INTEGRATION OF ASSET MANAGEMENT 2.0 IN PERMITTING, SUPERVISION, AND ENFORCEMENT AT RIJKSWATERSTAAT

The focus of this research is the implementation of Rijkswaterstaat's (RWS) focus point Asset Management 2.0 (AM 2.0) in the established process of *permitting, supervision, and enforcement* (*VTH*). This is a condensed version of the full thesis in Dutch, included as an attachment. The current process presents opportunities for optimization to better align with the requirements for operational management and to enhance information exchange and accountability. This is concerning from an asset management standpoint because of the complexity and intensity of using infrastructure. The research was conducted using the Design Science Research Methodology (DSRM). Data was collected through interviews with VTH-employees and AM and by analyzing existing documents and procedures. Throughout the research, the integration points were analyzed, discussed with stakeholders, and optimized. The aim of this research is to develop a design that uses five key *integration points* to optimize the already established process. These integration points include the provision of internal advice by the asset manager(s) (AM), the integration of permit data into a central GIS environment (1GIS), the verification of executed decisions (physical assets), and the transfer of (partial) accountability to the AM. By adapting these process steps, permit data will become accessible to stakeholders outside of PB, ownership will be clearly established, and RWS will work towards meeting the requirements of the BGT. The results show that adding these integration points can improve the quality of the process, monitoring, and sustainability of activities within RWS. This will contribute to achieving the organization's strategic objectives and fulfilling its social responsibilities. Although this research provides a solid foundation for process improvement, further steps are needed, such as detailing process steps and task descriptions and consulting with stakeholders to ensure practical implementation. This report is a first step in making AM 2.0 more efficiently integrated into the VTH process of RWS.

Keywords: Asset Management (**AM 2.0), Permitting, Supervision, and Enforcement (VTH), Rijkswaterstaat (RWS), Process optimization, Design Science Research Methodology (DSRM), Data quality, Stakeholders, Sustainability, Infrastructure management, Process optimization.**

*** *Italicized* words have translations at the end of this report.**

1. Introduction

Rijkswaterstaat (RWS) operates under the Ministry of Infrastructure and Water Management (IenW) and is responsible for tasks related to national roads, waterways, and the North Sea. These tasks include construction, management, maintenance, and renovation. RWS performs these duties both as an authority and advisor, with guidelines rooted in various laws like the Shipping Traffic Act and the Environmental Act (IPLO, 2024). The Asset Management program is a multi-year development initiative where RWS is working on the sustainable and efficient maintenance of these vital infrastructures (Assets) for the management of the main road network, main waterways, and main water system. The networks will maintain their high quality in the long run due to centralized setup and organization, cautious and consistent administration, and high quality in both quantitative and qualitative aspects. Asset management needs to be improved as the region expands, gets older, and is used more frequently (Rijskwaterstaat, 2022).

Asset management is a technique that attempts to maintain a balance between costs, risks, and performance within an organization, according to Brown and Humphrey (2005) (Humphrey, 2005). To achieve the most value, this strategy requires coordinating managerial decisions, technical decisions, and organizational goals. Establishing an organizational culture, business procedures, and information technology that can make clear and consistent spending decisions based on data at all levels is also crucial. The goal of asset management is to balance risks, performance, and costs while also coordinating organizational goals with spending choices and creating a long-term plan based on exacting, data-driven processes. The asset owner, AM, and asset service provider are the three roles that compose up the framework developed by Brown and Humphrey (Figure 1), which improves the efficacy and efficiency of asset management.

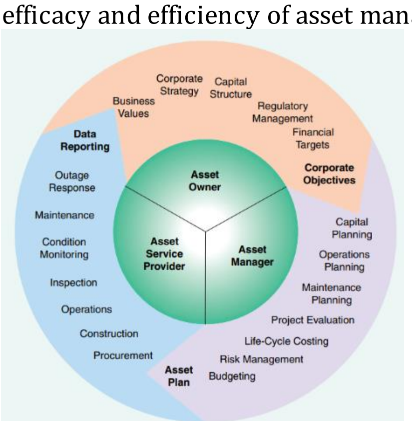

Figure 1: Asset management based on three functions (asset owner, AM, and asset service provider) (Humphrey, 2005)

The organizational structure of RWS, which is divided into numerous departments and roles, surely reflects this framework. Considering the asset management system presented by Brown and Humphrey, RWS maintains a distinct division of responsibility with a primary emphasis on data and data quality.

Asset management is defined by the ISO 55000 series as the coordinated actions taken by an organization to maximize the value of its assets, with an emphasis on optimizing assets as efficiently as possible over all phases of their life cycle (ISO, 2024). It aims to satisfy stakeholder expectations while optimizing value through efficient planning, application, maintenance, renewal, or disposal. Asset management is defined as a methodical approach that prioritizes long-term sustainability, assurance, and adaptability to create value and accomplish organizational goals. Many definitions can be found in the literature, but RWS follows the ISO 55000 framework. This approach differs from others, such as the approach of Brown and Humphrey. Additionally, RWS wants to become certified under ISO 55000, which calls for an organized approach to asset management to realize value and accomplish corporate objectives.

In the context of asset management, roles within an organization's procedures are essential. All the roles of stakeholders within the organizational structure need to be clearly defined to guarantee that processes function as intended. The RASCI model (Postma, 2019) is a well-known framework that has been created in the literature to define responsibilities.

The roles and responsibilities of individuals within a project or other operational tasks can be clearly defined using the RASCI model. This approach is widely utilized in the RWS organization to assign roles in various procedures. By offering this transparency, the RASCI model enhances efficiency and communication within an organization (Janse, 2024).

The five RASCI roles are described as follows:

1. **Responsible**: The person assigned to carry out a process or task. They also report to the person with overall responsibility.
2. **Accountable**: This person holds the ultimate responsibility for the project or task. They evaluate the final product and communicate the results.
3. **Supportive**: This role is assigned to those who support the process or project, performing various tasks, also known as functional roles.
4. **Consulted**: This person provides input, gives approvals, or offers other necessary contributions.
5. **Informed**: This individual is kept informed about decisions, processes, and outcomes related to the project or task.

There are two primary risks or pitfalls with the RASCI method. First, overly strict division of responsibilities can lead to inefficiency and silo thinking, where employees may avoid tasks that fall outside their official role but could still complete them. To prevent this, simplicity and flexibility are crucial when applying the RASCI model.

Data (asset information) is critical in asset management because the process is significantly reliant on information gathered during an asset's life cycle. This data is crucial for determining long-term trends as well as for organizing and scheduling tasks like asset replacement, maintenance, and redevelopment. Systems and technologies related to the asset management process are required to make it easier. The process cannot be carried out efficiently in the absence of complete and correct information. An earlier study of Shien Lin et al. (Shien Lin , et al., 2007) covered several subjects to highlight the significance of data quality:

- Optimized asset performance: AM can make well-informed decisions regarding replacement, maintenance, and use when they have access to reliable data. This lowers long-term costs and improves asset performance.
- Compliance and accountability: Complete documentation of asset-related operations promotes responsibility while helping firms comply with regulatory requirements and industry standards.
- Effective lifecycle management: Planning, supervision, and decision-making are improved at every level when assets are managed effectively throughout their lives, which is ensured by high-quality data.
- Stakeholder visibility and collaboration: Having high-quality data makes it possible for a range of stakeholders to obtain information about assets, which promotes cooperation and unity between asset management and other organizational procedures.
- Continuous improvement: By keeping data quality standards up to date, asset management procedures may be optimized continuously. Periodic data quality checks can be used to identify problem areas and suggest upgrades that are needed.

Permits awarded to third parties and associated notifications (meldingen) have a daily impact on the asset management operations by RWS. The way that RWS oversees its maintenance schedules and infrastructure is greatly impacted by these external factors. The Environment and Asset Management program relies heavily on the VTH department, which handles the processing of these permits (this includes permits as well as notifications.). The current focus point is on developing Asset Management (AM 2.0), which centralizes the evolution of asset management in accordance with future responsibilities for the water systems, roadways, and main road network. Establishing a reliable budget or plan is one of the main principles of AM 2.0. To achieve dependable management and efficient decision-making in the face of financial restrictions and issues like climate change, AM 2.0 (IenW, 2022) incorporates innovative techniques and technology for comprehensive analysis into condition, performance, risks, and expenses.

