# Bachelor Thesis

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*Estimating the workload through the analysis and monitoring of processes and their durations at the GEO-Team of the Municipality of Enschede*

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# Preface

Dear reader,

In front of you lies my bachelor thesis "Estimating the workload through the analysis and monitoring of processes and their durations at the GEO-Team of the Municipality of Enschede". The research has been conducted at the Municipality of Enschede and this thesis is the final part of the completion of my bachelor Industrial Engineering and Management at the University of Twente.

I would like to take this opportunity to thank everyone who has supported me while conducting this research. First of all, I would like to thank Thijs Jeurissen, my company supervisor, for the opportunity to conduct the research of my bachelor thesis at the Municipality of Enschede and for his guidance throughout the process. Furthermore, I would like to thank all the employees of the GEO-team for their warm welcome, and for their time and energy to provide the necessary input for my research. Whenever I had questions the employees were always there for me and I really appreciate that.

Next, I really want to thank Martijn Koot for being my first supervisor from the University. Throughout the process, Martijn has been of great value by providing clear and sincere help and feedback. His way of coaching is inspiring and made me feel very comfortable. Also, I would like to thank Rogier Harmelink for being my second supervisor from the University. I really appreciate the tips and criticism that you have given me.

Finally, I would like to thank my family and friends for their support throughout the process.

Enjoy reading!

Kind regards,

Thom de Porto
Enschede, July 2024

# Management Summary

This research has been performed at the Municipality of Enschede. This government agency strives to take the needs of its residents into account as much as possible. In order to perform all the tasks involved in this, the employees of the Municipality are divided into several departments, one of which is the GEO-information department. This department, and specifically the Vastgoed Informatie Beheerders (VIB'ers) within this department, are the focus group in this thesis.

VIB'ers are responsible for processing mutations (i.e. changes to buildings or other objects) in the outdoor space of the Municipality of Enschede. Any change in the actual outside world, must be recorded by the VIB'ers in the municipality's GEO maps to keep them up-to-date. For the processing of these mutations, a distinction can be made between permit-free mutations and permit-intensive mutations. Besides these mutations, the VIB'ers also regularly receive via a GEO team email address other measurement assignments from project leaders of another department within the Municipality. In the current situation, these measurement tasks are often outsourced, resulting in additional costs. This research focuses on reducing the number of outsourced measurement tasks by creating an overview for the VIB'ers that enables them to see who picks up which applications and how long each VIB'er is expected to take to process their picked up applications.
A process analysis will be conducted to generate time indications for all three types of incoming applications, i.e. permit-free mutations, permit-required mutations and additional measurement tasks. These time estimates will provide insight into the incoming workload, which can help in dividing the work and in this way achieve a more accurate work/hour distribution.
The main research question of this study is:

*"How can a process analysis create insight into mutation processing times to enhance transparency within the GEO-department of the Municipality of Enschede?"*

To answer the main research question, I adopted an approach inspired by the Design Science Research Methodology (DSRM) from Peffers et al. (2007). This DSRM focuses on designing, creating, demonstrating and evaluating an artifact and therefore focuses on a final product that can be of practical use. A combination of this practical utility, which this methodology focuses on, and a clear relationship with relevant literature led to an approach that perfectly matched the goals of this research. The artifact created by following the DSRM-based methodology, can be used as a tool to distribute incoming work based on process times, which are linked to process models

After identifying the problem in the first phase of this research, a literature review was then conducted. This focused in the first part on ways to obtain and use process times and in the second part on Computer-Aided Design (CAD) Systems and Geographical Information Systems (GIS). Regarding obtaining process times, two ways were found that may be of potential value in this research: using Redo Logs in databases and Expert Judgments techniques. For ways to use process times, the focus has been on activity lists and spreadsheets with visualization capabilities for creating a statement of work. The literature on CAD and GIS systems further provided insight into some interesting points that came in handy later in this study when describing the systems and software used by VIB'ers.

Then, a list of requirements was made. These requirements were based on the VIB'ers' identified problem, the main results of the literature review and the field of Requirement Engineering. The most important thing when following the Requirement Engineering discipline is the repetitive revising of requirements and tailoring the requirements to the exact needs and wishes of the stakeholders; the VIB'ers in this case. This resulted in a set of seven requirements, the key points of each of which are listed below:

1. Written-out version of all processes;
2. Process models of all processes;
3. Time linkage to process models;
4. Link between calculated process times and incoming requests;
5. Creating overview for work/hour distribution VIB'ers (artifact);
6. User-friendly artifact, i.e. use of software/systems with which VIB'ers are familiar;
7. Analysis capability artifact related to numbers of incoming applications;

Based on the above set of requirements, a comprehensive context analysis was then continued in which all processes of the three categories were written out in detail, with special attention to the differences and similarities of mutations within the same category. Within the category of permit-free mutations, the only thing that came out was the yearly mutation signalization process in which annual aerial photos are provided with coloured alignments of permit-free mutations. With regard to permit-required mutations, several differences between mutations and some overlap were identified. Based on these differences and patterns, this led to the identification of the following four permit-required mutation processes: OVG new building, OVG minor renovation/medium-sized demolition, OVG major renovation/splitting/merging/medium-sized demolition and Demolition. Finally, within the category of other measurement tasks, only one process was identified, namely incoming measurement tasks through the GEO-team email address.

Next, these six processes were divided into four process models. Times were then assigned to the process steps of each process in these process models based on the ways found in the literature. The way that, in consultation with the stakeholders, was given the highest priority - searching for Redo logs in the VIB'ers' databases - was tried first. However, such Redo logs could not be detected in the VIB'ers' databases. Then, the group session technique of the Expert Judgment method was used to obtain process times. In a group session with all VIB'ers, the process steps of each process were gone through to first distinguish process versions for a number of processes and then assign a process time to all process steps of each process (version). From this, a total process time was calculated for five of the six identified processes (and process versions where necessary) just mentioned. Only for the permit-free mutation process the process times were arrived at in a different way, because these do not come in at any time of the year like the other mutations, but all once a year at the same time via aerial photo files. Based on found data from last year, an avery processing time of 16.4 minutes per permit-free mutation was arrived at.

Subsequently, the times obtained were used to create an overview in Microsoft Excel of all the VIB'ers' incoming work. This tool in Excel was used to determine over a ten-week period whether there was under- or overcapacity, and thus whether or not outsourcing work was necessary during this period. This showed that even in the week with the most requests, the number of work hours (98.3 hours) did not exceed the capacity (101.2 hours). Based on this result, it can be concluded that using the tool, no outsourcing was necessary over the measured ten-week period.

Finally, based on the research performed at the Municipality of Enschede, the main recommendations were as follows:

- Implement the possibility to budget based on the data of the tool, in order to do so, make sure that after a restart of the planning the data is stored somewhere
- Break the processes down into even more process versions to get to even more accurate approximations of the process times
- Look for more advanced programs to visualize the data within in a work overview
- Look for other ways to receive process times, for example let the VIB’ers track their own work times over a certain period

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# 1. Introduction

This first chapter is divided into three sections. Section 1.1 will focus on a general description of the Municipality of Enschede and the specific department where this research takes place. Next, section 1.2 will focus on the problem identification. In this section, the problem of the department of this thesis will be introduced using the theory of Heerkens and Van Winden (2017). Finally, section 1.3 will address the research design of this thesis by establishing the research question and highlighting the problem solving approach.

## 1.1 Company description

According to statistics from het Ministerie van Binnenlandse Zaken en Koninkrijkrelaties (2023), the Netherlands has 342 municipalities, of which the Municipality of Enschede is one. A municipality performs tasks of direct interest to its residents ("Ministerie van Binnenlandse Zaken en Koninkrijkrelaties, 2023"). A municipality can decide on many matters itself, such as the construction of bicycle paths or housing. Furthermore, a municipality can also co-manage, in other words implement national laws. For example, a municipality issues passports and identity cards to its residents ("Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2024").

The Municipality of Enschede performs these tasks for the benefit of its residents. In the work done by the Municipality of Enschede, inhabitants, entrepreneurs and social institutions are central (Gemeente Enschede, 2024). The Municipality of Enschede (2024) also calls this way of working society-oriented. To best serve these residents, entrepreneurs and social institutions, the following four core values are central: trust, connecting, being free and setting a good example (Gemeente Enschede, 2024). In total, the municipality consists of a team of 1,800 employees, divided into different departments ( Gemeente Enschede, 2023). The department on which this research focuses concerns the GEO-information department.

The GEO-information department of the Municipality of Enschede, and specifically the Vastgoed Informatie Beheerders (VIB'ers), are responsible for (literally) mapping mutations within the Municipality of Enschede. These mutations relate to construction and renewal of all topography in the outdoor area (so this is very broad), and are processed in the Basisregistraties Adressen en Gebouwen (BAG) and the Basisregistraties Grootschalige Topografie (BGT). In this way, the location of all physical objects is recorded, such as buildings, roads, water and rail lines. This thesis will focus on the processes behind the processing of these mutations.

Below an example is shown of a map of the Municipality of Enschede with all objects in the outdoor space. In Figure 1, the map is zoomed out and the location of the city office of the Municipality of Enschede is indicated with a red cross. Figure 2 zooms in on the city office and the surrounding space (again, the location of the city office is indicated with a red cross).

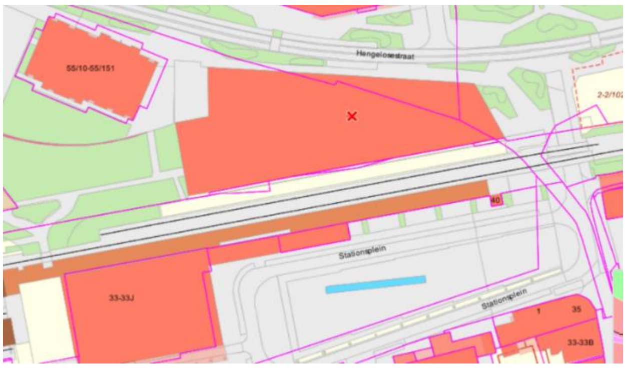


*Figure 2: GEO-map Enschede zoomed-in*

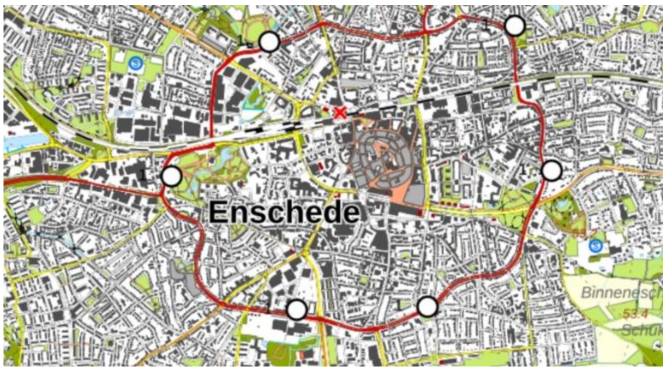



*Figure 1: GEO-map Enschede zoomed-out*

## 1.2 Problem identification

Based on meetings with employees and the GEO department head, several problems were identified. After identifying the problems, the relationships between these problems were examined and worked out into a problem cluster using the theory of Heerkens and Van Winden (2017). According to Heerkens and Van Winden (2017), a problem cluster is a tool to clarify all problems with their relationships. It serves to organize the problems in the problem context and identify the core problem. In this way, besides the problem you would like to tackle (the action problem), all other related problems are included. Starting with the action problem, the causes that lead to the problem are identified. Since in most cases these causes are problems as well, their causes are also identified, and this step is repeated until a core problem is identified (Heerkens & Van Winden, 2017).

### 1.2.1 Action problem

The assignments received by the GEO team can be categorized into permit-free mutations, permit-required mutations, and other measurement tasks. The employees of the GEO team responsible for measuring these requests and processing them in the systems are the Vastgoed Informatie Beheerders (VIB'ers). Given the current workflow and the number of VIB'ers, it is not always feasible to process all incoming orders internally. Consequently, some measurement tasks are currently outsourced to measurement agencies, resulting in additional costs. To minimize these outsourcing costs, this study will analyze, using data from this year and the previous year, whether the processing of permit-free mutations, permit-required mutations, and other measurement tasks is within capacity.

In the current situation, permit-free mutations are distributed based on a neighborhood distribution. Following this distribution, the neighborhoods are divided in such a way that the VIB'ers with the smallest surface area have the neighborhoods with the highest building density, so VIB'ers with neighborhoods in the middle of the city have a smaller surface area than VIB'ers with neighborhoods on the outskirts of Enschede. Permit-required mutations are divided partly according to the neighborhood distribution and partly on the basis of “Matenplannen.” The reason that permit-required mutations are not, like permit-free mutations, fully distributed according to the neighborhood distribution is because processing a permit-required mutation takes a lot more time. For example, a permit-required mutation may involve a completely new apartment complex and in order to carry it through, so-called Matenplannen can be used, Matenplannen of the VIB’ers consist of permit-required mutations that are not in their districts but which they must process. The processing of a completely new apartment complex takes such a long time that a VIB'er may fall behind on his other work if he has to process it, this application will therefore be able to fall into the Matenplan of another VIB'er who has the fewest permit-required mutations in his districts at that time/has the most time.

