregelen toets zorgt voor 1-2 jaar die de kwalitatieve planning. Daarna ga je naar de cyclische planning die je 60 jaar naar voren plant, maar dat is puur op leeftijd
Programming	<ul style="list-style-type: none"> •Vooral in samenspraak met andere overheden, als provincie kun je niet zomaar een weg eruit halen. •Ligt ook aan aannemer 	<ul style="list-style-type: none"> •Deze sectorale maatregelen stemmen we integraal af met andere assets (riolering, groen etc.) •en externen (nuts-partijen, woningbouwverenigingen) •Dat kan van alles zijn, de grootste spelers zijn wel wegen en riolering •De gemeentelijke programmering van projecten worden meerdere keren per jaar besproken met de nuts-partijen, •Ja, er is een 'MJP-tafel' (Programmeertafel) die gezamenlijk tot budgettering en projectdefinities komt. Daarbij programmeert men de projecten tot ongeveer 4 jaar vooruit. 	<ul style="list-style-type: none"> • Planning wordt richting integrale opdrachten gebracht. Samen afstemmen met meerdere assets. Wijk ontwikkeling ook aan toevoegen. • 4 momenten in het jaar om onderhoud met elkaar af te stemmen. • Riool en verharding zijn leidend. • onderhoudscyclussen van grote assets worden op elkaar afgestemd. Vervanging wegen bijvoorbeeld gelijk met vervangen riool • Merken wel dat de externe partijen (NUTS etc.) ander belang hebben. • Hoogste prio zijn invalswegen, ziekenhuizen etc. • Kwaliteit, veiligheid, bereikbaarheid
Short-term exec. Planning			<ul style="list-style-type: none"> • Lange termijn ook voor communicatie naar de raad voor de onderhoudsopgave. De kwaliteitsplanning is voor het echte onderhoud
Set up project plans In or extern	<ul style="list-style-type: none"> •hebben een IB. Die doen vooral kostenramingen etc. 	<ul style="list-style-type: none"> •basisbestekken en standaard PvE's voor het uitvragen van ingenieursdiensten bijvoorbeeld. 	<ul style="list-style-type: none"> • intern IB die veel zelf kan voorbereiden. Maar ze kunnen niet alles •Integrale projecten via RAW-bestek • Hebben nu een 2-fasen raamcontract

Project execution	<ul style="list-style-type: none"> •10 jarige gebiedscontracten •Onderhoud via Preferred Supplier systeem •Investerings worden los in in de markt gezet. Vrijwel altijd UAV-GC of Bouwteam 	<ul style="list-style-type: none"> •Reguliere standaardprojecten kunnen prima op die wijze aanbesteed worden, maar ik denk zodat we meer waarde gaan hechten aan duurzaamheid, circulariteit of andere innovaties, dat dit niet meer de beste manier van aanbesteden is. 	<ul style="list-style-type: none"> • Nieuw contractvorm, reden: We misten essentiële dingen, accuraat handelen. slagvaardige opgaven.
Evaluation	<ul style="list-style-type: none"> •Er vindt een toetsing plaats. En evaluatie van de projectteams wordt gedaan 	<ul style="list-style-type: none"> •Alle projecten dienen te worden geëvalueerd, door tijdgebrek lukt dit echter niet altijd. 	<ul style="list-style-type: none"> •Nee wordt eigenlijk niet geëvalueerd.

Appendix VIII Given answers for improvement of IAM processes

Table 16 Overview most mentioned answers to the two key questions during the interviews

Nr.	Codes/answers	Occur. (N=12)	Which cases
1	Road maintenance / IAM policies	1	1;
2	Improve the AM System and make it more usable	8	2;3;4;5; 7;9;10;12;
3	Set concrete objectives in projects	2	4;12;
4	Feedback to policy objectives	1	4;
5	Focus programming on combined projects with multiple assets	3	5;10;12
6	Use intelligent techniques for inspections	2	5;12
7	Use intelligent techniques for project planning	1	5;
8	Understand how other governments are implementing IAM	1	6;
9	Cost distribution on projects with combined asset projects	2	7;8;
10	Relationship between internal principal team and engineering team	2	7;9;
11	Involvement of citizens and other stakeholders	2	8;9;
12	Update road categorisation	1	9;
13	Reduce preparation, administration and monitoring costs (VAT costs)	1	10;
15	Setting up predictive maintenance	1	10;
16	Monitoring the condition of the assets	1	11;
17	Set up IAM generally	2	1;12;
18	Make data and management systems more useful for planning and budgeting	8	2;3;4;6; 7;8;9;12;
19	Address management per area	2	4;10;
20	Generate multiple variants	1	4;
21	Feedback to policy objectives	2	5;7;
22	Process of the construction phase	1	5;
23	Circularity	1	7;
24	New techniques to monitor the condition of assets	1	11;
25	All IAM processes need to be done in cooperation with market parties	1	10;

Appendix IX Results second focus group**Confidential**