For RWS to manage its assets, the data produced by VTH operations is essential. Due to incorrect task assignment to stakeholders within the VTH process, the necessary data is currently not effectively and appropriately delivered to asset management, resulting in a poor data flow and accountability. Furthermore, although the importance of data quality is regularly emphasized in the asset management literature, less attention is paid to how organizational process efficiencies might support maintaining of this quality. This clarifies the basis for this study, which is to investigate data collection and security procedures for asset management instead of the VTH process themselves.

1.1 Problem statement

In 2023, RWS processed a significant total of 9,298 permit applications and notifications, of which 2,534 (27.3%) notifications were positively assessed and 3,826 (41.1%) permits were granted as a positive decision.

Permits ensure that activities affecting RWS-managed areas are conducted safely and responsibly, maintaining quality and safety without harming the environment or other users.

The VTH department is responsible for ensuring that activities on or near RWS networks meet quality standards and function properly without disrupting network operations (Rijkswaterstaat, 2024). This department also plays a key role in managing network performance to help achieve organizational goals. AM are responsible for ensuring the performance and quality of RWS networks, providing internal advice as part of the permit process, and making decisions about maintenance, replacement, or renovation of assets based on long-term strategies (Rijkswaterstaat, 2024). VTH is divided into two departments: the "Permitting" department, which falls under the "Network Development" directorate, and the "Enforcement" department, which falls under the "Network Management" directorate (IENW, 2022). The "Supervision" department also falls under the "Enforcement" department. The AMs are part of the "Network Management" directorate, and they carry out their tasks within the road and water districts (Rijkswaterstaat, 2024). These structures are extensively explained in the Dutch thesis report that has been attached as an appendix.

The current process at RWS does not meet the needs of operational management (Asset Management). Following an internal meeting on 7 February 2024, a task was created to identify and map key integration points between AM 2.0 and VTH proces. The installation of assets by third parties on or near the RWS areas may cause problems, especially during routine maintenance, and result in unforeseen maintenance costs. The following issues hinder data from being accurately collected and integrated into the relevant asset management systems:

1. <u>Permit data is not accessible outside the VTH:</u> Currently, VTH uses the PowerBrowser (PB) system to manage the process of permits (IenW, 2023), but the data is accessible only to VTH employees, making information sharing difficult. PB also lacks the ability to handle permit data with precise geometry, requiring a GIS solution for more accurate asset mapping (Rijkswaterstaat, 2024).
2. <u>Unclear ownership:</u> Ownership of permits within RWS is unclear, leading to inefficient transfers of responsibilities between departments. It is essential to clearly assign ownership and document responsibilities in procedures.
3. <u>Non-uniform data storage hinders information exchange:</u> Additionally, poor information exchange, such as the lack of integration between PB and maintenance systems like Ultimo, causes issues for AMs, who currently receive permits via email without a centralized repository for future reference.
4. <u>Optimization for the benefit of the BGT:</u> RWS must comply by the law relating to the Large-Scale Topography Base Map (BGT), which mandates that visible assets be documented with a maximum variance of 20 cm. Furthermore, citizens have the right to request complete information about an asset under the Open Government Act (Woo). The goal of RWS is to organize and make data freely accessible both internally and publicly to guarantee public access to information about assets and government activities. Meeting BGT regulations efficiently and streamlining procedures depend on effective internal access.

These issues reflect the essential requirements of RWS. It is clear from the study and present procedure that there is room for optimization to enhance operational management (AM).

1.2 Research scope

A distinction is made between two types of permits:

1. Internal Work Permit: These permits are requested and processed internally within RWS, for example, when the "GPO" department wants to carry out a project within the area under the responsibility of RWS.
2. Permit for a Third Party: These permits are requested by external parties outside the RWS organization.

The scope of this research exclusively focuses on the process related to permits for third parties; internal work permits are managed through contracts with market parties. The research encompasses the VTH departments and operational management (Asset Management), emphasizing the integration of these process stepts. The focus is on the information flow, data assurance, and the assignment of responsibilities, without conducting a separate substantive assessment of the processes.

1.3 Research objective

The goal of this research is to evaluate the current VTH process for external permits. This involves assessing the efficiency and effectiveness of information exchange within RWS, the integration of asset management systems, compliance with BGT legislation, and the organization of asset data for Woo legislation. The research will result in process components that will be added to existing process steps to optimize the quality, monitoring, and sustainability of activities within RWS's area. The points in the existing process where these components are added are referred to as integration points. These optimized integration points will comprise the final design that meets the requirements of RWS. RWS will receive a document for VTH (integrating the focus point AM 2.0) detailing the process steps for the integration points. This document will facilitate the implementation of the process within the overall organizational structures.

This goal will be achieved by:
- Analysing the current VTH process;
- Identifying integration points between VTH and Asset Management;
- Discussing the proposed process optimization with RWS stakeholders;
- Elaborating on the added roles and functions;
- Optimizing the process according to RWS criteria (ARIS-compliant).

1.4 Research questions

To address the problem described in the previous paragraph and achieve the objective of this research, a main question has been formulated. To answer this main question, several sub-questions have been established that must be answered first.

Main Question: How can the VTH process be optimized within the framework of AM 2.0 to enhance the information flow within RWS?

Sub-questions:

1. How does the current permitting, supervision, and enforcement process operate?
2. How is permit data stored and made accessible to stakeholders both within and outside RWS?
3. How can the process of storing and sharing permit data be optimized?
4. At which specific points in the VTH and Asset Management process is the information flow managed to ensure transparency and visibility for all stakeholders?
5. What are the requirements of the stakeholders for an ideally optimized process after the integration of VTH and AM 2.0?

1.5 Reading guide

In order to effectively supply asset management with accurate information in support of the AM 2.0 focus point, this thesis examines the VTH process steps. Reviewing the current VTH process, Chapter 2 highlights the necessity of process optimization. The research technique, which was based on academic literature, is described in Chapter 3. The results of the investigation are presented in Chapter 4, where the RASCI model is used to identify and optimize important process interactions. The thesis concludes in Chapter 6 with a final reflection on the research and a discussion (chapter 5) of the results.

2. Current process

In this chapter, the current process of VTH is presented; the specific connections with Asset Management are therefore not elaborated upon. During the permit issuance process, various departments provide input to reach a decision on a permit application or notification. Each of the departments or staff members contributes individually to this process through their specific tasks and input for issuing a permit. The process is centred around the VTH department. The other departments play limited roles in the form of evaluations and/or advice The VTH department is primarily in charge of making sure that operations carried out on, within, and close to RWS networks comply to the necessary functionality and quality requirements without interfering with the networks' ability to function (Rijkswaterstaat, 2024). The task of VTH consists of three main responsibilities:

1. Permit issuance: This is the process of assessing applications for events occurring in, around, or inside networks. These could be applications for environmental permits, building permits, or permits to use or emit specific chemicals or materials. Ensuring that the actions adhere to all applicable laws, rules, and standards for the networks is the aim. Following the assessment, a choice is made.

2. Supervision: Apart from the process of issuing permits, the VTH department also oversees adherence to the regulations concerning the decisions rendered. This entails monitoring operations to make sure they adhere to the published decision and any applicable restrictions. The appropriate action is taken when there are infractions.

3. Enforcement: This entails acting when regulations, such as those found in a decision, violated within the context of the RWS. Enforcing the rules might involve anything from stopping noncompliant actions to giving warnings and fines. To ensuring standards are followed and the networks' quality and operation are ensured, enforcement is crucial.

The domain of the VTH process consists of:

1. VTH initiation process;
2. Permit issuance process;
3. Supervision process;
4. Enforcement process.

This chapter's paragraphs go into more detail about the procedures. Since several steps of the procedure are not relevant to our research, they are not covered in depth. However, a broad synopsis of the procedure's elements is given. These current VTH process identify the integration spots.

2.1 VTH initiation process

The initiation process is where the whole VTH process begins. An application is filed as part of this procedure. The request is made via the Environmental Portal in the *Digital System for the Environment and Planning Act* (DSO) (IPLO, 2024)` and takes the form of a notification, informational request, or permission application.