Then there are the other measurement tasks. These are requests from the Design and Realization department that a reconstruction or other type of modification has been/will be made to road, green space and water objects and a VIB'er is asked to measure it. The project leaders responsible for the mutation in question forward such a measurement task to a shared email address of the GEO-team (geoinformatie@enschede.nl). Three team members of the GEO-team have access to this email and coordinate the distribution of this “extra work” among the VIB'ers. Again, this distribution is done based on which VIB'ers have the most time for this. If none of the VIB'ers have time, the measurement is outsourced.

Both the permit-required mutations that fall into the matenplannen and the additional measurement tasks that come in on the shared email address are divided based on which VIB'er has time for this.

However, this subdivision is complicated by the fact that it is currently not clear which VIB'er is working on what and how much time it takes. This means that when dividing up the time, it must be asked who has time and it is more difficult to estimate in whose planning the most space actually lies. A weekly consultation moment on Monday morning currently gives the VIB'ers something of an overview and transparency, but it would help them to have a continuous overview of each other's activities. This will result in fewer scheduling bottlenecks and a reduced need to outsource additional measurement tasks to external measurement agencies.

The action problem of this research is defined as:
*“The number of mutations outsourced should be reduced in order to reduce outsourcing costs.”*

### 1.2.2 Core problem

Having defined the action problem, the next step is to investigate its underlying causes. This process involves identifying and analysing these causes iteratively until the root cause is determined. Once the core problem is established, the cause-and-effect relationships among all issues outlined in subsection 1.2.3 will be illustrated through a problem cluster.

As written in subsection 1.2.1, the action problem is related to the current working method and the number of VIB'ers, which results in the GEO-team lacking sufficient capacity to handle all incoming mutations and additional measurement tasks internally. Consequently, some measurement tasks must be outsourced, incurring additional costs. This outsourcing is a consequence of planning bottlenecks - issues that hinder VIB'ers from completing all required tasks.

Several factors contribute to these bottlenecks, specifically: insufficient clarity regarding responsibilities, challenges in subdividing mutations, and inaccurate estimations of the time required to process mutations. These issues are themselves rooted in two problems: inadequate clarity about employee availability and limited insight into work performance. The lack of clear information on which VIB'er is available to handle incoming tasks, combined with poor visibility into work performance, results in ambiguous responsibilities, inefficient work distribution, and inaccurate assessments of processing times.
The underlying cause of these issues is a workflow characterized by poor transparency, which leads to unclear availability and insufficient monitoring of work performance. Ultimately, the core problem of this research pertains to this lack of transparency in the workflow.

The core problem of this study was defined as:
*"No insights into the current work processes and their durations for the VIB'ers within the GEO-department"*

### 1.2.3 Problem cluster

All the problems described in the previous subsection are depicted below in the problem cluster with the cause-effect relationships.

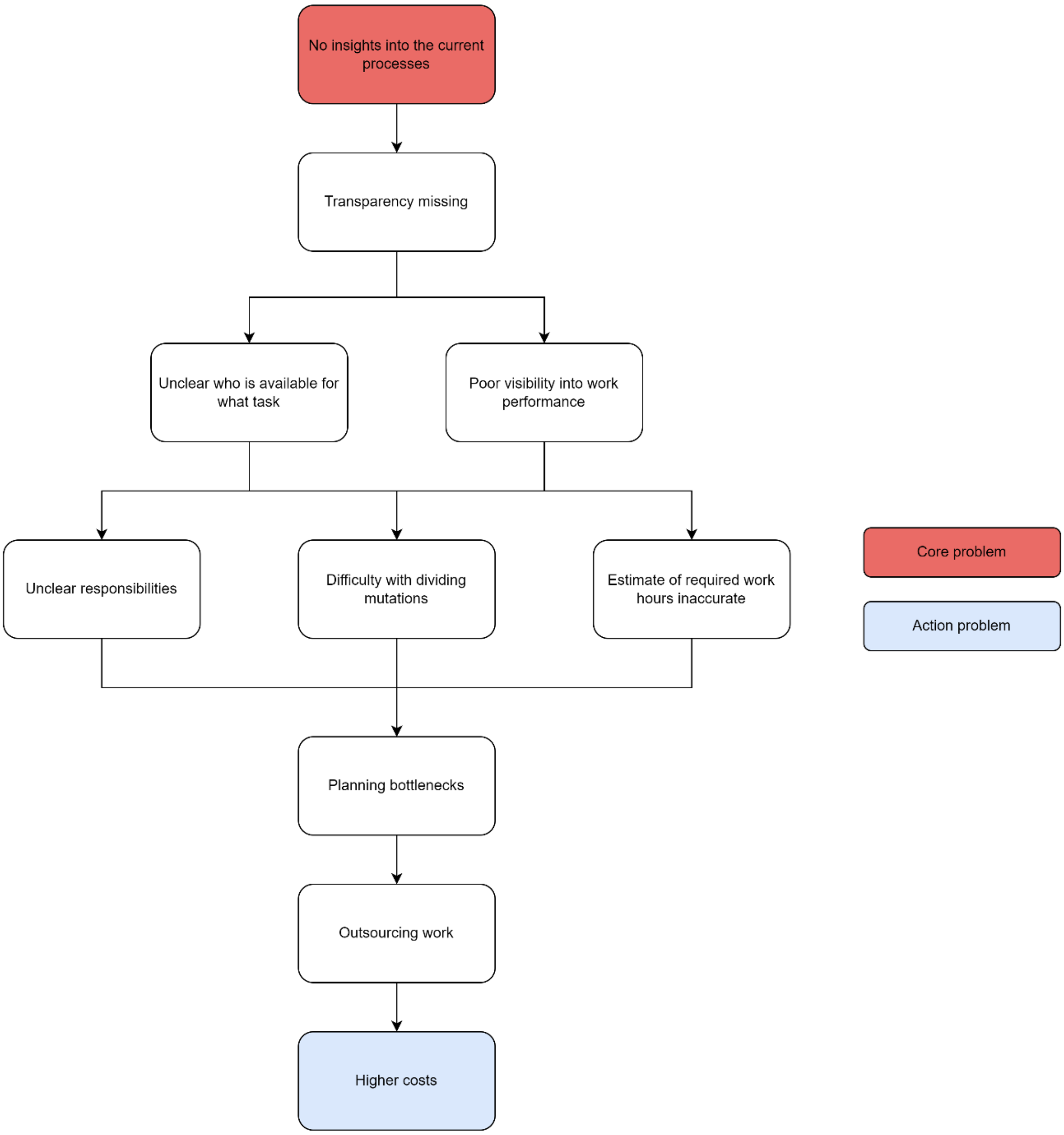



*Figure 3: Problem cluster*

### 1.2.4 Gap between norm and reality

As defined in the core problem, the reality is that the VIB'ers of the GEO-team of the Municipality of Enschede, currently miss insight into their processes and therefore cannot make an accurate time indication of the duration of process (steps). As an ultimate consequence, additional measurement tasks have to be outsourced, leading to higher costs.

The norm is therefore to give the VIB'ers insight into work processes and process times in order to make estimates on this basis of how long the expected processing time is and what a good distribution of incoming work is in a working week. This will lead to more overview of incoming work and its distribution, which in turn can lead to a reduced need for outsourcing to external measurement agencies.

## 1.3 Research design

This section of the thesis discusses the main research question. In addition, the problem solving approach is discussed. All steps made in the phases of this approach are briefly discussed along with the sub-questions that will be answered.

### 1.3.1 Research question

The main research question is based on the core problem of the VIB'ers of the GEO-team of the Municipality of Enschede. As described earlier, the VIB'ers' current method of mutation processing lacks insight into the processes and is therefore lacking transparency. The purpose of this research is for the VIB'ers to gain more insight into the time they take to process mutations, which will allow for a better time estimate of each VIB'ers' work and facilitate the subdivision of mutation work.

The main research question is defined as:
*"How can a process analysis create insight into mutation processing times to enhance transparency within the GEO-department of the Municipality of Enschede?"*

### 1.3.2 Problem solving approach

Looking at the just defined main research question, crucial components of the problem solving approach can be identified. In any case, the method of mutation processing will need to be analysed to better understand how VIB'ers operate. This analysis will therefore focus on (understanding) the different types of mutations and the processes behind the processing of these mutations; what (sub)steps are involved in the processes and how can these processes be visualized. In doing so, the processes for processing permit-free mutations, permit-required mutations and additional measurement tasks, will all be written out in detail.

Once all processes are written out, they can be modelled. EngageProcess will be used for modeling. The choice of Engageprocess as a modeling tool has several important reasons. First of all, this modeling tool makes it possible to assign times to each process step in order to easily arrive at total process times. Furthermore, the Municipality of Enschede already has a license for this program, so the GEO-department can use it for free. Several other departments are already using it, and uniform use by all departments can ensure consistency within the Municipality of Enschede. Finally, another advantage is that process steps of a process model in Engageproces, with the assigned times, can be exported from this tool to Microsoft Excel. These Excel reports provide at-a-glance insight into which process steps are completed in each process and how much processing time is assigned to each process step. This may be of value at a later stage of this study in creating a solution to the VIB'ers' practical problem: the missing overview, by using the process (step) times to calculate the total processing time of incoming work and subdividing work based on this.

A solution as just described will involve the design and creation of an artifact. An artifact as a work allocation/scheduling mechanism can serve as a solution to the practical problem of VIB'ers by providing insight into the processes and (expected) processing times of incoming work. Therefore, a research methodology focused on designing and creating an artifact to solve a practical problem is appropriate in this research. After comparing various design methodologies, the Design Science Research Methodology (DSRM) of Peffers et. al (2007) seems the most appropriate for this research. According to Peffers et. al (2007), DSRM creates and evaluates IT artifacts intended to solve identified practical problems of organizations.

Figure 4 below shows the stages involved in following DSRM.

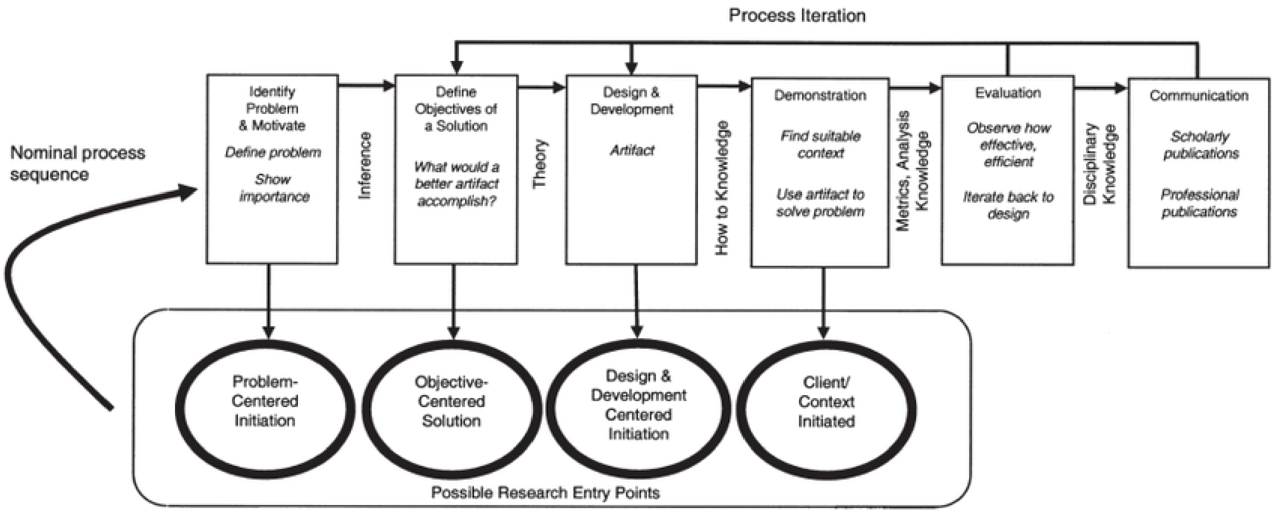



*Figure 4: DSRM Process Model (Peffers, et. al, 2007)*

This research will not fully follow the phases of DSRM as shown in Figure 4, but the approach in this study is inspired by them. This approach consists of the following six phases:

1. Identify Problem & Motivate (section 1.2).
2. Theoretical Framework (Chapter 2)
3. Define Objectives of a Solution (Chapter 3).
4. Context Analysis (Chapter 4)
5. Design & Development (Chapter 5)
6. Demonstration & Evaluation (Chapter 6 and 7)

The choice not to follow the exact phases of DSRM, but an inspired approach to it, is because in this academic research there is a strong emphasis on literary justification and a (substantive) way of writing that helps the reader understand the research. By adding the "Theoretical Framework" and "Context Analysis" chapters and omitting "Communication," this has been attempted.

How exactly phases two through six will be completed in this research and what sub-questions are answered in each of these phases will now be discussed. Phase one will not be discussed here because this phase is already finished in sections 1.1 and 1.2 of this research.

<u>Phase 2: Theoretical framework</u>
This phase will include targeted literature research on process times and methods to use these process times in work distribution. Furthermore, research will be conducted on Computer-Aided Design Systems and Geographic Information Systems (GIS) to later on in this research look how CAD and GIS systems relate to the systems that the VIB'ers use to process mutations.

In completing this phase, answers will be given to:
**Sub-question 1:** What methods and techniques are described in the literature for measuring and utilizing process times to achieve effective work distribution within organizations?
**Sub-question 2:** What are the differences between Computer-Aided Desing Systems and Geographical Information Systems?

Phase 3: Define Objectives of a Solution

In this third phase the goals of this thesis will be determined. These goals will be based both on the problem definition defined in phase 1 and the found literature in phase 2. To achieve these goals both quantitative and qualitative research will be conducted. The qualitative research will consist of a literature review and the use of literature, meetings with VIB'ers and other staff, the attendance of workshops, and walkthroughs in the office and at measurement times. The quantitative research will mainly focus on linking process times to the elaborated processes and creating a final artifact that can be used by VIB'ers in practice.

In completing this phase, an answer will be given to:

**Sub-question 3:** What Requirement Engineering-based goals can be established based on the identified problem and found literature?

Phase 4: Context Analysis

The information in the "Context Analysis" chapter, will form the basis for the rest of the research. First, it will reveal more about VIB'ers, the focus group within the GEO-team, and look at how and what kind of mutation work is coming in. Next, the two main databases used by VIB'ers to process mutations (both permit-free and permit-required) will be discussed. These two databases are the Basisregistraties Grootschalige Topografie (BGT) and the Basisregistraties Adressen en Gebouwen (BAG). A description will be given about what each of these two entails and what systems are used to process data into the BGT and the BAG. Subsequently, the processes for processing BGT and BAG data will be written out and finally, the (now sometimes outsourced) additional measurement tasks received by the GEO-team on the shared email address will be excerpted. While writing out these processes, the focus will be on similarities in process steps. Similarities in processing steps of different mutations can help in the next phase when modelling the processes and assigning process times.

The data in this phase will be qualitative in nature, as the data will be extracted from meetings with employees. A meeting with the department head will clarify the division of functions and tasks within the team and based on this information, meetings will be scheduled with employees from the GEO-team. These will mainly be meetings with the VIB'ers, as they carry out the work processes on which this thesis focuses. During these 1-on-1 meetings, each mutation process (permit-free, permit-required and other measurement tasks) will be discussed in detail and it will be observed how VIB'ers perform certain crucial process steps. These meetings will also clarify the various systems used by the VIB'ers for the registration of both BGT and BAG data. It is important that the elaboration of a process is not based entirely on the input of one VIB'er, each process will be discussed with several VIB'ers.

To arrive at an accurate definition of the BGT and the BAG, and to arrive at a clear distinction of all types of mutations, additional desk research will be done. The information in this additional research will be extracted from documents from het Kadaster and het Ministerie van Binnenlandse Zaken, and (initial) versions of process manuals of the GEO-team.

In completing this phase, an answer will be given to:

**Sub-question 4:** How are the entry, distribution, and processing mutations managed by the VIB'ers?

**Sub-question 5:** What are the BGT and the BAG, and through what systems is data recorded within these databases?

**Sub-question 6:** What are the detailed processing procedures for permit-free mutations, permit-required mutations, and other measurement tasks?

Phase 5: Design & Development

This fifth stage will also play a crucial role in this research. Peffers et. al (2007) write that the resources needed to move from objectives to a design and a final artifact include knowledge of theory that can be used in a solution. This knowledge of theory was gained in phases 2 and 4. In phase 2, literature was collected on the use of process times and GIS, while phase 4 revealed what the GEO-team's current workflow is and what processes are involved in keeping the BGT and BAG up to date. So, based on phase 2 and 4, each process can be modelled in EngageProcess.

In Phase 4, while detailing the processes, attention is focused on identifying overlaps among the processes, specifically mutations that (partially) follow similar procedural steps. In modelling these processes, potential similarities will be addressed by consolidating applications with identical processing steps into a single model, thereby avoiding duplication. Upon completion of the process modelling, time estimates will be assigned to each process step. Multiple versions of the processes will be developed as needed to accurately allocate these time estimates. This classification into various process versions will be necessary to accommodate processes where the time required per request may vary significantly. To arrive at all process times, methods found in the literature of the Theoretical framework will be used

Once (each version of) each process is modelled and provided with processing times, its data will be used to create an artefact. Here, data refers to the activities completed in each (version of a) process, with the given time indications. At the end of this phase, an introduction to the artifact will be given and reference will be made to an implementation plan of it which can be found in the appendix.

In completing this phase, answers will be given to:

**Sub-question 7:** What is important to consider when modelling the processes in EngageProcess?

**Sub-question 8:** What times can be assigned to each (version of each) process based on the input of the VIB'ers?

**Sub-question 9:** What are the key functionalities of the developed artifact, and how can it facilitate insight into work distribution for VIB'ers?

Phase 6: Demonstration & Evaluation

This phase will first demonstrate in Chapter 6 how the artifact can be used to solve the problem of the VIB'ers. By using the process times of all requests from Phase 5 and by examining the frequencies of requests over a period of time, the artifact will provide insight into whether the current outsourcing of work is necessary or not.

Subsequently, Chapter 7 will present an evaluation of the artifact. This evaluation will be conducted in two parts: firstly, by assessing the artifact against the requirements outlined in Chapter 3, and secondly, by evaluating the feedback obtained from a questionnaire completed by the VIB'ers regarding their perceptions of the process models and the artifact.

In completing this phase, answers will be given to:

**Sub-question 10:** Can the developed artifact provide insight into the necessity of the current work outsourcing practices?

**Sub-question 11:** What conclusions can be drawn based on the set requirements and on the results of a questionnaire filled in by the VIB'ers?

# 2. Theoretical Framework

This chapter will cover the theoretical framework for this research. This theoretical framework will consist of three sections. Section 2.1 will address the measurement and use of process times and ways to distribute work to workers based on these process times.
An answer to the following sub-question will be sought in this section:
*"What methods and techniques are detailed in the literature for measuring and utilizing process times to achieve effective work distribution within organizations?"*

Subsequently, section 2.2 will encompass a literature research on Computer Aided-Design Systems and Geographic Information Systems. As the VIB'ers also work with CAD and GIS, examining the definition of both CAD and GIS, will later in this thesis provide insights into how this relates to the software and systems that the VIB'ers use to process the mutations.
This section will look for an answer to the following sub-question:
"*What are the differences between Computer-Aided Desing Systems and Geographical Information Systems?*"

The answers obtained in sections 2.1 and 2.2 will provide a non-expert reader with the background knowledge needed to understand the information and choices made in the remainder of this thesis. Finally, the chapter will be concluded in section 2.3.

## 2.1 Process times

In order to analyse processes, it is important that these are worked out. An elaboration of a process can be a textual description of all process steps but can also be done by means of a process model. Linking times to these process steps can lead to great benefits for an organization. Van Der Aalst (2016) emphasises that assigning times to process steps enables organisations to achieve better planning and resource allocation, with resource allocation referring to the assignation of resources (people, machines and capital) within work processes. Van Der Aalst (2016) writes that this time data enables managers to get an overview of the overall lead time of processes and determine where optimisations are possible.

Russel et al. (2016) also discusses improved resource allocation as a result of assigning times to process steps. According to Russel et al. (2016), these process times can be supportive in balancing work across different resources. Based on a study of workload balancing based on time-based process models, they came to the following findings, among others:

- Improved process performance through more effective/even distribution of work
- Increased productivity and employee satisfaction
- Overloading of specific resources is reduced

### 2.1.1 Methods to obtain process times

When it comes to how process times can be obtained, Seidmann and Sundararajan (1997) discuss the importance of accurate time predictions of processes based on historical data. By understanding the time taken by previous similar jobs, organisations can plan better by arriving at more accurate estimates of lead times. This not only increases efficiency but also the reliability of an organisation/business (Seidmann & Sundararajan, 1997). De Murillas et al. (2015) address how to obtain historical process time data through process mining. They focus on the use of redo logs in databases, which are files that record all changes made to a database. Often in databases Redo logs can be used to obtain timestamps for each database operation (De Murillas et al., 2015).

Another way to obtain process times is by expert judgment. Meyer and Booker (2001) wrote a book in which a comprehensive overview is given of expert judgment elicitation techniques. The following three techniques were examined: structured interviews, group sessions, and the Delphi Method. Structured interviews, as described by Meyer and Booker (2001), involve one-on-one interactions with experts, using carefully designed questions to obtain detailed information. Group sessions, on the other hand, consist of interactive workshops where multiple experts engage in discussions and provide collective insights. The Delphi Method, also described by Meyer and Booker, is an iterative process in which anonymous questionnaires are administered and feedback rounds are held so that experts can revise their responses. In this method, experts independently answer a series of questions in multiple rounds. After each round, a facilitator summarizes the responses, and experts are given the opportunity to revise their answers in the light of feedback from the group (Meyer & Booker, 2001). This iterative process is designed to narrow the range of responses, ultimately leading the group to a more accurate or “correct” answer.

Finally, direct measurement of process (step) times is a way to determine total process durations. Masniar et al. (2023) discuss the use of a stopwatch to measure process (step) times. By observing employees as the perform their tasks, an average process time can be calculated based on the process times of all or multiple employees.

### 2.1.2 Methods to utilize process times

For an organization, there are several methods and techniques for utilizing process times for resource allocation and work distribution and ultimately enjoying benefits as just mentioned. Some of these options will now be highlighted.

Galbraith et al. (2002) emphasize the use of activity lists to distribute tasks within an organization. By having a clear overview of activities through a list, it can be ensured that all tasks are completed without overlap or omission and progression can be tracked. Kerzner (2017) elaborates on this by also making the link to process times. According to Kerzner (2017), understanding the hourly distribution of employees by linking process times to tasks in an activity list is an essential aspect of effective project management. By measuring process times and linking them to tasks to be completed, insight can be gained into how work hours are spent. If applicable, tasks can be prioritized in the process (Kerzner, 2017).

Spreadsheets such as Microsoft Excel can also be used to distribute tasks and manage work hours within organizations. Hans and Mowen (2005) discuss the use of Excel to improve productivity by assigning tasks to specific employees, with a focus on workload and time management. This provides an overview of task distribution and progress (Hans & Mowen, 2005). Additionally, linking process times to tasks in spreadsheets can provide valuable insights into how work hours are allocated, as emphasized by Davenport and Harris (2007). They argue that analyzing and using process times by linking them to tasks is crucial for improving operational efficiency and data-driven decision-making. Moreover, organizations can use the spreadsheets to record the actual time spent on a given task, which can offer a comparison between planned or expected times and actual durations. This enables organizations to identify discrepancies.

LaMeres (2017) further emphasizes the importance of data visualization. Graphs in spreadsheets can be used to provide a visual overview of the distribution of time across different tasks and employees. These visualizations can help in improving communication and decision-making in organizations and can help in easily identifying trends and bottlenecks. According to a study by Ferreira and Otley (2009), visualizations via histograms and bar charts can be used not only to present data but also to perform in-depth analysis. These graphs provide at-a-glance insights into how work (hours) are distributed and how frequently certain tasks are performed by which employees.

An analysis in a spreadsheet can go one step further by using Gantt charts. Wilson (2003) writes that Gantt charts help organize and plan tasks over a period of time. These charts show not only which tasks are performed by whom at a given time, but also the duration of each task, any order in which tasks should be performed, and dependencies between tasks. Kerzner (2017) adds that Gantt charts are also very useful in project planning because they provide an overview not only of planned activities but also of the actual progress of a project.

## 2.2 CAD-systems and GIS-systems

This Section will discuss Computer-Aided Design (CAD) systems and Geographical Information Systems (GIS). In Subsection 2.2.1, the definition of a CAD-system will be determined and the main functionalities of these systems will be highlighted. Then, in Subsection 2.2.2, the same will be done for a GIS-system to finally discuss the differences and similarities of the two systems in Subsection 2.2.3.

### 2.2.1 CAD-systems

Computer-Aided Design (CAD) systems can be used in different ways depending on the industry and purposes. The core of CAD lies in its ability to accurately define complex geometries in order to achieve more efficient designs (Zeid, 2005). Since the design of (complex) geometries is most relevant in this study, the design/modelling function of CAD systems will be discussed. This will be followed by a further discussion of some of the key components and aspects that enable the design functionalities of CAD systems.

Using CAD systems to design products can be done in either a 2D or 3D model (Zeid, 2014). These models allow designers to create a visual and measurable representation of a finished product and can be used to generate drawings needed for production. An important aspect of CAD within design and modelling is parametric design (Shih, 2014). According to Shih (2014), parametric designs allow designers to quickly modify designs simply by adjusting parameters. This way of designing can lead to increased efficiency and flexibility, given that changes in one part of a design are automatically reflected in other related parts (Shih, 2014).

To achieve complex designs and models, CAD systems consist of a number of key components or aspects that collectively support functionality. First, according to Zeid (2014) Geometric modelling involves mathematically defining the shape and structure of objects. Here, CAD systems often offer different types of modelling techniques such as a surface model or solid modelling (Zeid, 2014). Solid modelling provides a 3D representation of an object, including properties such as volume and mass, which allows thorough analysis of designs.
Furthermore, an important component of a CAD system is a graphical interface (Shih, 2014). Shih (2014) emphasizes that such an interface allows the user to interact and work visually with models. A graphical interface makes it possible to manipulate objects, such as rotating, scaling and editing geometries. On top of that, it often supports multiple windows and view modes, which simplifies working with complex designs. Finally, data management is an important aspect of CAD systems (Groover, 2015). CAD systems often include tools that manage design visions, track changes and organize large amounts of data which can also make it possible to collaborate with multiple designers in a CAD system (Groover, 2015).