The *Service Center for Permits* (SCV), which oversees receiving and processing these requests, accepts them. The SCV employee's first responsibility is to register the application and confirm that it already exists. After that, the employee ascertains which competent authority has been given permission to handle the application. The application is sent to the proper authority and the initiator is notified if RWS is deemed to be the incompetent authority (Henri, et al., 2023).

An SCV staff member notifies stakeholders through a publication and provides an acknowledgement of receipt to the initiator of an application that does not require a consent advisory—that is, when it is processed only by RWS. The application is promptly assigned to the area if it needs a consent advisory. Once a specific region has been assigned by the SCV staff member using the case management system PB, the application is reviewed and assigned to the relevant department by the VTH workload distributor (Henri, et al., 2023).

The *VTH workload distributor* verifies the registration and ascertains if the application is meant for the *Permit Issuer* (VV) or *Supervision and Enforcement* (TH). The distributor sends the application to TH if it is for TH. There is a handler designated if it is for VV.

After receiving the application, the permit handler verifies once more that RWS is the last competent authority. The application is sent to the appropriate authority if RWS is deemed to be the incompetent authority. The final step is to choose the application processing protocol if RWS is the ultimate competent authority.

There are six types of procedures that can be chosen for the permit issuance process:

1. Activities with an Information Obligation
2. Activities with a Notification Requirement
3. Application with Regular Procedure
4. Extended Procedure
5. Consent Advisory
6. Magnet Activity

The procedures are discussed in the following paragraph.

2.2 Permit issuance process

Three categories of requests are distinguished, as outlined in the preceding paragraphs: actions subject to an information duty, notifications subject to an obligation, and permit applications. These fall within the six categories that are listed in the VTH initiation process. All actions that influence the physical environment must adhere to the guidelines set forth in the actions *Decree for the Living Environment (Bal)* (GIerman, 2024). These regulations, which are applicable to governments, corporations, and individuals, are meant to guarantee responsible use and preservation of the environment. The Bal lists the necessary steps for several activities that have an influence on the environment.

For ***activities with an information obligation***, the Bal requires the submission of data and documents before the activity begins (IPLO, 2024). There is no restriction on beginning the action before submitting the required information, in contrast to the notice requirement. Instead of concentrating on the unapproved beginning of an activity, enforcement targets the lack of data. This is a quick step in which the HH workload distributor verifies the information is complete, and if it is, it is sent to the Enforcer (HH) for the Supervision process. These process steps are extensively explained in the Dutch thesis report that has been attached as an appendix.

Certain actions cannot be completed without first notifying the appropriate authorities for ***activities that have a notification requirement***. The Bal defines this commitment. The obligation for notification serves to make sure that the appropriate authorities are aware of any planned activity so they can create custom regulations or conduct any necessary supervisory measures. There may be deadlines for providing the notification before the activity can proceed, depending on the activity. This process is akin to the permit application process; however, it is more intricate than the information obligation procedure. The permit handler checks for completeness first, then evaluates the requirements to see whether any special steps are required. The cost procedure is initiated, and decisions are made regarding the guidance questions for the internal advisory process.

Following receipt of the internal counsel, the (draft custom) decision is made. The choice about the (final custom) is made following a quality evaluation stage. Before the case is closed, the administrative role holder completes an administrative and data check, following which the decision is finalized, published, and made public.

Four distinct procedures, each with somewhat different phases, can be used to complete a permit application. Except for the regulatory evaluation stage if special measures are required, the **normal procedure** is the same as the notification requirement procedure. This stage is not necessary for a permit application, as no custom measures are specified (Henri, et al., 2023).

The **extended procedure** differs solely in the steps of 'public inspection' and 'handling of opinions.' This indicates that interested parties and the initiator can view the (final) draft decision at any time. The impact of these viewpoints on the decision is evaluated in the following stage, "handling of opinions." If they do, you might have to go through a few stages again. These measures add to the procedure's potential six-month duration (Henri, Ruud, & Alies, 2023).

The permit handler asks an advisory body within RWS for advice and then permission in the **consent advisory method** (Henri, et al., 2023). After it is drafted, the (final) decision (as advice) is sent for evaluation to the appropriate advisory personnel. The permit handler receives the review's findings back so that any concerns can be addressed. The permission is developed based on comments received from the RWS advisory group. The decision cannot be made until the advisory body has approved the draft permit, which is sent back for approval.

A **magnet activity** is an activity within a multiple permit application that determines the competent authority (Henri, et al., 2023). Because of its significant weight, this activity guarantees that all other activities are under the same competent authority, assigning complete responsibility for the permission application to one agency. In this procedure, other responsible authorities are actively involved, particularly in areas pertinent to them. Until the judgment can be made, more data, counsel, evaluations, opinions, and permission are aggressively sought. Furthermore, further information and viewpoints cannot be provided without the initiator's active participation. Each of these process steps are extensively explained in the Dutch thesis report that has been attached as an appendix.

2.3 Supervision process

The supervisory procedure begins when a decision is made on a notification, information obligation, or permit application. Furthermore, if a signal is received from the municipality, the police, the stakeholders, or any other appropriate authority, the oversight procedure can also start.
The initial stages are to plan and set priorities. To detect a potential acute scenario, such as an environmental event or a problem affecting traffic safety and smoothness, the first step in this process is to evaluate the notification or signal. In cases of doubt or complexity, relevant departments are consulted, including the VWM, district, or VV. Permits or notifications are prioritized with the highest priority going to acute cases based on this examination and recommendations. The next step is to draft a supervision plan to guarantee that the issue is handled promptly and effectively (Henri, et al., 2023). The workload distributor then assigns the enforcer to plan the supervision in conjunction with other relevant competent authorities, execute the supervision, and evaluate it. The Supervision Process goes into detail about each of these proces steps.
Following the stages of planning and preparation, supervision is conducted, and the outcomes are recorded in a report. It is decided whether a violation has happened once the report has undergone an internal quality assessment. The process, which includes the legality evaluation, shifts to enforcement if a violation is found. If there are no infractions noted, it is determined if more supervision is required. The Supervision Process goes into detail about each of these process steps. Each of these process steps are extensively explained in the Dutch thesis report that has been attached as an appendix.

2.4 Enforcement process

The enforcement procedure is initiated upon the discovery of a possible infraction during the supervision phase. To ascertain if enforcement is required, the *Enforcement Officer* (HH) first performs preliminary assessments. An enforcement decision needs to be made if it is evident that enforcement is necessary. The legalizing process is started if the infraction is unclear. Legalization is the process of granting official status to a situation that was previously noncompliant, either because no authorization was previously issued or because the decision to deviate from it was deemed acceptable. If there is a genuine possibility of legalizing, enforcement may be suspended if a permit application has been filed and is likely to be accepted. If enforcement proceeds without a permit, the initiator is required to submit an application and request a temporary tolerance, frequently in the form of a warning letter (Henri, et al., 2023). The enforcement procedure is started after the decision is documented; this procedure is not included in this research because it is not important. The Enforcement Process goes into detail about these steps in the process. This process steps are extensively explained in the Dutch thesis report that has been attached as an appendix.

2.5 Current information flow

As was previously said, the VV, Th, and AM are the three main positions in this research. Following the commencement procedure, the VV oversees the issue of permits, gathering and entering information into the VTH case management system (PB). Additionally, the VV and Th collaborate and share information and advice on how to carry out their task effectively. The Th adds information during supervision and utilizes PB to obtain permission data that the VV previously added. After a decision is made, the AM participates in the VTH process for advice and gets pertinent data via email. The current information flow is presented in Figure 2.

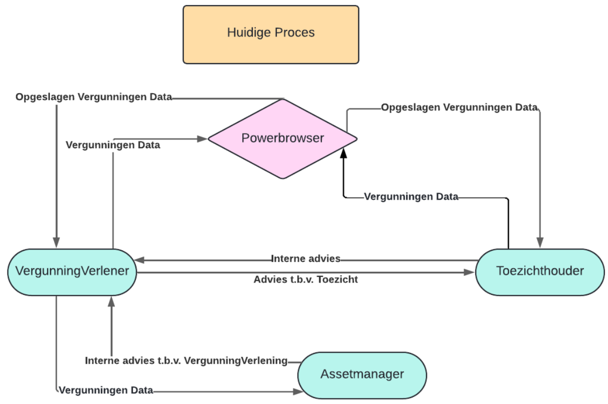

Figure 2: Current information flow.