### 2.2.2 GIS-systems

Geographic Information Systems (GIS) are integrated systems designed to capture, store, manipulate, analyse, manage and present spatial or geographic data (Longley et al., 2015). GIS combine maps and other spatial data with database technologies, enabling complex analysis of geographic information. These systems provide a framework for collecting and organizing (large amounts) of spatial data and therefore can be of value in many industries (Longley et al., 2015). Now this Subsection will continue with information on the important functionalities and components of GIS systems

GIS systems are used in a huge number of industries due to their ability to perform complex spatial analysis, some of the main applications will now be described based on found literature. First, GIS systems are used for spatial analysis and visualization. According to Clarke (2003), GIS allows data to be visualized in the form of maps, and these maps can then be used to understand spatial relationships. This can be of great use for example in urban planning, to determine how infrastructure should be distributed throughout an area (Clarke, 2003). Furthermore, GIS can play an important role in decision making (Goodchild, 2007). According to Goodchild (2007), GIS is used by businesses and governments to make decisions about locations for example of buildings or transportation networks. In these cases, the combination of data with spatial analysis realized by GIS provides valuable insights that are difficult to obtain with the use of many other systems (Goodchild, 2007).

Regarding the main components of GIS-systems, Longley et al. (2015) address the following five:

1. **Hardware**: This includes the physical computer systems and peripherals needed to run GIS software and process geographic data. The hardware must be powerful enough to process large amounts of data and perform complex spatial analysis.
2. **Software**: GIS software is the core of the systems. The software programs provide the functionalities for storing, analysing and visualizing spatial data.
3. **Data**: The geographic and attribute data that form the basis for all GIS analysis and visualization. GIS data can come from various sources, such as satellite images, aerial photographs, and field observations.
4. **People**: The GIS professionals, analysts and end users who operate the systems and interpret the results. The expertise and skills of these people determine how effectively a GIS is deployed within an organization.
5. **Methods**: Techniques and procedures used to analyse and interpret geographic data. This includes both the technical methods for data manipulation within the system and the organizational processes for collecting and managing data.

### 2.2.3 CAD in comparison to GIS

Based on the information found in the literature of Subsections 2.2.1 and 2.2.2, a number of differences and similarities between CAD systems and GIS systems can be identified. Regarding differences, these include the purpose of use, data and models, and functionalities of the systems. Looking at the similarities, this is about the geometric modelling and visualization/interface of the systems. These differences and similarities will be presented below using Table 1.

*Table 1: CAD in comparison to GIS*

| | **CAD-systems** | **GIS-systems** |
|---|---|---|
| Purpose of use | Design and modelling of objects. Focused on accuracy and detail in rendering physical objects | Analyse and visualize geographic data to identify spatial relationships |

| | | |
|---|---|---|
| Data and models | Geographic models based on mathematical entities such as lines, circles and arcs | More abstract spatial presentations in, for example, maps |
| Functionalities | Comprehensive tools for designing, simulating and analysing objects | Comprehensive options for spatial analysis and visualization of geographic data |
| Geometric Modelling | Geometric models to present objects or spaces | |
| Visualisation and interface | Intensive use of visual representations | |

## 2.3 Takeaway

The literature review conducted in Chapter 2 has been used to answer the sub-question: "*"What methods and techniques are detailed in the literature for measuring and utilizing process times to achieve effective work distribution within organizations?"* and "*What are the differences between Computer-Aided Desing Systems and Geographical Information Systems?*".

To answer the first sub-question, section 2.1 is divided into two Subsections: "Methods to obtain process times" and "Methods to utilize process times".
Regarding the methods to obtain process times, in Chapter 5 it could first be investigated whether the databases used by VIB'ers also contain Redo logs as De Murillas et al. (2015) emphasized. If this is the case, process times could be obtained this way. In case the databases do not contain Redo logs or a similar tracking system, process times will have to be sought in other ways. Here, Expert Judgment from Meyer and Booker (2001) will be a good way. Moreover, when using this method, there is a choice of three techniques: the structured interviews, group sessions and the Delphi Method.
Looking at what has been found in the literature on methods of using process times, a combination of the activity lists described by Galbraith et al. (2002) and Kerzner (2017) and the use of spreadsheets as described by Hans and Mowen (2005) would be a good way. By using process times using an activity list in a shared spreadsheet program, a digital division of labor can be achieved to which all employees have continuous access. Moreover, visualization options can be considered here with, for example, histograms and Gantt Charts as described by Davenport and Harris (2007) and Wilson (2003), respectively.

To answer the second sub-question, Section 2.2 was divided into three Subsections: "CAD systems," "GIS systems" and "CAD in comparison to GIS." This revealed the main functionalities and components of both systems and the differences and similarities between the two. Given that VIB'ers also work with CAD and/or GIS systems, the literature found in this theoretical framework can help in understanding the systems that the VIB'ers work with. These systems will be discussed in more detail when investigating the Contextual analysis in Chapter 4.

# 3. Define Objectives of a Solution

The aims of this study are based on the shortcomings resulting from the current way of working of the VIB'ers in the GEO-team and what has been found in Chapter 2 “Theoretical framework”, about measuring and utilizing process times and CAD -/GIS systems. In terms of the shortcomings of the current working method, as depicted in the problem cluster in Section 1.2 "Problem Identification," primarily concern the lack of an overview in the existing working methods. This deficiency results in poor or non-existent transparency, leading to the necessity of outsourcing additional measurement tasks, which incurs additional costs.
At the end of this third Chapter, an answer will be given to the following sub-question:
*“What Requirement Engineering-based goals can be established based on the identified problem and found literature?”*

## 3.1 Defining the Requirement Engineering-based goals

The field of Requirement Engineering (RE) as described by Rehman et al. (2013) has been used to sharply define requirements. According to Rehman et al. (2013), RE is an organized approach in which RE activities comprise the core of software development. There are two stages in the RE process, i.e. Requirement Gathering and Requirement Implementation. The phases within these stages will be followed in this thesis to arrive at sharply focused requirements and to cover these requirements as best as possible.

The requirement gathering stage consists of the following four phases:

1. Requirement elicitation and development
2. Documentation of requirements
3. Validation and verification of requirements
4. Requirement management and planning

In the first phase, there is a choice of five different techniques to gather information, i.e. traditional techniques, cognitive techniques, group elicitation techniques, modern elicitation techniques and contextual techniques (Rehman et al., 2013). Which of these to use depends on available resources, time constraint and the type of information being looked for (Rehman et al., 2013). To complete this phase, traditional techniques and group elicitation techniques have been used in this thesis

Regarding the traditional techniques, unstructured interviews were done with the department head to get a clear idea of what exactly the problems are and what the desires are. This revealed that the main desire is to get an overview of who is taking on which tasks and how long each employee is expected to take on their tasks. Based on this, incoming requests can then be distributed more easily than they are now. Next, the employees on whom this thesis is focused, the VIB'ers, were interviewed to find out whether they recognized this problem and whether they had the same wishes. There was one point on which a number of VIB'ers had their doubts, namely how to make a time link with their work, because according to them their work is very variable.

In terms of group elicitation techniques, a Brainstorming session was done. Once the problem and the requirements were a little clearer, a Brainstorming session with the head of the department, the Municipality's thesis supervisor and an external consultant considered possible ways of tackling the problem and once again discussed the requirements. Hereby all the steps to arrive at a final work overview were discussed.

After gathering the necessary information in the first phase, the second phase can be continued, which is the documentation of the requirements as they stand after conducting the interviews and brainstorming session. This resulted in the following list of (sub) requirements:

1. Written version of all work processes of the VIB'ers
2. Process models in EngageProcess of all work processes of the VIB'ers
3. Linking process times to process models
    a. Obtaining process times through Redo logs in software used by the VIB'ers
    b. Obtaining process times through Expert Judgment
4. Digital overview of work/hour distribution VIB'ers
    a. Spreadsheet programs
    b. Use of any visualization options such as histograms or Gantt charts
5. Ability to analyse numbers of incoming requests of each mutation

Having compiled a list of (a first version of) the requirements, phase two is finished and the Validation and Verification of the requirements can continue. Most important in this phase is to verify that the requirements actually meet the needs of the stakeholders (Rehman et al.,2013). Therefore, in this phase the set requirements are presented to the VIB'ers and the department head and in this way it will become clear if the requirements list covers the needs or if adjustments have to be made. This resulted in a number of adjustments to the requirements so that after completion of the Validation and verification phase, the list of requirements looks as follows:

1. Written out version of the processes of each category of mutation, i.e. permit-free mutation processes, permit-required mutation processes and other measurement tasks
    a. Making distinctions of mutation processes within each category, e.g. distinguish between the different permit-required mutations
    b. While distinguishing mutations within each category, looking for commonalities to limit the number of different processes
2. Process models in EngageProcess of all written out processes (taking into account the distinction made of mutations within each category)
3. Linking process times to process models taking into account how much processing time a mutation takes by (where necessary) creating multiple versions of a mutation processing process[1]
    a. Obtain process times by Redo logs in VIB'ers' software
    b. Obtain process times by Expert Judgment
4. Based on the obtained (total) process times for each mutation, in the solution a process time should be given to incoming requests
5. Digital overview of work-/hourdistribution VIB'ers[2]
    a. Spreadsheet programs - Use of any visualization options such as histograms or Gantt charts
    b. Alternatives
6. User-friendliness - the solution should not require the use of systems or software that VIB'ers do not currently have access to or have not previously worked with

[1] First the possible redo logs in the software that the VIB'ers use to arrive at process times will be examined, if this does not yield anything Expert Judgment will be used
[2] First the use of a spreadsheet program to create an overview with visualization options (as described in the literature in Chapter 2) will be explored, if this does not solve the problem alternatives will be sought.

7. Enable the VIB'ers to conduct an analysis on the distribution of incoming requests for each type of mutation, as well as to evaluate the total time spent processing each mutation type

The requirements list is now adapted to the wishes of the stakeholders, thus completing phase 3 of the first stage of the RE process. The last phase of the first stage is Requirement management and planning. To execute this stage properly, it is important to keep track of any changes to the requirements and focus on planning for the implementation of the requirements (Rehman et al., 2013). Keeping track of any changes to the requirements will be done as this thesis progresses (where necessary). However, this thesis will skip planning for the implementation of the requirements.

This completes the four phases of the first stage of the RE process and allows us to proceed to stage 2: Requirement Implementation. This stage will be performed in Chapters 4 through 6 after which, in Chapter 7, an evaluation of the requirements will be performed. This evaluation will reflect on why all seven requirements have or have not been met.

## 3.2 Takeaway

In this third chapter, an answer to the following sub-question has been searched for: *"What Requirement Engineering-based goals can be established based on the identified problem and found literature?"*

In order to define RE-based goals, stage 1 of the RE process of Rehman et al. (2013) has been completed in this Chapter. This stage consists of the following four phases: Requirement elicitation and development, Documentation of requirements, Validation and verification of requirements, and Requirement management and planning (Rehman et al., 2013). To complete the first phase, traditional techniques and group elicitation techniques were used to gather information. From this, a first version of the requirements list came out in phase two. Then, in phase three, the requirements list was discussed with the stakeholders (VIB'ers and the department head) to check whether it was entirely to their wishes. Based on what the stakeholders said, the list of requirements was adjusted. After this, all that remains from stage 1 is the completion of phase 4. This phase consists of the possible change of requirements as the research in this thesis is carried out and making a planning for the implementation of the requirements. The planning will be skipped in this thesis so in the following Chapters can directly be continued with stage 2 of the RE process, which is Requirement Implementation. Once this second stage has been completed, Chapter 7 of this thesis will do further evaluation on the six stated requirements. This will reflect on why each of the six requirements has or has not been met.

# 4. Context Analysis

This fourth Chapter serves to inform the reader of this thesis of the key information necessary for understanding the rest of this research. Section 4.1 will provide a (brief) explanation of the GEO department, an identification of the key stakeholders for this research, and an overview of the information inputs. In this Section the following sub-question will be answered:
*"How are the entry, distribution, and processing of mutations managed by the VIB'ers?"*

Next, Sections 4.2 and 4.3 will discuss the two main databases the GEO-team works with: the BGT and the BAG. Research will be done on what systems are used to register data in the BGT and BAG. The focus will be on CAD and GIS functionalities of the systems, where information from the literature can be used. Based on the information found in these Sections, answers will be given to the following sub-question:
*"What are the BGT and the BAG, and through what systems is data recorded within these databases?"*

Then, the processes for processing permit-free mutations, permit-required mutations and additional measurement tasks will be discussed in Sections 4.4, 4.5 and 4.6 respectively. This will show that BGT and BAG play a crucial role in many of these processes. These sections will answer the sub-question:
*"What are the detailed processing procedures for permit-free mutations, permit-required mutations, and other measurement tasks?"*

Finally, the chapter will conclude with Section 4.7, which answers the research questions and describes the relevant information for Chapter 5.

## 4.1 GEO

The GEO-team of the Municipality of Enschede maintains the GEO maps on behalf of the Municipality of Enschede. To do so, the GEO-team receives a large amount of information from various sources, e.g. permit applications for renovation or new building from the Permit department of the Municipality. To process this information, a distinction can be made between databases of the Basisregistratie Grootschalige Topografie (BGT) and the Basisregistratie Adressen en Gebouwen (BAG). The BGT is a large-scale, digital map that manages the layout of the living environment. All physical objects such as buildings, roads, water and greenery are unambiguously recorded in it. The BAG contains data on all addresses and buildings in the Netherlands. The Kadaster manages the BAG and makes the data available through various applications. Both databases will be discussed in detail later in this chapter.

The GEO-team consists of a total of 18 employees. Seven of these employees have the Vastgoed Informatie Beheerder (VIB) function. As told earlier, these are the employees who take care of processing mutations. They also do the measurements of objects in the outdoor space, going out into the street with measuring equipment. VIB'ers process both permit-free mutations and permit-required mutations. In addition, the GEO-team occasionally receives additional measurement tasks via the shared e-mail address. In principle, these are also carried out by the VIB'ers, but, as indicated in the problem statement, this does not always fit in with the planning.

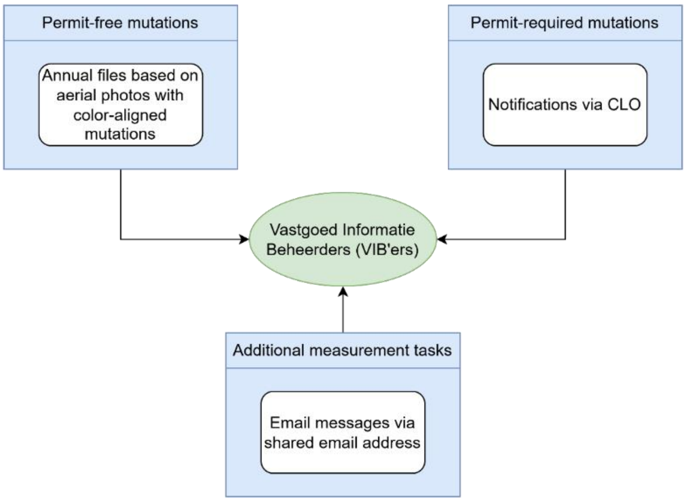



*Figure 5: Input VIB'ers*

As illustrated in Figure 5, for processing permit-free mutations, VIB'ers wait for the annual mutations signalization from a plane. This is because every year an aircraft is hired to take photos of the Municipality of Enschede. These photos are compared by a foreign company with the previous year's photos, supplied by the VIB'ers, to note changes. The VIB'ers then receive the new photos from the foreign company in return with all permit-free mutations from the previous year. These photos allow the VIB'ers to also see mutations on private land such as backyards of houses. Without these aerial photos, it would be very difficult for the VIB'ers to gain insight into those kind of mutations. In these aerial photos, the mutations are distinguished by coloured alignment, with each colour represents a particular type of mutation.

The figures below show, by way of illustration, a piece of the map returned to the VIB'ers. In the left figure you can see the coloured alignments with the aerial photographs as background and in the right figure you can see the coloured alignments with a black background. For example, the red coloured alignments here represent newly built dormers and the yellow coloured alignments represent mutations where something in the outdoor space has disappeared. The process description of permit-free mutations later in this chapter will show that these coloured alignments are not always very accurate.

*Figure 6: Mutation signalization aerial photos with coloured alignments (aerial photo background)*

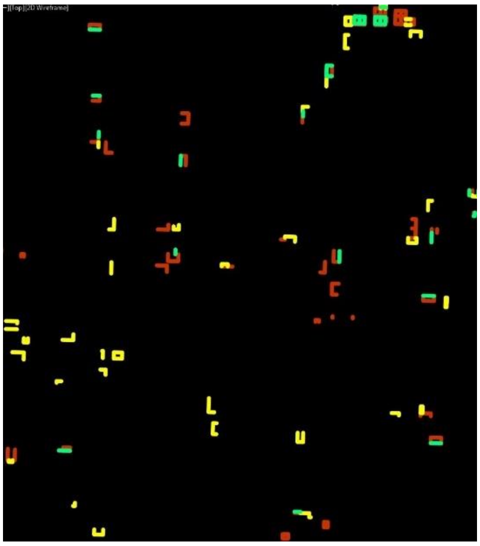


*Figure 7: Mutation signalization aerial photos with coloured alignments (black background)*

All these permit-free mutations are distributed on the basis of a neighbourhood distribution. As described in section 1.2.1, following this distribution, the neighbourhoods are divided in such a way that the VIB'ers with the smallest surface area have the neighbourhoods with the highest building density. Section 5.2.1 of this study will examine whether VIB'ers actually spend the same amount of time processing permit-required mutations in their neighbourhoods. If it turns out that some VIB'ers spend more time on this than others, a separate expected processing time for permit-free mutations will be used for each VIB'er in the final artifact. It should be further appointed that some mutations on the aerial photographs are also responsible for changes in the BAG. For example, if an extension is built on a house, this causes a change in the usable area. This will therefore then also have to be adjusted in the BAG. A description of exactly how this is done will be given later in this chapter.

Figure 5 also shows the input flow of permit-required mutations, which come in via the programme Centric Living Environment (CLO). Here, the Permit department makes the OVG-application available with the supplied documents, and the VIB'ers see this OVG-application in CLO. The possible OVG-applications here are an OVG new construction, an OVG renovation, OVG splitting/merging or an OVG complete demolition. The distribution of these mutations is done based on availability of VIB'ers through matenplannen. These permit-required mutations are registered in both the BGT and the BAG at all times.

Finally, Figure 5 shows the additional measurement tasks received by the GEO-team that are to be carried out by the VIB'ers. These additional measurement tasks come in on a shared email address (geoinformatie@enschede.nl) from the Design and Realisation department. These are often relatively large measurement tasks and for the distribution of these, the VIB'ers are asked to indicate who has time. This shows that not always a VIB'er is available to do a measurement task, in such a case it is outsourced.

To avoid ambiguities in the further course of this thesis regarding the use of the BGT/BAG and its applications[3], this has been made clear in tables 1 below:

*Table 2: Difference BGT and BAG*

| | BGT | BAG |
|---|---|---|
| **Genereal explanation** | The BGT records all physical objects in outdoor space, such as buildings, roads, water and greenery.<br>No justification is required for making changes to the BGT. | The BAG contains data on all addresses and buildings in the Netherlands.<br>Making changes to the BAG does require justification through brondocumenten |
| **Needed applications + explanation** | • TopoCAD<br>Used for registration of BGT data related to geometry<br>• CLO<br>Used as an information system through which the GEO-team receives new requests | • Key2BAG<br>Used to register BAG objects such as buildings and residential objects<br>• SmartDocuments<br>Used to create brondocumenten<br>• Corsa<br>Used by the Municipality as document archive, brondocumenten are stored in this application<br>• CLO<br>Used as an information system through which the GEO-team receives new requests |

[3] detailed explanation of BGT and BAG and the applications used for processing data in each will follow in Sections 4.2 and 4.3

| | | |
|---|---|---|
| **Use of BGT/BAG per mutation type** | Permit-free mutations<br>Permit-required mutations (usually)<br>• OVG new building<br>• OVG renovation, splitting/merging or demolish<br>Additional measurement tasks (if registration is required) | Permit-required mutations |

## 4.2 Basisregistratie Grootschalige Topografie (BGT)

### 4.2.1 Introduction BGT

The BGT is a topographic object file that is uniform in content and quality across the Netherlands (Boer et al., 2017). Whereas previously organisations used different base maps, from 1 January 2016 the BGT is a uniform base map (Kadaster, s.d.). It is standardised and available as open data to all organisations that need this data. These include municipalities, provinces, water boards, Rijkswaterstaat, ProRail, Ministerie van Defensie en Ministerie van Economische Zaken (Boer et al., 2017). The BGT is intended for use at a scale of approximately 1:500 to 1:5000, and contains topographic objects such as buildings, roads, green spaces, water and railways (Boer et al., 2017). For a total overview of the different objects in the BGT, see the figure below.

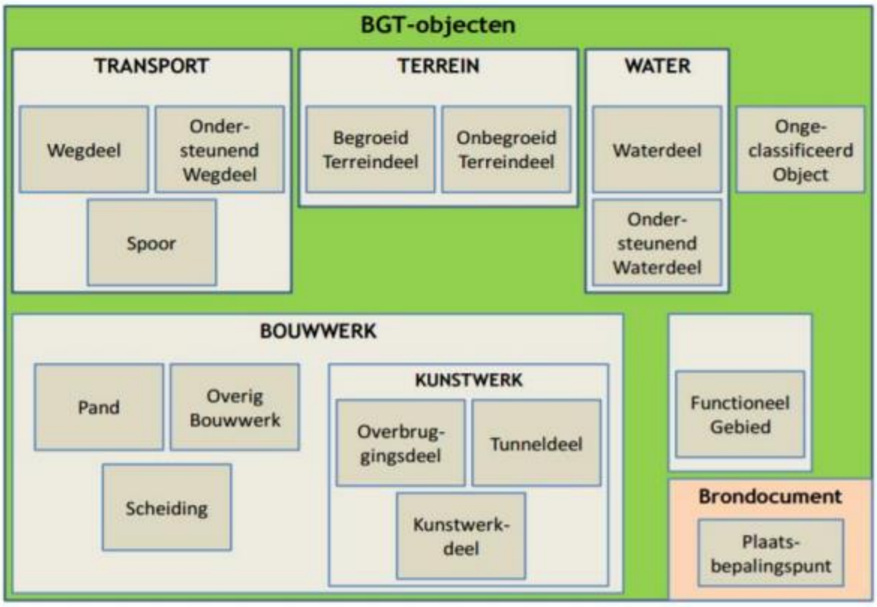



*Figure 8: The object types of the BGT (Boer et. al., 2017)*

So using the BGT saves a lot of time, because organizations only have to collect or sign in information once. For example, when a municipality reports a broken lamppost, it can use the BGT to see exactly where the lamppost is. Planning, designing and maintaining public spaces and buildings are also facilitated by the BGT. For example, in a situation where the Municipality of Enschede wants to construct an additional road surface that connects to the provincial road, but at the location of this road surface there is a ditch and a railroad. Because of the presence of the ditch and the railroad track, in addition to the road/green managers of the Municipality, Prorail, the water board and the province are also involved. By means of the BGT, the administrators can derive the basic data of all these objects from the BGT at once, allowing the road surface to be realized efficiently (Kadaster, n.d.).

The BGT is available as open data through Publieke Dienstverlening Op de Kaart (PDOK). The figure below shows an example of the BGT accessed through PDOK. To illustrate, the figure searched for the address of the City office of the Municipality of Enschede.

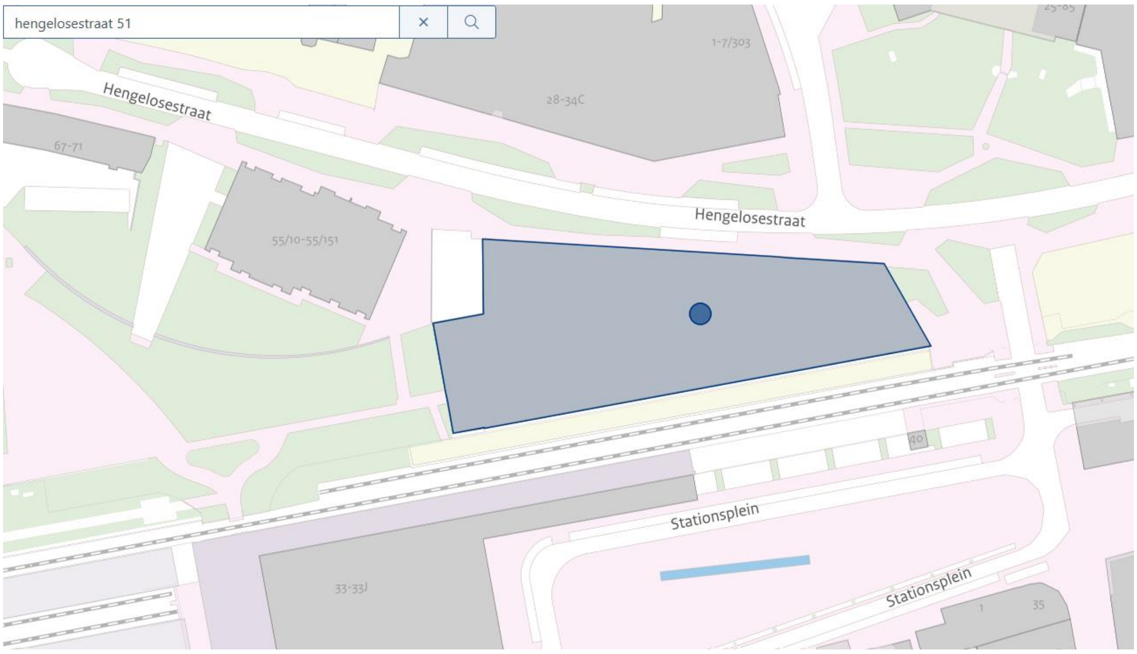



*Figure 9: Example of BGT-view using PDOK*

## 4.2.2 Processing of BGT-data

To process BGT mutations, the VIB'ers of the GEO-team use the Topographical Computer-Aided Design (TopoCAD) program. This is an application for managing and maintaining geodata. TopoCAD connects to the NedGeodataWarehouse (NGdW) which is a central database in which all BGT data must be stored. Through a check-in module of TopoCAD, all objects are formed according to an information model, checked and stored in NGdW. In addition, using TopoCAD to process BGT data allows the GEO-team to connect to the BAG by linking data from the BGT to the BAG through ID numbers.