3. Methodology

A design has been developed to achieve the objectives of this research in the context of process optimization, ensuring alignment with the strategic goals and societal responsibilities of RWS. This design consists of optimized integration points that provide support and enhancement within the design process.
When selecting a research method focused on process optimization within RWS, several design-oriented approaches were considered:

1. Product Design Methodology: This approach uses a systematic design framework with creative, analytical, and execution steps, offering evaluation, simulation, analysis, and synthesis. While useful for product development, it focuses on physical products rather than abstract processes or systems required for this research.

2. Design Science in Information Systems (IS): This method focuses on developing and evaluating technological artifacts through an iterative cycle between problem and solution spaces. It is useful for digital tools but less suitable for organizational process optimization in RWS, as it emphasizes technology over organizational or policy-related aspects.
3. Science-based Organizational Design: This method designs organizational processes through a cyclical model, starting with problem identification and using a systematic research and design cycle. While suitable for organizational processes, it sometimes lacks the practical applicability needed for complex, multidisciplinary problems like those in RWS.

The Design Science Research Methodology (DSRM) is a systematic approach to design research focused on creating and evaluating artifacts such as models, methods, or systems. It serves as the foundation for developing the design in this study. DSRM combines both applied and theoretical elements to define problems and find solutions (PEFFERS, et al., 2008). This structured model, based on design science, provides researchers with a framework to conduct their research.

While DSRM is the most suitable method for this research, certain steps may not apply due to existing processes within RWS, which complicate the application of a specific methodology. Despite this, DSRM aligns well with the thesis's objectives.

DSRM focuses on offering a common framework for design research, helping researchers identify relevant problems, develop objectives for solutions, design and develop artifacts (like the DST), and evaluate and communicate the results. By following this method, researchers ensure their work is both relevant and rigorous, contributing effectively to solving key problems.

The **six activity steps of the Design Science Research Methodology (DSRM)** include the following key points (PEFFERS, et al., 2008):

1. **Problem Identification and Motivation**: This step involves clearly defining the research problem and justifying the benefits of a solution. The aim is to motivate both researchers and stakeholders by highlighting the problem's relevance and importance. In this research, the nature of the problem is explored through interviews with stakeholders and the review of existing proposals and documents within the organization.
2. **Define Objectives for a Solution**: The goals of the solution are derived from the problem definition and can be either quantitative (e.g., developing innovative solutions) or qualitative (e.g., solving previously unsolved problems). The objectives for this research are in line with the study's purpose and the assignment from RWS.
3. **Design and Development**: This step involves creating the design, including determining its functionality and architecture. The development process involves identifying the integration points and adding steps to the existing processes to create the final design.
4. **Demonstration**: The design is demonstrated to show how it solves the identified problem. The aim is to gather suggestions for future enhancements and to show that this design, in the form of integrated processes, is genuinely successful. This is done through presentations to RWS stakeholders to gather feedback and assess its practical effectiveness.
5. **Evaluation**: The results of the design are measured and compared against the defined objectives. However, this step falls outside the scope of this research, as further refinement is required for operational purposes within RWS after the demonstration.
6. **Communication**: The problem, the DST, and its usefulness are communicated to relevant audiences, especially stakeholders. Involving stakeholders early ensures that diverse perspectives are considered, leading to a better final design.

DSRM is considered the best fit for this design-oriented research, as it helps develop solutions and assess their effectiveness. The iterative nature of DSRM allows for continuous improvement through feedback and discussion, with three design cycles completed in this research. Regular sessions with RWS stakeholders were crucial in refining the design based on their feedback.

3.1 Design cycle 1

During step 1 of the DSRM process (Problem Identification and Motivation), several meetings were held between the researcher and the RWS supervisor to develop a clear graduation assignment. The research assignment, which stemmed from an internal RWS meeting on February 7, 2024, was discussed. The need to address the issues described in Chapter 1.1 (Problem Description) is evident. This led to the task of identifying integration moments where process optimization should be applied.

Interviews were conducted with stakeholders involved in the VTH and Asset Management process to verify whether this problem is indeed occurring. Key stakeholders included:

- Justin Jansen: Project Leader, Data, and Information Services, RWS-ON (Supervisor)
- Joël Hendriks: Senior Advisor, dep. Permitting, RWS-ON
- Brian Bakker: Asset Management Advisor, District East, RWS-ON

- Jules Heijckers: Inspector/Enforcement Officer, RWS- ZN
- Alies Visser: Advisor and Soil Specialist, dep. Permitting, RWS-ON
- Steven van der Velde: Specialist Advisor, dep. Permitting, RWS-NN

These interviews confirmed the need to address the issue, particularly for operational management. Once the integration moments are identified, they must be secured in the process steps. After approval from stakeholders, this process optimization will be implemented in the RWS organizational structures.

The next step defined the research objectives to ensure an efficient information flow, as outlined in 1.2 (Research Scope). The final result for RWS will be a document with detailed process steps on the identified integration moments (1.3: Research Goal).

Results: In Design Cycle 1, four integration moments were identified to ensure the information flow. A feedback session was held on July 18, 2024, with RWS stakeholders. The session aimed to gather critical feedback on the proposed integration moments and their solutions, considering the stakeholders' daily involvement in these process steps.

Key feedback from the stakeholders included:

1. Align the AM's internal advice with the business value matrix, ISO 55000, SAMP, and long-term regional strategies.
2. Use newly developed processes rather than ARIS-based ones.
3. Use RASCI to clarify roles.
4. Further elaborate on the role of the previously mentioned Data Manager.
5. Reanalyse the oversight process, as not all permits can be verified.
6. Outline the next steps after the research.

This feedback was incorporated into the second design.

3.2 Design cycle 1

During Design Cycle 2, a deeper focus was placed on identifying the integration moments. A new integration moment was added (internal advice from the AM in line with the SAMP and RWS's corporate values), based on feedback from the first design cycle. Existing processes were also further developed according to the latest version, as explained in Chapter 3. Process steps at the integration moments were refined according to the standards of this new process version. A new role was introduced, with a job description added, following the use of the RASCI model as suggested in the feedback session. For integration moment 2, the new role was renamed to (Senior) GIS Data Manager (sGG), with its functions and role further defined. The verification of the decision execution was reanalysed, with the location of optimization in the existing processes adjusted and further refined. Lastly, the thesis's added value to the organization and the steps needed to reach the final goal were outlined.

Result: The revised design was demonstrated to RWS stakeholders in a feedback session on August 23, 2024. Minor improvements were suggested, but the design was deemed sufficient for the research, making a further design cycle unnecessary. Based on the feedback, the final DST, in the form of optimized integration moments, was presented in Chapter 4. To avoid complexity and confusion, only the final design is included in the report.

4. Results: Identified Integration Points

In Chapter 3, the current process of VTH and Asset Management are discussed in detail. It does not focus on the existing VTH process but rather highlights its shortcomings in relation to Asset Management. After gaining insight into the existing process and its associated steps, integration points can be identified while considering the objectives of this research and the needs of RWS. These integration points indicate areas in the (sub)process where adjustments are necessary because certain roles or tasks are not well-established (see Chapter 1.1 Problem Description).

The integration points were established by thoroughly analysing the process steps in the ARIS portal of RWS and in the new VTH process (November 2023). Additionally, interviews were conducted with officials within RWS who are involved in Asset Management and the VTH process (see 2.1 Design Cycle 1). By optimizing the process steps at these integration points, tasks can be clearly defined and efficiently assigned to the appropriate staff.

This chapter addresses the five integration points that have been identified for process optimization. The subsections describe and elaborate on the tasks and roles at these integration points.