According to a handbook from the company Adtollo, which is the company that developed TopoCAD, TopoCAD is a CAD system made for surveying, designing and mapping. TopoCAD connects to field instruments but also to other design systems, GIS systems or databases. Furthermore, TopoCAD is a stand-alone program without another CAD system. Concerning the similarities of CAD systems with GIS systems of Table 1 in Subsection 2.2.3, it can be stated that in TopoCAD both similarities can be seen. For example, the program uses Geometric modeling to show not only objects but also geographic spaces, and TopoCAD can also be used to create visual representations of designs or models. This shows, as the company Adtollo writes in their handbook, that TopoCAD also incorporates GIS standards. Furthermore, TopoCAD is a 3D CAD system, which means that the system is advanced enough to also create 3D models. Based on these models, all kinds of calculations such as mass and volume calculations can be done. Here, points and vectors are used to indicate and seal surfaces, this works exactly as in Zeid's (2014) literary paper on Solid modelling (Subsection 2.2.1).

A VIB'er can distinguish between a planned building and a completed building in the TopoCAD program. In processes where permits play a role (see Section 4.5), a VIB'er must already draw in the contours of the building during a permit application. At this point it is not known whether the permit application will get through at all, let alone whether the building will eventually be built. To indicate in TopoCAD the difference between a planned building and a completed building, the alignments are marked with a different colour and the details of each building are coded PMVP or MVP. Here, the code PMVP represents a planned building, and thus a building that is not (yet) there in reality, and the code MVP represents a building that has already been built.

In figures 10 and 11 the difference in TopoCAD between a building that is not yet there and therefore a planned building (PMVP) and a building that is already there in reality (MVP) are shown.

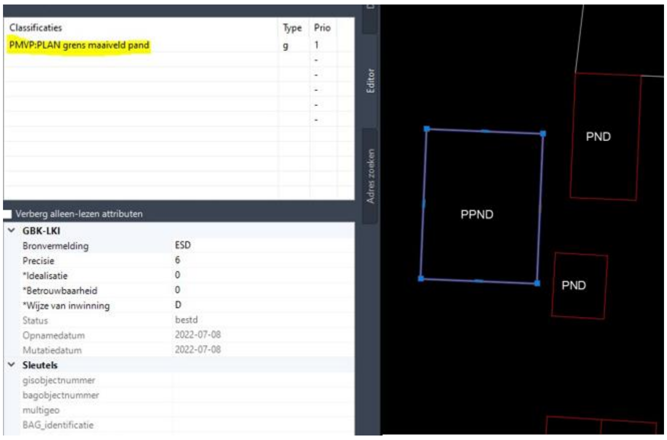



*Figure 11: PMVP in TopoCAD*


*Figure 10: MVP in TopoCAD*

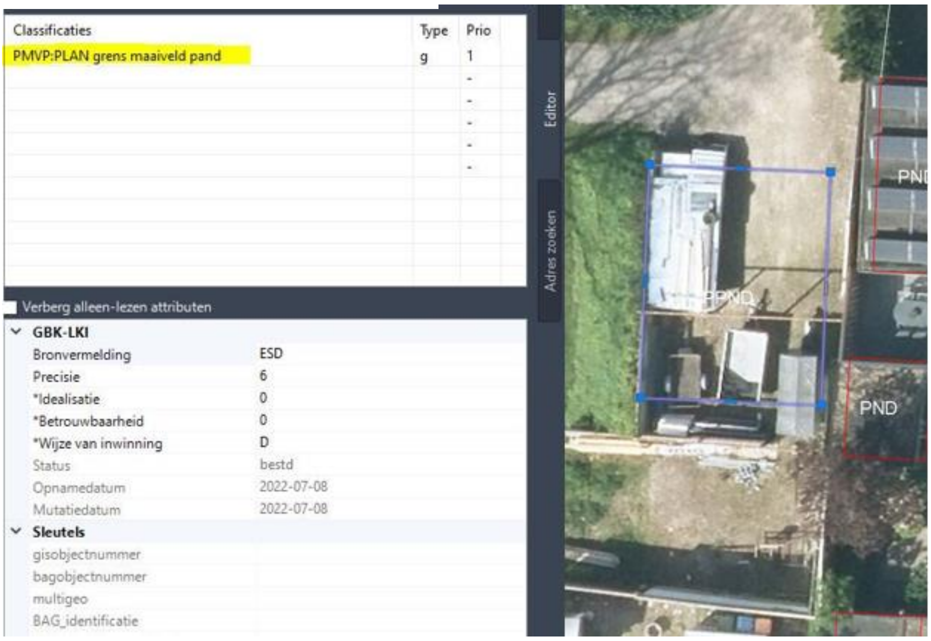



*Figure 12: Extra PMVP and MVP*

As can be seen in the figures above, the colours of the contours of a planned building (PMVP) and an already completed building (MVP) differ. Moreover, for completeness, an additional figure 12 has been inserted showing the same planned and already constructed building. For the planned building, it can be seen that the contours in blue are already shown and in addition, it can be seen that the contours of the built building are shown in red.

## 4.3 Basisregistratie Adressen en Gebouwen (BAG)

### 4.3.1 Introduction BAG

Since 2009, municipalities have had the legal duty to maintain data on addresses and buildings in the BAG (Ministerie van Binnenlandse Zaken, 2018). The BAG is part of the government's system of basisregistraties. The BAG contains data on all addresses and buildings in the Netherlands. This includes property data such as the year of construction, surface area, purpose of use and location on the map. Municipalities throughout the Netherlands are source holders of the BAG, they ensure that all data are included in the BAG and guarantee its quality (Kadaster, n.d.).

An address in the BAG is a composite of three objects: Woonplaats, Nummeraanduiding and Openbare ruimte (Ministerie van Binnenlandse Zaken, 2018). An address cannot exist in the BAG without an associated addressable object. The addressable objects are: Verblijfsobject (VBO), Ligplaats and Standplaats, and addresses must and can be assigned to these objects. A primary address is assigned to each addressable object. If a number of conditions are met, then extension addresses can be assigned. Here, the extension address is a pand of the same object as the associated main address. The extension address is explicitly not a particular part of an addressable object. Non-addressable objects are represented by (part of) properties. In this case, there is a pand without a VBO. The order for entering BAG-objects is first Woonplaats, then Openbare ruimte, then Pand, then Verblijfsobject and lastly an possible Nummeraanduiding. In the case of a Nummeraanduiding, the number indication of the main address should be determined first, then number indication of any secondary addresses (Ministerie van Binnenlandse Zaken, 2018).

Thus, object registration is central to the BAG. In the registration, objects are specifically delineated and given a unique designation. To these objects, the data to be registered are then labelled. In this way, the geometric and/or administrative properties of the objects are recorded in the BAG (Ministerie van Binnenlandse Zaken, 2018). The BAG objects can be divided into three groups: addresses, addressable objects and buildings. An official address is composed of the objects Woonplaats, Openbare ruimte and Nummeraanduiding. An official address is assigned to an addressable object, in other words a Verblijfsobject, Standplaats or Ligplaats. In the BAG, Standplaatsen en Ligplaatsen are seen as permanent locations and are therefore distinguished from moorings and mooring places, for example. In order to actually be recognized as a permanent location in the BAG, a competent authority must designate the location as an official location. Regarding Buildings, Panden and Verblijfsobjecten can be observed. Here, not every Pand contains a Verblijfsobject, but every Verblijfsobject is part of a Pand.

The figure below shows the three groups of objects:

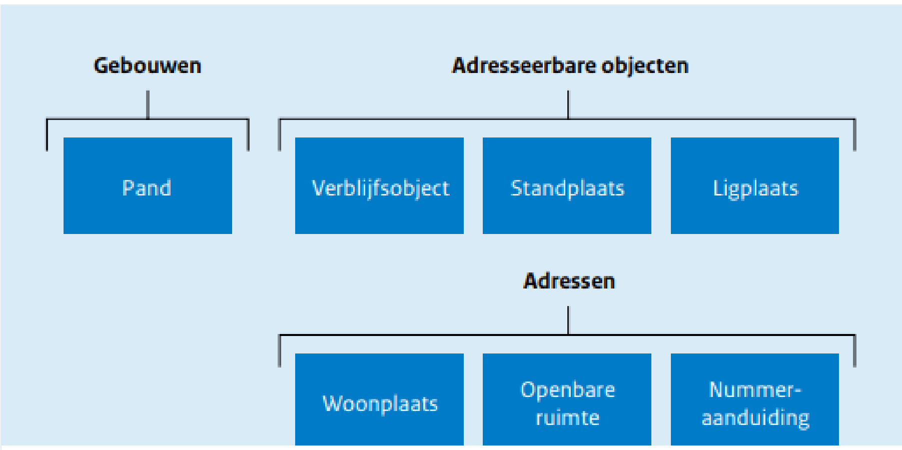



*Figure 13: The object types of the BAG (Ministerie van binnenlandse zaken, 2018)*

The data that municipalities include in the BAG are made available centrally through de Landelijke Voorziening BAG (LV BAG). The administrator of the LV BAG is het Kadaster. The Kadaster makes the data available to various customers (Kadaster, n.d.). One tool through which the Kadaster makes the BAG data available is the BAG Viewer. Selecting a property in this web system gives access to all BAG data registered for the property. For example, you can find at least the address, purpose, year of construction, status, area and the relevant municipality. Furthermore, you can find the unique identification number (Pand-ID) of each property. In case the building contains an VBO, and there is an address associated with it, you will also find the data of this. These data include the Verblijfsobject-ID, purpose of use, status, area of use of the VBO and Nummeraanduiding-ID, zip code, status and house number of the number designation.

To illustrate, in the figure below, the address of the City office of the Municipality of Enschede was searched via the BAG Viewer. This was then selected and the left side of the figure shows the data of this building.

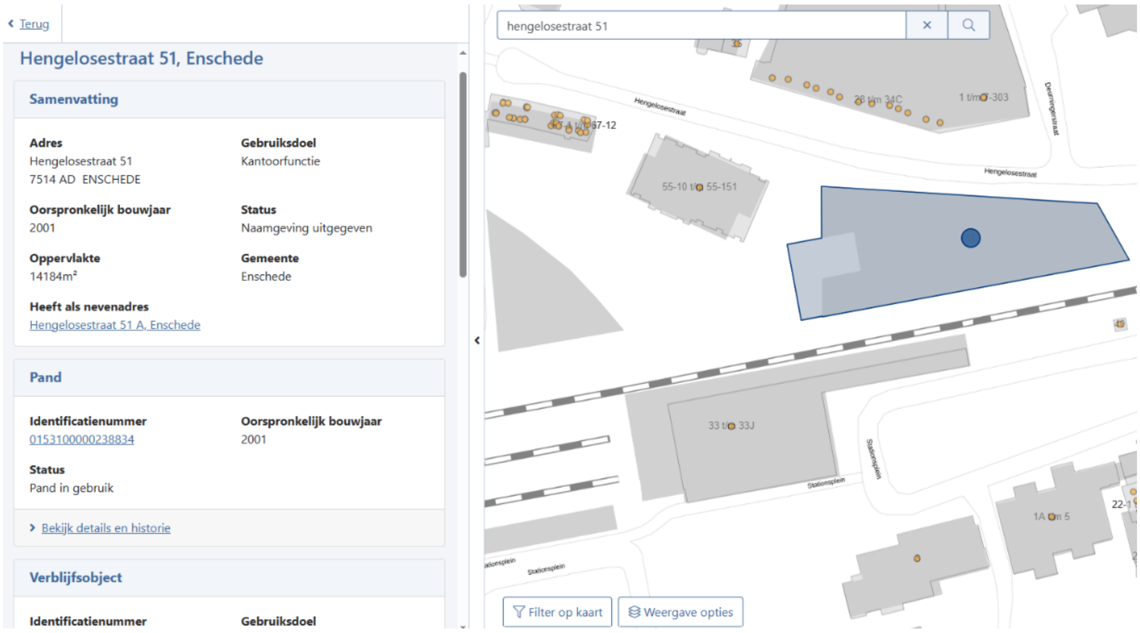



*Figure 14: Example of BAG-view using BAG Viewer*

## 4.3.2 Processing of BAG-data

Any change of data in the BAG must be justified by means of a brondocument. For example, when an object is detected or data is corrected, a brondocument must be prepared by the source holder. All allowed brondocumenten are collected in het Besluit basisregistratie en gebouwen (Ministerie van binnenlandse zaken, 2018). A brondocument may concern one or more objects and/or attributes and may not be removed from the source holder's archive. To create brondocumenten, the Municipality of Enschede uses the program "Smartdocuments". This program uses templates to create brondocumenten. For example, Smartdocuments for the GEO department contains the four different brondocumenten that are used, each with its own template.

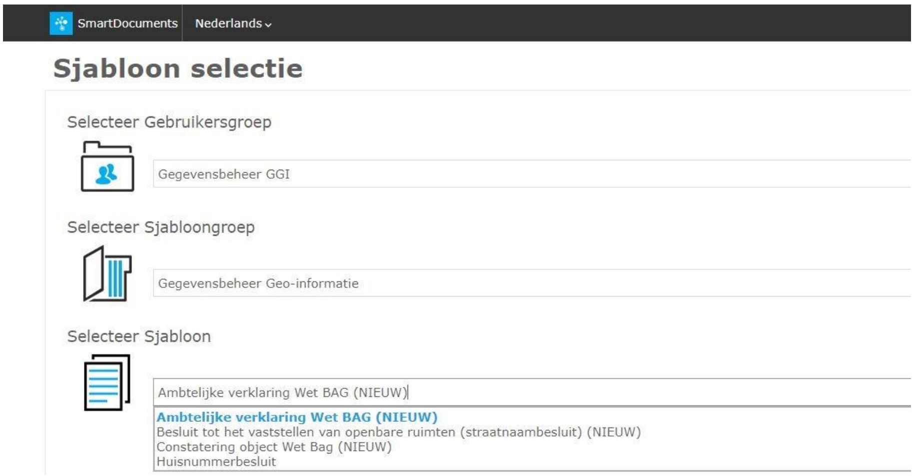



*Figure 15: Smartdocuments - brondocumenten*

Smartdocuments is linked to Corsa; the archive of the Municipality of Enschede in which all documents are stored. Every brondocument that is created in Smartdocuments gets a unique number: the brondocumentnummer. Each brondocument can be found in Corsa by means of this unique brondocumentnummer. The brondocumenten are permanently stored in Corsa, so that changes can always be viewed. After creating the brondocument and saving it in Corsa, the VIB'er can complete the registration in the BAG. The system the VIB'ers use for registration in the BAG is "Key2BAG." In Key2BAG, the change is done and the brondocument is added. To add the brondocument, the VIB'er uses the brondocumentnummer. After completing the changed data and adding the brondocumentnummer, the registration can be done in Key2BAG. Approval of the registration will then eventually lead to final processing of the change in Key2BAG.

The four brondocumenten listed in the drop-down menu shown in Figure 15 will each appear multiple times in the written-out processes (later in this chapter) for accounting for data in the BAG. However, the subprocess behind the creation of a huisnummerbesluit is by far the most complicated and will therefore be written out separately in Subsection 4.3.3. When an huisnummerbesluit has to be created in the process descriptions later in this chapter, reference will be made to this Subsection 4.3.3.

Finally, the relationship of the Key2BAG system to CAD and GIS. According to an article by the company behind Key2BAG, Centric, Key2BAG has an integrated GIS component and standardized interfaces with also CAD systems. So where TopoCAD is a CAD system with GIS standards, Key2BAG has an integrated GIS component and interfacing with CAD systems as well.

### 4.3.3 Brondocument Huisnummerbesluit

Once the huisnummerbesluit is created via Smartdocuments, the VIB'er will immediately check if the new house number falls into an existing house number range. If this is the case, the existing postal code can be taken from the PostNL postal code portal and directly included in the huisnummerbesluit. Furthermore, the VIB'er adds a situation drawing and floor plan with a house number as an attachment, and other data such as the address and name of the applicant (this can be obtained from OVG decision in CLO). After saving this huisnummerbesluit, it is in Corsa with a brondocumentnummer.

The next step is to copy the brondocumentnummer to Key2BAG and insert attributes of the number designation and change the status of the number designation, belonging to the VBO, to "Naamgeving uitgegeven". Then the VIB'er must copy the Verblijfsobject-ID and Nummeraanduiding-ID to the huisnummerbesluit and then save it in Corsa. The huisnummerbesluit is ready and should be sent to the OVG applicant. Furthermore, the house number must be added to the property in TopoCAD.

If the house number was not in an existing house number series, no zip code was added to the huisnummerbesluit. In this case, the zip code must be requested through a request form from the PostNL zip code portal (the huisnummerbesluit must be sent with this). Then the VIB'er will receive a mail message from PostNL with the assigned postal code. This mail message can be saved in Corsa and is given a brondocumentnummer. The VIB'er then creates an Ambtelijke verklaring Wet BAG, which can refer to the brondocumentnummer of the saved mail in Corsa. The zip code can then be added to Key2BAG using the brondocumentnummer of the Ambtelijke verklaring Wet BAG under the corresponding number designation. After a few days, the postal code will also be registered in Key2BAG; the VIB'er does not need to do anything more for this.

Finally, the VIB'er needs to extract the Pand-id from Key2BAG and add it to TopoCAD, and link the verblijfsobject-ID to the TopoCAD house number. This causes the BGT to link to the BAG. The Nummeraanduiding-ID does not need to be put into the BGT, as it is linked to the VBO.

## 4.4 Permit-free mutations

As announced at the beginning of this Chapter in the explanation of incoming information flows, the annual aerial photos are used to process permit-free mutations. The mutations identified in these photos are implemented by the VIB'ers in the BGT and possibly in the BAG. The overall processing of this is outlined in Subsection 4.4.1.

### 4.4.1 Mutation signalization aerial photos

This process starts for the VIB'ers when they receive the aerial photos with colour-aligned mutations. A first check will be done by the VIB'ers. The VIB'ers make sure that the mutation type classifications and colour indications are correct. Based on the neighborhood distribution, lines can be drawn in the file and each VIB'er can see which mutations fall into his districts. Each VIB'er can get to work on drawing in the mutations in their own neighbourhoods. The VIB'ers do this separately from each other.

While processing the mutations, the VIB'er checks whether the coloured alignment actually concerns a mutation. For example, it may be that some grass has grown over a dirt path, so that the path is no longer aligned as a path at every point by the external company, but as a piece of grass; the VIB'er does not have to adjust the alignment of the path in this case.

Once the VIB'er has done the check just mentioned, a check will be made to see if the mutation is/seems to be permit-free. If the mutation is/seems not permit-free and therefore permit-required, the VIB'er will make a notification of this and register the mutation in the BGT and in the BAG. The registration in the BGT will be done by an drawing of the mutation in TopoCAD. To register the change in the BAG, the brondocument Constatering object Wet BAG will be created. Using the brondocumentnummer the property can be registered in Key2BAG. During this registration, the VIB'er checks the box "Geconstateerd", in this way a signal is sent to the department Handhaven Bouwen en Milieu (HBM). Then the VIB'er does not have to do anything with this until a report is received back. If this report shows that the property is permit-free after all, the check mark at "Geconstateerd" can be removed and the process for permit-free mutations can be continued. To remove the checkmark in Key2BAG, the brondocument used is an Ambtelijke verklaring Wet BAG referring to the mail of the notification, or an Ambtelijke verklaring Wet BAG stating that the property has been identified by the VIB'er himself. If the property is indeed found to require a permit, the process for the VIB'er ends here and the owners must submit an OVG-application.

If the mutation is or appears to be permit-free, the VIB'er will first check whether the mutation involves a property, in order to determine whether BAG-registration is required.

If the mutation does not involve a property, it is up to the VIB'er only to draw the mutation in TopoCAD, so that it is registered in the BGT. For this, the VIB'er can often adopt the coloured alignment, but sometimes this alignment deviates slightly and then the VIB'er adjusts the contours slightly.

In case the change does involve a property, the change will also first be drawn in TopoCAD for registration in the BGT. Next, the VIB'er will assess whether it concerns a new property or a change to an existing property.[4].

- If a new property is involved, the VIB'er will assess whether the new property has informal care as its purpose of use. A new building with informal care as its purpose of use is an exception: this is the only new building that can be built with a VBO without a permit. If the new property is used for informal care, the VIB'er will have to register a new property and a new VBO with number designation in the BAG. Status of the new property will be changed in Key2BAG by the VIB'er to "Pand in gebruik (niet ingemeten)" or "Pand in gebruik" if it has already been measured. The VBO will be given the status "Verblijfsobject in gebruik (niet ingemeten)" or "Verblijfsobject in gebruik" and the number designation “Naamgeving uitgegeven”. For the registration of the new property and the VBO, the VIB'er will create an official declaration Wet BAG. For the number designation at the VBO, a huisnummerbesluit will be made (see procedure in section 4.3.2.1).
- If the new property does not have informal care as its purpose of use, only a new property needs to be registered in the BAG, a VBO and possible number designation is not involved in this case. Status of the new property will be changed in Key2BAG by the VIB'er to "Pand in gebruik (niet ingemeten)" or "Pand in gebruik" if it has already been measured in.

In the case of a mutation to an existing property, it will first be assessed whether the contours of the property change. If the contours do not change, nothing needs to be registered in the BAG. If the contours do change, registration in the BAG is required.

During this registration in the BAG, the VIB'er must check whether the mutation relates to the renovation of a building with or without a VBO. If changes also occur to VBO(’s), not only the building but also the VBO will be changed in the BAG. For the registration of the changes to the building and possibly the VBO, the VIB'er will create an Ambtelijke verklaring Wet BAG.

[4] If a VIB'er is unsure whether an object can be designated as a property, the decision tree in appendix A1 for identifying a property can be used

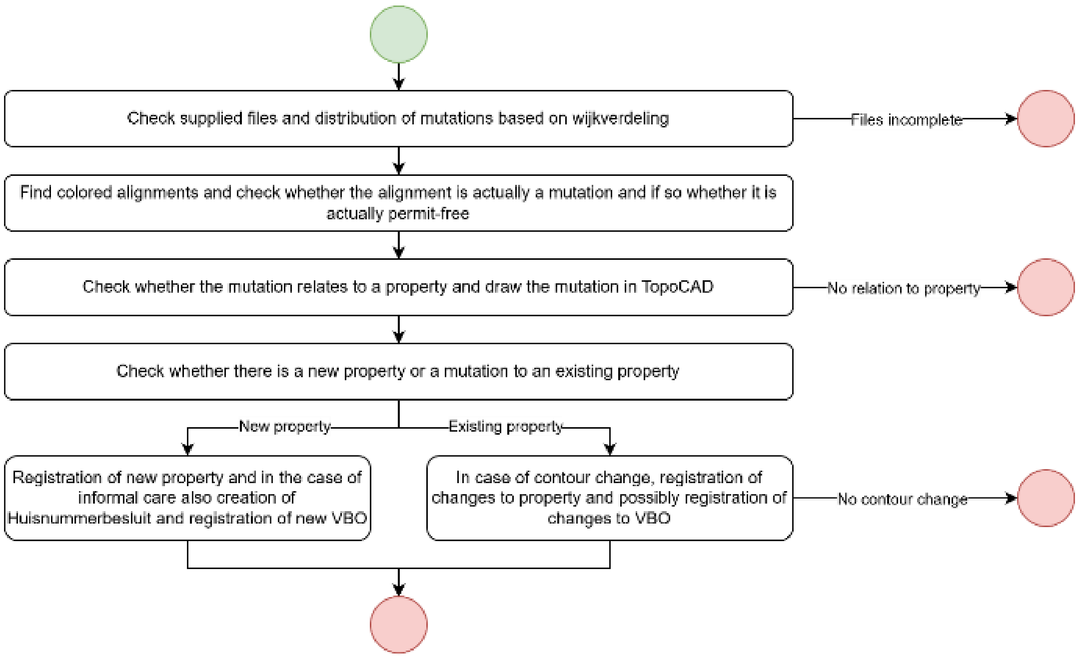



*Figure 16: Simplified process of Mutation signalization*

## 4.5 Permit-required mutations

To process permit-required mutations, VIB'ers should consult both the BGT and the BAG. First, section 4.5.1 will describe the process for an omgevingsvergunning (OVG) new building and then section 4.5.2 will describe the process for an OVG renovation, splitting/merging or demolish. Here, attention will be paid to possible similarities in the processes in order to facilitate making process versions and assigning time indications in Chapter 5.

### 4.5.1 OVG new building

This process starts with the application for an OVG with construction activity by a citizen or organization. This application enters the permit department and is then forwarded with documentation to the GEO-department through the CLO program. All VIB'ers in the GEO-team have access to this system and, based on the matenplan, the mutation is divided.

The VIB'er picking up the mutation first assesses the application's documentation. For a proper initial assessment, the documentation provided should at least include a drawing of each floor and a drawing of the location of the application. Thus, with this supplied information, the gebruiksoppervlakte (GBO) can be determined and the VBO delimited. With this information, the preliminary geometry of the property can be drawn in TopoCAD. Besides drawing in TopoCAD and thus in the BGT, nothing is registered in Key2BAG yet. This phase also includes the preparation of a decision on the address or addresses to be allocated in case the requested OVG is granted for the (re)construction of a building in which one or more VBO's are newly distinguishable. The VIB'er will hereby indicate in TopoCAD a planned number designation. To prevent the VIB'er from losing the overview, the VIB'er can attach a label to each planned OVG-id in TopoCAD and enter the number of the OVG-application in this label, so that TopoCAD can retrieve which OVG-id is linked to which OVG-application. Finally, in case of new VBO's, the VIB'er fills out a form of de Wet waardering Onroerende Zaken (WOZ) for registration of WOZ sub-objects. These WOZ sub-objects are parts of a VBO, for example a kitchen or a bathroom.

Then the application returns to the permit department. They review the application, paying attention to whether the contours of the preliminary geometry match the building plan. Building requirements are taken into account in this assessment and it is checked whether the building actually falls in an area where building is allowed.