4.1 Integration moment 1: Internal Advice Asset Management

This integration point has been identified to ensure that advice from an AM is provided more efficiently during the permitting process than in the current process. Integration Point 1 applies during the process step "sub-processes of internal advising" within the Permitting process, as illustrated in the standard procedure. In this process step, the processor of the permit application requests advice from various internal stakeholders, which have been determined during the preceding process step "Determining advisory questions" ("Bepalen adviesvragen"). AM is a crucial internal stakeholder, as they are responsible for formulating long-term strategies for the area where the permitted activity will take place. From an asset management perspective, AM assesses to what extent granting the permit conflicts with the maintenance of an asset, based on their own insights.

The current approach does not assess whether the permit or notification aligns with the organizational goals of the Ministry of Infrastructure and Water Management (IenW) and RWS, making this method insufficient for formulating a strong recommendation (advice). In this context, a connection is required to ensure the appropriate internal advice of the AM into the Permitting process. IenW and RWS utilize the international standard ISO 55000 and the iAMPro methodology when developing asset management (SAMP, 2024). This information is documented in the Strategic Asset Management Plan (SAMP). The first version of the SAMP, which describes the asset management strategy of IenW and RWS, was published in January 2023. The second version of the SAMP, including several development points, was published in March 2024 (SAMP, 2024). The SAMP primarily illustrates the relationships between the tasks of RWS and how they are executed.

In accordance with the policy directorates-general (DGs), RWS contributes to the goals of IenW by balancing costs, performance, and risks. This balance is achieved through a careful assessment of risks based on the risk acceptance indicated by the policy DGs. To make this decision consistent, the organizational values have been documented in a *corporate values matrix* (bedrijfswaardenmatrix) (SAMP, 2024). These values, derived from the societal value of IenW and the organizational goals of RWS, support transparent and integral decision-making. The five organizational goals of RWS are:

- A sustainable living environment
- Dry feet
- Sufficient and clean water
- Smooth and safe traffic over land and water
- Reliable and useful information

From these five organizational goals, the corporate values have been established. The six corporate values are (SAMP, 2024):

- **Safety**: RWS ensures safety with other water managers during high water events, safe traffic over land and water, and the safety of employees working close to risks, such as road inspectors and project workers.
- **Liveability**: RWS is responsible for the quality of the physical environment, including air, water, soil, spatial quality, cultural heritage, noise, and vibrations, microplastics, litter, nature, biodiversity, and active mobility, all of which contribute to quality of life.
- **Sustainability**: RWS evaluates its activities based on their impact on the planet, striving to be a sustainable organization while working towards a climate-neutral and circular future.
- **Accessibility**: RWS ensures mobility over roads and waterways, essential for economic growth and prosperity, collaborating with other managers and partners for a well-connected Netherlands.
- **Social Impact**: This involves maximizing societal value at the lowest costs while considering public goals that do not primarily fall under the ministry's responsibilities.

By operationalizing the corporate values and providing measurable risk indicators, the corporate values matrix ensures consistent and uniform decision-making. This tool enables effective application of the corporate values at strategic, tactical, and operational levels, leading to clear and consistent decision-making. This integration point is extensively explained in the Dutch thesis report that has been attached as an appendix.

4.1.1 Tasks at integration moment 1

In this sub-paragraph, the tasks of the AM and VV are elaborated to specify the exact activities carried out at integration moment 1.

Tasks of AM:

1. AM assesses whether the activity applied for a permit or notification conflicts with the long-term strategies of the region.
2. Using the business values matrix, AM checks whether the application aligns with the business values and objectives.
3. AM provides advice, considering already approved activities in the region, to determine if the new permit causes any conflicts.

Tasks of VV:

1. VV makes the decision based on the comprehensive advice from AM and other internal advisors.
2. VV saves the advice in the PB.

4.1.2 Step in integration moment 1

In this sub-paragraph, the process step at coupling moment 1 is elaborated, and the roles of the involved parties are named. The process step is developed in accordance with the elaboration of the permitting process, published on November 27, 2023 (Henri, et al., 2023). The comprehensive report includes a graphic representation of this process step (see appendix).

4.2 Integration moment 2: Permit data in 1GIS

In the current permitting process, this link remains open and unnamed. There is no specific responsibility assigned for mapping the permit information that needs to be available for the internal (and external) organization of RWS. This information must reach the Asset Management systems of RWS correctly and through the appropriate roles in the process. The current process focuses on decision-making and lacks insight into permits in a general digital environment (geography is mapped by the applicant, and sometimes a correction occurs within PB by VV (the geographic layer used is geometrically imperfect)), this need is described in Chapter 1: Introduction. The data can be extracted from PB, where all permit data is currently stored and added by an expert in the general RWS GIS-environment (1GIS). In this environment, awarded and rejected permits can be added and displayed, along with the corresponding attribute information. Therefore, there is a need for a new role within the permitting process: *(Senior) Data Manager GIS* (sGG).

This process step is applied in the following procedures:

1. Notification obligation (if customization is requested);
2. Regular procedure;
3. Extended procedure;
4. Advice with approval;
5. Magnet activity.

The aforementioned procedures were chosen because advice is requested from the AM in all these procedures, after which a decision is made on the approval or rejection of the application. The best moment to insert an sGG into the permitting process is between the process steps "Determine advisory questions" (Bepalen adviesvragen) and "Draft (concept) decision" (Opstellen (concept) besluit).

Integration moment 2 is the moment in the permitting process when the application is still "In progress" (Onderhanden). In other words, no decision has yet been made about the application, and the processor is busy collecting and analysing the necessary information. This is the appropriate moment because the advice from various departments has already been received, and the permit application file is complete with all relevant information the sGG needs to perform its tasks. Moreover, this moment was chosen so that the sGG does not need to work repeatedly but has all the necessary information at once.

This information is essential for operational management to carry out their tasks adequately; therefore, this step of the sGG is crucial to add to the process. This ensures that the data is accurately available for all stakeholders within RWS. This integration point is extensively explained in the Dutch thesis report that has been attached as an appendix.

4.2.1 Tasks at integration moment 2

This sub-section outlines the tasks of the sGG and the VV at integration moment 1.

Tasks of a VV:

1. The VV completes the file in PB, after which the sGG receives a signal to get started.

Tasks of an sGG:

1. The sGG accurately draws the geometry of the permit applications in 1GIS under a unique identifier, using the extracted geographic information (As-planned drawings) from PB.
2. In the current GIS environment, there is a feature class Business Legal that is subdivided into six identified fields:
    - Date of current decision (which can be categorized under StartDate and End Date)
    - Decision reference (decision number) or Case number (which can be categorized under Number)
    - Permit holder (which can be categorized under Holder) (*GDPR* check)
    - Subject
    - Status (Under consideration)
    - Cadastral or geographic data/location code

StartDate, End Date, Number, and Holder are already existing attributes in the current GIS environment. The approval to add the fields Subject, Status, and Cadastral or geographic data/location code is finalized. The sGG will also be the key user of this feature class.

<u>One-time action</u>

Creating an application that automatically connects PB to the core 1GIS is a one-time task. The unique identifier in GIS is connected to data in PB (such as date, decision reference, permit holder, subject, status, and cadastral or geographic information) and is automatically updated. This eliminates the requirement for manual re-entry and guarantees effective data synchronization between the two systems.

<u>Job requirements sGG</u>

The sGG requires a thorough understanding of GIS systems and a professional education level of at least HBO, ideally in geoinformatics, geography, urban planning, or civil engineering. It is crucial to be able to interpret as-planned designs and extract important information. It is necessary to have prior experience as a key user with ArcGIS or QGIS, as well as to have a basic understanding of permits and as-planned/as-built information. Information security and privacy expertise are also crucial, as is understanding to administrative and political factors. As a trustworthy partner, the sGG ought to provide the promised level of quality.

4.2.2 Step in integration moment 2

In this paragraph, the process step at integration moment 2 is elaborated, and the roles of those involved are specified. The process step is detailed according to the permit issuance process, as issued on November 27, 2023. See the appendix for a detailed explanation.

4.3 Integration moment 3: In Progress" to "Decision"

Integration moment 3 is identified in the permit issuance process, focusing on changing the status of the permits once a final decision has been made. The decision can be either positive or negative, and this step is taken after the objection period has passed. At this point, the VV needs to change the status from "In Progress" (Onderhanden) to "Decision" ("Granted" or "Rejected") (Besluit).

A sGG is not required at this stage unless there are geographic deviations after the objection period. In such cases, the process reverts to integration moment 2, where adjustments are made to geographic data in 1GIS. This step is performed in PB, with the adjustment automatically linked to 1GIS and Asset Management systems. Currently, this step is manual, with the VV sending the information to operational management (AM) via email.

This process step applies to the following procedures:

1. Notification requirement (if custom request);
2. Regular procedure;
3. Extended procedure;
4. Advice with consent;
5. Magnet activity.

4.3.1 Tasks at integration moment 3

The tasks added at integration moment 3 for the VV are:

1. The VV changes the status of the permit in PB from "In Progress" to the final "Decision": Granted/Rejected.

One-time action in PowerBrowser:

- Developing an (automatic) connection from PB to 1GIS environment and Asset Management systems.

4.3.2 Step in integration moment 3

In this paragraph, the process step at integration moment 3 is elaborated, and the roles of the involved parties are identified. The process step is outlined in accordance with the permit issuance process, issued on November 27, 2023. See the appendix for a detailed explanation.

4.4 Integration moment 4: verification of executed decision

Integration moment 4 has been identified within the supervision process. After the process of granting permits, the transfer of data and responsibility takes place from the VV to the department of TH. In the current process, supervision (verification) is performed, but only for a limited number of granted permits. The selection of permits for supervision occurs in the process step "Prioritizing and Scheduling Supervision" (Prioriteren en Toezicht inplannen) where it is determined whether new permits indicate a potential acute situation (Henri, et al., 2023) regarding environmental or safety concerns. Not all granted permits are checked; This stage only pertains to assets that are physically located in RWS's maintenance and management area and are under the management of "nat & droog". The current risk tool, which is being used to prioritize oversight actions, may be utilized to further detail this step.

Multiple stakeholders, such as road inspectors and officials, are active in the field, but responsibilities lie with the *supervisor* (Toezichthouder (Th)), who has the legal knowledge to analyze permits and has the authority to step in if it does not comply.

The lack of control can lead to inefficiencies and potentially harmful situations. Integration moment 4 adds two process steps:

- **4a**: In the "Planning and Preparing Supervision" procedure, the supervision of the other granted permits is also scheduled.
- **4b**: In the "Executing and Evaluating Supervision" procedure, this integration moment is added for adjustments in the execution of supervision.

Integration moment 4 is an expansion of existing steps and is important for scheduling supervision of the assets. The responsibility for 4a lies with the work distributor (werkverdeler) to make sure that the verification of all granted permits is planned, while the Th (responsible for 4b) assesses whether the requirements in the decisions are met. If there are deviations in the geographical data of the objects, the process continues to the HH.

Adding this verification moment improves the reliability and accuracy of RWS data, making the work process more efficient and preventing issues arising from incorrect executions.

4.4.1 Tasks at integration moment 4

Tasks Added for the Work Distributor at **integration moment 4a (Scheduling):**

- The work distributor must ensure that all granted permits are included in the *Implementation Plan* (UP). The current prioritization methodology remains applicable to determine the order.

Tasks Added for the Th at **integration moment 4b (Executing):**

- The TH is responsible for verifying whether the 'object' (asset) is located in the correct place according to the decision (if not, an assessment must be made to determine if it can be legalized).
- Verify that the As-built drawing is provided with metadata and has been correctly inserted into the DMS of RWS.
- Verify if an as-built drawing is provided with metadata and has been properly placed in the RWS Document Management System (DMS).
- Check if there are specific agreements in the permit for providing additional information. If so, verify that this information is correct and has been delivered to the right place.
- Attribute fields in 1GIS must be rechecked, after which the status must be changed to 'executed'.

One-time Action in the Case Systems:

- Build an (automatic) connection between the case systems and 1GIS.

4.5 Integration moment 5: transfer of responsibility to the AM

The last integration moment involves the practical transfer between VTH and Asset Management (HH remains legally responsible but only acts when requested or when identified). The transfer occurs when the Th changes the status of the permit to 'executed' (as detailed in the Th's tasks at integration moment 4). Integration moment 5 is identified in the Supervision process, at the end of the "Executing and Assessing Supervision" (Uitvoeren en beoordelen toezicht) procedure, once all verification tests have been conducted and the supervision assessment has taken place.

During the permitting process, the VV requests internal advice from the AM, making the AM aware of the application and thereby contributing to the permitting process (also secured through integration moment 1).

The AM assumes responsibility for a permit within its area as the asset(s) will fall under its management from that moment on. From the moment of transfer, the AM is responsible for the daily management of the asset. The AM must maintain the relationship with the permit holder, and in case of specifics related to the asset, both within and outside the organization, this must now proceed through the AM and no longer through the VV.

The relevant AM has access to all documentation of the permit data due to previously arranged integration moments, ensuring that the information is secured in the relevant case systems. This allows the AM to efficiently trace which colleagues were involved during the permitting and supervision process. However, the VV/Th/HH are still legally responsible.

4.5.1 Tasks at integration moment 5

Through this action, where the responsibility now lies with the AM, an additional task is introduced that needs to be further developed within the AM's field of work:

- The AM receives a notification within 1GIS after the Th has changed the status of the permit from 'Decision' to 'Executed'. This means the AM is responsible for the daily management of the asset.

At this process step, no specific action is required from the AM, as the data has already been checked in the previous steps during the coupling moments. The tasks are only completed when the data has been correctly added to the appropriate places. Therefore, no extra process step is needed for this integration moment.

4.6 RASCI -model: overview of responsibilities

In this paragraph, an overview of roles at the five identified coupling moments is presented using the RASCI model.

- R = Responsible: Responsible party/parties
- A = Accountable: Accountable party
- S = Supportive: Supportive party/parties
- C = Consulted: Consulted party/parties
- I = Informed: Informed party/parties

The roles of the stakeholders at each of the five integration points are explained in Table 5 (found in the comprehensive Dutch report). The table provides information from the perspective of the role holder (vertical) as well as the integration points (horizontal). Both viewpoints are important to RWS since they assist in determining the implications of a particular integration point for a role holder's responsibilities and vice versa.

4.6.1 Integration point perspective

The responsibilities of role holders at the integration points are covered in this subsection.

Integration moment 1 (internal advice AM): The AM is responsible for providing the advice correctly (in accordance with the SAMP and the business values matrix). The VV is accountable and must be informed when the advice is complete.

Integration moment 2 (permitting data in 1GIS): The sGG is the one who must execute the tasks to place the permitting data in 1GIS. The VV is then ultimately responsible and supports the sGG in analysing the data. The stakeholders within the organization are the employees of RWS, who can view the data through this general 1GIS environment and can be informed via an automatic notification (it still needs to be determined who will perform this task and how).

Integration moment 3 (modification of permit status): Here, the responsibility for execution and ultimate responsibility lies with the VV, as this involves only a minor action in PB to change the status of the permit. Furthermore, the work distributor of Supervision is informed via an automatic notification in PB.

Integration moment 4 (verification of executed decision):

Integration moment 4a (scheduling): The tasks are assigned to the work distributor of Supervision, who is responsible for scheduling as outlined in Chapter 4.4. The work distributor is responsible for the task and the accountable party. Moreover, the Th is informed.

Integration moment 4b (execution): The tasks at this process step are assigned to the Th (as detailed in Chapter 4.4), who is also the accountable party, as the data can only be transferred when it has been correctly and appropriately added. The VV is familiar with the permit and can therefore be consulted in case of uncertainties, questions, or advice. The AM is informed (automatically) via 1GIS.

Integration moment 5 (transfer of responsibility to AM): At this process step, no tangible action is required. This follows the last action of integration moment 4b. The ultimate responsibility lies with the Th, as the responsibility can only be transferred when the data is correct. This corresponds with integration moment 4b. The AM is only automatically informed and receives the responsibility, thereby establishing the daily management. Moreover, the stakeholders and the VV are also informed.

4.6.2 Stakeholders' perspective

The implications of the integration points for the stakeholders' responsibilities are covered in this paragraph.

AM: According to AM, implementing integration point 1 includes more accountability for offering internal recommendations, as specified in the procedure step. AM also receives automatic notifications at integration points 4b and 5 informing it when the responsible party complete the process steps.

VV: At integration point 1 (internal advice), VV is responsible and needs to know when AM complete the task since it affects the next steps in the processing of permits. If the sGG discovers any confusing information at integration point 2 (input of permit data into 1GIS), VV is consulted. It is the responsibility of a VV to update the permit status to the decision for integration point 3. Th consults VV at integration point 4 if necessary and at integration point 5, when all accountability is passed to AM, VV is informed.

VV Department Head: At integration point 3, when the permit status is converted to a decision, the VV department head carries final responsibility for the action.

AM Internal adviser: The role of the internal adviser is to assist AM at integration point 1 by offering valuable advice as needed.

sGG: The sGG oversees integration point 2, making sure that permit data is added to 1GIS in accordance with the procedure step.

Stakeholders: Employees of RWS who depend on the data for their daily tasks are considered stakeholders. At integration points 2, 4, and 5, they get informed.

Work Distributor (Supervision): When a permit decision is taken, the work distributor is notified at integration point 3. From there, they handle responsibilities at integration point 4a, such as arranging for the physical permit assets to be verified.

Th: Th is in charge of confirming permit data at integration point 4b and accountable at integration point 5, making sure data is accurately recorded prior to AM taking over.

Th Department Head: The Th department head is ultimately in charge of carrying out the permit verification and is notified when it is scheduled by the work distributor.

5. Discussion

Effective asset management is essential for maintaining aged infrastructure, especially when asset complexity and volume rise. A strong asset management system is crucial for institutions like RWS, which oversees national networks. This is relevant considering issues like aging infrastructure, climate change, and constrained budget. Modern, advanced asset management systems are necessary for the reliable and predictable management that is demanded.

Effective asset management depends critically on data quality, as the thesis introduction emphasizes. Improving data quality is essential to propel AM 2.0 forward and to boost asset understanding and control. Making educated decisions about investments, replacements, and maintenance requires timely and accurate data.

The goal of this thesis is to optimize VTH procedures to improve data quality within RWS, specifically with relation to asset management. Optimizing these process steps will enhance the information flow to asset management, promising more effective and progressive management under the AM 2.0 program. These process steps are important sources of data for asset management.

The key findings of this design-oriented study are based on the identification of five critical integration points for the final design, aimed at optimizing the process steps within RWS. These integration points include:

1. Internal advice from Asset Management (AM).
2. Adding permit data to 1GIS.
3. Adjusting the permit status.
4. Verifying the decision.
5. Transferring responsibility to AM.

These integration points were studied, debated, improved, and aligned with the guidelines of RWS. The report provides a solid foundation with guidelines for RWS to address the identified problems and needs.

5.1 Research Contribution

RWS process optimization is the focus of this thesis, which blends theoretical foundation with practical applications. This paragraph makes a distinction between the direct contribution of this research to RWS and its wider scientific significance. The research is grounded in theoretical knowledge from the literature, although the results are based on the organizational requirements of RWS. This thesis makes a substantial contribution to scientific knowledge of process optimization and organizational efficiency in addition to supporting RWS optimize its daily operations.

5.1.1 Research contribution to RWS

As stated in the literature (Shien Lin , et al., 2007) and cited in the thesis introduction, the five integration points that were found in this design-oriented research directly contribute to guaranteeing data quality. Every integration point contributes to efficiently carry out asset management within RWS and satisfies certain needs for accurate data quality:

1. **Optimized Asset Performance**: Improved permit decision-making ensures better maintenance and asset use, which is facilitated by the AM's internal advice (integration point 1). While integration moment 4 validates the accuracy of asset data after implementation, integration moment 2 makes sure assets are properly located in 1GIS. This provides accurate data, enhances asset performance, and lowers long-term expenses.

2. **Compliance and Accountability**: These integration points allow adherence to the BGT law, which also assist effectively compliance of the Woo Act. Permit data must be properly entered into 1GIS (integration moment 2) to satisfy legal requirements, improve traceability, and define responsibilities.
3. **Efficient Lifecycle Management**: According to integration moment 5, AM is explicitly given responsibility for asset lifecycle management. To facilitate long-term management, moments 2 and 4 assure data quality throughout the asset's lifecycle.
4. **Stakeholder Visibility and Collaboration**: The new procedures improve organizational teamwork and visibility by ensure that permit data is shared 1GIS and then transferred to AM.
5. **Continuous Improvement**: The basis for continuous process and data quality improvements is established by this research. As assets expand and age, subsequent steps should be taken to address changing organizational demands and promote cooperation for even more optimization.

As the literature showed, the transparent accountability in addition to a strong data flow are essential for efficient asset management. The RASCI model (Chapter 4.6) is used to explain how various integration moments affect stakeholders. The outcomes indicate that the VV is mostly involved. During the first three integration moments of the permit procedure, it holds (final) responsibility and then becomes more supportive. The AM takes on more accountability when offering the VV thorough advice, which enables the VV to take the long term into account when making decisions. In addition, the Th assumes accountability for integration moments 4 and 5 by accurately confirming and forwarding data to the AM, who then assumes complete accountability for the daily asset management. Furthermore, it is the department heads of VV and Th who ultimately must make sure that tasks are carried out correctly. By improving stakeholder awareness and providing access to additional asset data within RWS, this process optimization supports them with daily responsibilities and reduces their dependency on other data sources.

5.1.2 Research contribution to science

A significant portion of this thesis emphasizes its scientific contribution. The results are aligned with various literature on asset management (including the asset management principles according to the ISO 55000 series), using the guidelines of Shien Lin et al (2007) as a framework to optimize data quality. This is elaborated in more detail in the Dutch version of this thesis (see Appendix).

In a study that examined 337 publications, Chen and Bai (2019) gave a thorough summary of how optimization applies to asset management decision-making. According to their research, optimization techniques greatly enhance the capacity to handle intricate problems in vast infrastructure networks, resulting in more unbiased and well-informed choices. This thesis updates the steps in the existing VTH process to apply design-oriented optimization techniques. These techniques are comparable to the heuristic and deterministic process and workflow optimization strategies covered in Chen and Bai's (2019) paper. By enhancing data quality and information flows, these strategies hope to facilitate more effective and knowledgeable asset management decision-making.

This is consistent with the contributions of this thesis to RWS, which highlight process optimization to ensure accurate data management and systematization. The thesis supports Chen and Bai's concept by showing how process optimization improves RWS's decision-making effectiveness, especially through enhanced data architecture.

Chang et al. (2022) seeks to improve information quality in asset management using technical solutions, and they recommend additional research to investigate the causes of quality degradation. According to the paper, the main causes of data degradation are: incomplete data due to poor handover document quality; inconsistent data from heterogeneous information sources; the unclear effects of emerging technologies like BIM and IoT on data quality; and a diminished emphasis on data quality in recent BIM-based asset management research (these are elaborated in the Dutch version).

This thesis aligns with their proposals by highlighting major drivers of data degradation, such as poor spatial data management and insufficient validation in 1GIS. Solutions are suggested in the paper, such as the creation of better policies and processes for handling and creating handover documentation. This is consistent with the concept, which optimizes process steps across the board at VTH. Another solution presented in the thesis is integrating data from different sources, which aligns with creating a comprehensive, accessible GIS system in the thesis that gathers and incorporates data from multiple sources like PB. Furthermore, as the thesis highlights, the paper promotes a stronger emphasis on data quality in subsequent studies. In addition to improving data quality for RWS, this work answers issues brought up in the literature, like Chang et al.'s concerns about data quality decreasing in asset management. To better comprehend information quality in asset management, the thesis therefore links theoretical ideas from the literature with practical approaches, demonstrating how the challenges identified correspond with the reasons of data deterioration addressed in the paper.

One of the key objectives of this research is to establish ownership explicitly in process steps inside the optimized VTH-process. The findings of Hrabal et al. (2017) support the importance of ownership, concluding that process ownership plays a critical managerial role in organizations that choose a process-oriented approach rather than traditional functional structure. Their research demonstrates that process owners must possess specific abilities to assure good process management, which they categorize as knowledge, skills, and social competencies. In accordance with these findings, the process optimizations proposed in this thesis allocate ownership based on the individual competencies of the role holders. For example, the verification of physical data has been allocated to a supervisor with the legal understanding required to complete the task efficiently and correctly. Furthermore, the introduction of a new role, such as the sGG, has been characterized by GIS knowledge and skills, making sure that geographic data is managed with precision and intent. Th and sGG capabilities mentioned in the description of the optimized process steps are among the several listed by Hrabal et al. that closely match the demands of roles. Professional knowledge considered essential for organizations like RWS, such as expertise in software, technology, and legislation, displays notable overlaps. Additionally, these roles require social competencies like teamwork and handling sensitive data, as well as communication abilities like written communication, leadership, and presentation. The results of the paper demonstrate these competences, which are essential for carrying out activities efficiently.

The optimizations in this thesis not only support Hrabal et al.'s conclusions about the importance of specialized competences for process ownership, but also contribute to their practical application in the context of asset management process.

The research done by Guillaume (2024) emphasizes the significance of visibility and transparency in the supply chain through technology investments, such as cloud-based systems, as well as stakeholder participation. The VTH process in RWS is comparable to the idea of a supply chain, although coming from a different context. Both use a variety of technologies to manage subsequent process phases and engage several stakeholders. Similar insights are required in the VTH-process, which is reflected in the emphasis of the paper on transparency and visibility. Identical to the cloud-based systems described in the paper, PB is a cloud-based system used by VTH. The stakeholders, therefore, are all parties within RWS who require access to permit data for their work. According to the outcomes, the interaction of systems, as well as an open and collaborative culture, are critical for data interchange and cooperation optimization. This thesis confirms up these conclusions by implementing process improvements that increase visibility and involvement of stakeholders, particularly by storing permit data in 1GIS. Furthermore, connections have been established between this 1GIS and several case management systems. This makes it easy for different role holders to access vital data that was previously unavailable. Collaboration is promoted by making this data accessible and shareable across departments, which aligns the findings of this thesis with Guillaume's conclusions. The thesis contributes to the literature by realistically implementing Guillaume's recommendations, resulting in improved processes and more efficient collaboration in asset management.

Both this thesis and Guillaume (2024) work emphasize the importance of continuous improvement [9] and transparency inside organizations. Guillaume believes that educating and developing staff to adapt to new technology and data-sharing methods is critical to increasing visibility and transparency. Furthermore, effective communication pathways and regular feedback are essential to maintain everyone informed. This is aligned with the contribution of this thesis, which emphasizes the need of effective collaboration and communication among stakeholders in improving processes. The optimized procedures serve as the foundation for future improvements in data quality and organizational responsibilities. Both studies emphasize the need of continuous improvement in integrating and adapting processes to the changing demands of the company, allowing long-term goals to be efficiently met.

The need of continuous improvement in asset management is emphasized in the Maletič et al. (2020) article. It emphasizes how important senior management support, clear communication, and feedback are to adjusting to changes and promoting strategy improvements. The writers additionally dive into how communication, feedback, and monitoring are fundamental components of change implementation in organizations. These results show that the strategies described in the paper are consistent with the results of this thesis.

Another important consideration is the implementation of the RASCI model in asset management process. In asset management, the RASCI model is rarely utilized directly because managing positions and responsibilities in this field frequently calls for more sophisticated methods. Technical, financial, and operational factors all play a part in asset management, which usually require more specialized methods. Nonetheless, the RASCI model is applied in this thesis because it is in line with the process-focused approach and is commonly employed in RWS. It is an initial effort to use the RASCI model in a particular asset management context.

Suhanda et al. (2021) agrees that the RASCI model facilitates communication among team members by explicitly defining tasks for each team, ensuring that everyone understands their individual function. This strategy has proven effective in companies and is an important component of this thesis. RWS already uses the RASCI model to create transparent processes within the organization, and stakeholders have underlined its value during optimization sessions. This thesis adds to the academic literature by proving that the RASCI model performs particularly well in complex organizations with diverse stakeholders. This discovery offers new potential for organizations facing similar difficulties, and it aims to promote collaboration across departments.

This thesis adds to the scientific literature by connecting process optimization within a complex public organization, such as RWS, to existing concepts on asset management and data quality. The study demonstrates, using five specific integration moments, how enhanced data flows and clearer roles increase asset data quality. This is in tune with theoretical discussions regarding data quality, while also providing specific procedural applications for organizations. By carefully connecting the findings of this thesis to existing literature, it is possible to conclude with confidence that this work contributes significantly to the academic field. The results are a valuable addition and can be used as a reference for comparable or relevant studies in the future.

5.2 Limitations and Recommendations

Although not everything could be elaborated in detail, the study offers valuable insights relevant to both the operational and strategic goals of RWS. It emphasizes the efficient management and safeguarding of data within relevant departments, particularly focusing on AM.

The report acknowledges that further steps are needed, such as addressing capacity shortages and improving collaboration between different stakeholders, such as contractors and teams within RWS. After further refinement and discussion, these process steps can be submitted to RWS decision-makers for approval and implementation in the ARIS portal, where all process steps are documented.

Additionally, further meetings are recommended to practically and thoroughly develop the process steps and assign the appropriate tasks. This is essential to ensure that the process run smoothly and efficiently and that the organizational goals of RWS are achieved.

6. Conclusion

This study focused on the focus point AM 2.0 and investigated the potential and necessity for optimization of process steps within the VTH process of RWS. Optimizing information flows and responsibilities is essential as infrastructure utilization grows more complicated and intensive.

The study identified five critical integration moments capable of improve responsibility distribution and data exchange, both of which are necessary for efficient asset management. Through these integration points, internal advice from AM are delivered more effectively, allowing for consideration of long-term visions and the impact of the requested activity or asset. Additionally, geographically recording permit data in 1GIS is crucial to provide AM with data for daily area management. By integrating verification steps into the process, the data becomes reliable, having been verified in practice. This ensures the data can be confidently used by other stakeholders within the organization.

By applying the RASCI model into practice, task coordination and role distribution became clearer, improving process efficiency. As a result of the addition of new process steps, this overview offers insight into the capacity and responsibility of stakeholders. Decision-makers may find it useful since it aids in making well-informed choices on the implementation of this process optimization.

Regarding the AM 2.0 focus point, the process improvement found in the integration moments leads to a more effective data flow, improved data assurance, and a clear assignment of responsibilities within the VTH process. By adapting these process steps, permit data becomes accessible to stakeholders outside of PB, ownership is clearly established, and support this thesis RWS in efficiently securing data according to the BGT.

This study emphasizes how crucial it is to keep an eye on and assess these procedures on a regular basis to guarantee advancements in infrastructure quality and asset management. The results support RWS in accomplishing its operational and strategic goals by adding to the foundation of understanding in science and practical advancements.

Translation of italicized terms

- Permitting, supervision, and enforcement (VTH)= Vergunning, Toezicht en Handhaving (VTH)
- integration points = koppelmomenten
- Digital System for the Environment and Planning Act= Digitaal Stelsel Omgevingswet (DSO)
- Service Center for Permits= Service Center Vergunningen (SCV)
- VTH workload distributor= VTH-werkverdeler
- Permit Issuer= Vergunningverlener (VV)
- Supervision and Enforcement= Toezicht en Handhaving (TH)
- Decree for the Living Environment= Besluit activiteiten leefomgeving (Bal)
- activities with an information obligation= activiteiten met informatieplicht
- activities that have a notification requirement= activiteit met meldingsplicht
- normal procedure = reguliere procedure
- extended procedure uitgebreide procedure
- consent advisory method = advies met instemming
- magnet activity = magneetactiviteit
- *Enforcement Officer/Enforcer* (HH)= Hanhdhaver
- corporate values matrix = bedrijfswaardenmatrix
- (Senior) Data Manager GIS= (Senior)Gegevensbeheerder GIS (sGG)
- Documentation management system = Documentatie Management Systeem (DMS)
- Algemene Verordening Gegevensbescherming = General Data Protection Regulation (GDPR).
- Supervisor = Toezichthouder (Th)
- Implementation Plan = Uitvoeringsplan (UP)

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Appendix I – Literature search

MSc. Thesis_Pravesh Gangabisoensingh_Integratie van Assetmanagement 2.0 in vergunningverlening, toezicht en handhaving bij Rijkswaterstaat – Dutch extended version