If the review reveals that the OVG-application is incomplete or inadequate, it is denied. This can result in the OVG being withdrawn and thus the end of this process, or new data can be supplied and the OVG can be returned to a VIB'er from the GEO-team via a modified application.

If the assessment shows that the OVG can be granted, a document will appear in CLO stating that the OVG has been granted. Before this happens, 6/7 weeks have often passed.

From the moment the OVG is listed as granted in CLO, the VIB'er has 5 working days to register the final huisnummerbesluit and all attribute data of the application in the BAG. Upon receipt of the document of the granted OVG, the VIB'er checks whether the OVG has actually been granted, whether the date is correct (given the hard deadline of 5 working days to complete the registration) and whether the document has been signed. The VIB'er does not need to make a brondocument of the OVG (the property and possibly the VBO('s)) because it has already been made by the Permit department. The VIB'er can therefore retrieve the besluitnummer of the OVG from the OVG decision that has been placed in Corsa by the Permit department. The VIB'er registers this besluitnummer in Key2BAG. Here the VIB'er looks up the property in Key2BAG and then selects it. Once the property is selected, the besluitnummer of the OVG can be added. To register the property, the VIB'er selects "Add property" in Key2BAG and takes the geometry from TopoCAD. Then the property attributes are entered and the status is changed to "Bouwvergunning verleend". When selecting the property in Key2BAG, the VIB'er is asked if a new VBO should be added. If this is the case, the VIB'er must enter the VBO attributes and hereby assign the status "Verblijfsobject gevormd".

Once the attributes of the VBO are implemented, the VIB'er will be asked if a main address should be added. If this is the case, the VIB'er must create a huisnummerbesluit and assign a zip code (following the procedure described earlier). Once this is completed, the VIB'er must also do registration in the WOZ. Here the surfaces of each WOZ sub-object must be entered into the I-objecten application. If the VIB'er waits a day after the (just described) registration in Key2BAG, data such as the address and Verblijfsobjecten-ID are automatically transferred from Key2BAG to I-objecten.

The next event is "Melding start bouw." This notification can come in from HBM. It is also possible that a VIB'er is ahead of the notification and has signalled himself that the construction has started. The status of the building is changed by a VIB'er to "Bouw gestart" and the status of the VBO remains "Verblijfsobject gevormd". Usually the VIB'er starts monitoring from "Melding start bouw" when a final measurement is possible. Once the construction scaffoldings are gone it is usually the moment to measure. The VIB'er is then not bothered by a fence that interferes with measuring or people already living in the property by then. These dimensions resulting from this measurement are almost always (slightly) different from the dimensions entered into Key2BAG during the permit application. These final dimensions must therefore be accurately entered into both TopoCAD and Key2BAG. The VIB'er first registers the final measurements in TopoCAD and then transfers them into Key2BAG, with justification by means of an Ambtelijke verklaring Wet BAG.

The next event is "Melding gebruiksgereed" This notification can also come in from HBM, or from Burgerzaken (BZ) if they receive notification that a new resident wants to be registered, or from GBTwente. It is also possible that this event is signalled by a VIB'er himself. This notification means that the property is finished and as soon as this notification is received, the VIB'er must do the final measurement and register it in TopoCAD and Key2BAG within six months. If the final measurement has already been done, the status of the property can be changed immediately to "Pand in gebruik" and the status of the VBO('s) to "Verblijfsobject in gebruik". If the final measurement has yet to be done, the statuses will first change to "Pand in gebruik (niet ingemeten)" and "Verblijfsobject in gebruik (niet ingemeten)". Once the final measurement has been done, the result of this must be plotted in TopoCAD and then transferred to Key2BAG (with an Ambtelijke verklaring Wet BAG)). Of course, the status of the property/VBO must then be changed to "Pand in gebruik" and Verblijfsobject in gebruik". Once the final measurement has been registered and processed in the BAG, the VIB'er does not have to do anything more.

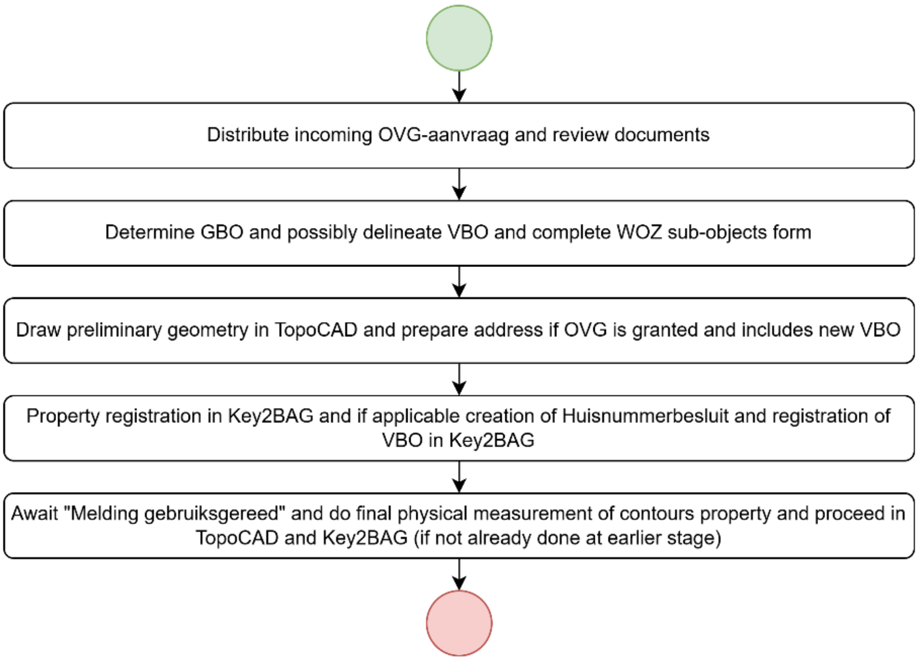



*Figure 17: simplified process OVG new building*

### 4.5.2 OVG renovation, splitting/merging or demolish

This section will discuss the processes of an OVG for a minor renovation, a major renovation, a splitting/merging and a demolition. A minor renovation refers to a renovation of an object(s) in which no changes occur in the distinction between VBO's. A major renovation involves a change in the distinction between residential objects, because one or more new VBO's are added as a result of the renovation. The new VBO's are hereby created from parts of original VBO's. In the case of a division, new VBO's are created from one complete VBO. When VBO's are merged, one VBO is created from only complete VBO's.

These processes start with an OVG-application that is placed in CLO by the permit department. A VIB'er picks up the OVG and checks what kind of OVG it is: a renovation, division/merger or a demolition. The process of a demolition can also be announced through a "Melding voornemen tot sloop". VIB'ers then receive this notification from HBM.

If the OVG-application concerns a renovation, the VIB'er first checks if there are any changes in the property geometry. If so, this modified geometry is drawn in TopoCAD. Next, the VIB'er assesses whether new VBO's are created during the renovation, in other words: whether it concerns a small renovation or a major renovation.

### 4.5.2.1 Minor renovation

In the case of a minor renovation, the VIB'er must register the changes to the property (both geometry and property attributes) and VBO’s in Key2BAG. Furthermore, the status of the property to be renovated must be changed to "Verbouwing pand" and the status of the VBO to be renovated to "Verbouwing verblijfsobject". To justify this, the VIB'er uses the OVG decision of the renovation placed in Corsa by the Permit department.

Next, the VIB'er can wait for "Melding verbouwing gereed" that can come in from HBM. This notification means that the renovation is finished and as soon as this notification arrives, the VIB'er must take the final measurements within six months and register them in TopoCAD and Key2BAG. Instead of the notification, the VIB'er can also signal himself that the renovation is finished. If the final measurement has yet to be done at this point, the statuses of the property and the VBO will first change to "... in gebruik (niet ingemeten)". After the final measurement, the result of this must first be plotted again in TopoCAD in order to then take over the drawing in Key2BAG (with an Ambtelijke verklaring Wet BAG). Of course, the status of the property/VBO must then be changed to "Pand in gebruik" and "Verblijfsobject in gebruik".

In addition, the status of any VBO’s and number designations that cease to exist should change to "Verblijfsobject ingetrokken” and “Naamgeving ingetrokken”. Once this registration in Key2BAG is completed and processed, the VIB'er is done with this process.

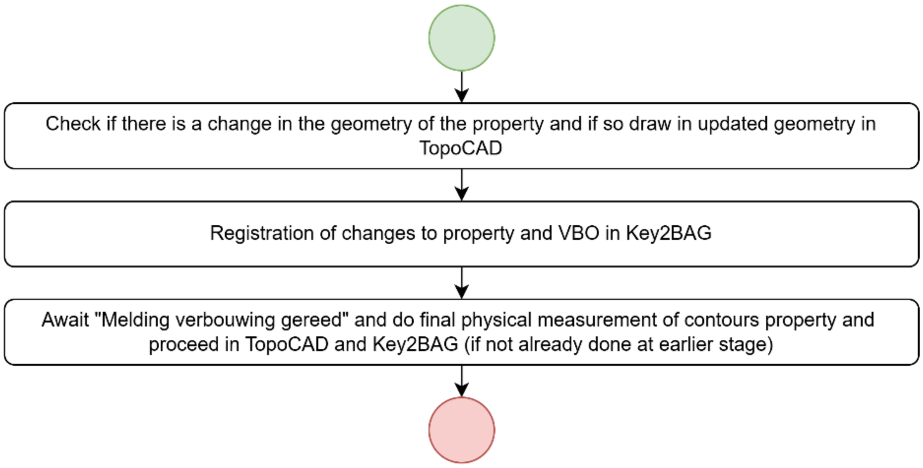



*Figure 18: simplified process minor renovation*

### 4.5.2.2 Major renovation

If it is a major renovation, one or more new VBO’s will be created as a result of the renovation. The changes made that create the new VBO’s, and the new attribute values of the VBO’s, will be recorded by the VIB'er in Key2BAG. The status of the recorded VBO’s will become "Verblijfsobject gevormd" and the status of the associated number designations will become "Naamgeving uitgegeven".

The new VBO’s can be created without any changes to the property. However, if the renovation does change one or more attributes of the property, the property status (as with the minor renovation) will change to "Verbouwing pand".

For clarification, this is shown schematically in figure 19 below:

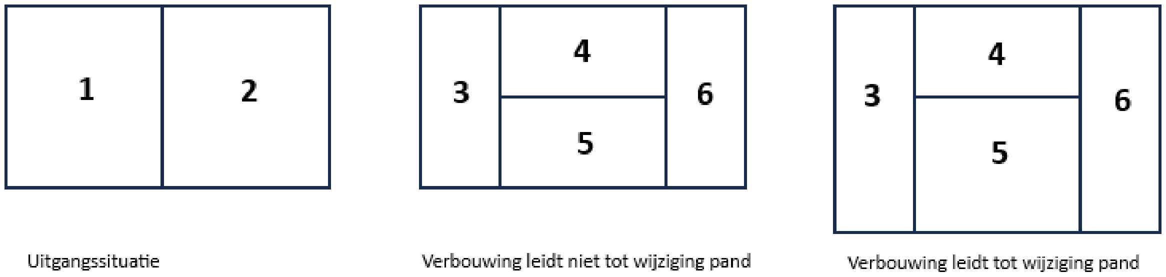



*Figure 19: Renovation of property does/does not lead to contour changes*

To account for all the changes just described in Key2BAG, the VIB'er can use the OVG decision placed in Corsa by the Permit department. The new VBO's must be numbered so the process will continue with the creation of a huisnummerbesluit and registration of the number designation and postal code in Key2BAG (this subprocess has been written out earlier). After then establishing the link between TopoCAD and Key2BAG by means of the Pand-ID and Verblijfsobject-id, one can wait for "Melding verbouwing gereed" and the process continues as written out above for the process of a small renovation.

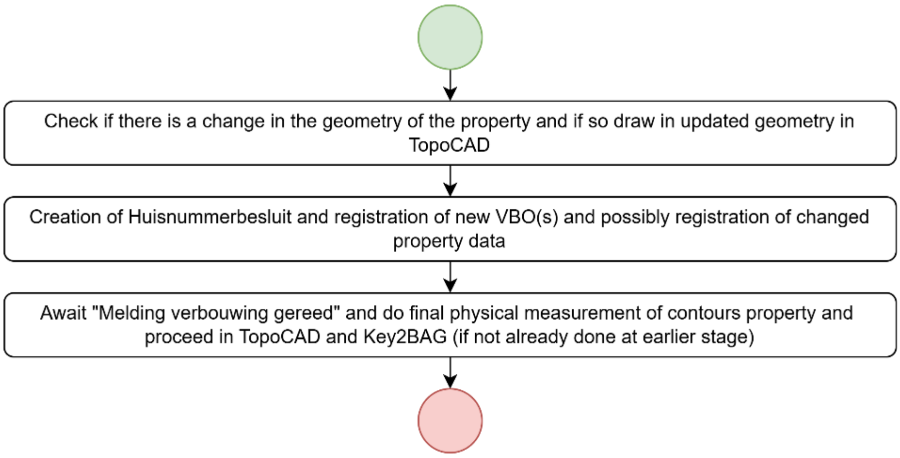



*Figure 20: simplified process major renovation*

#### 4.5.2.3 Splitting/merging

If the OVG-application involves a splitting/merging, any changed property geometry should also be drawn in TopoCAD. This process is then continued in exactly the same way as the above process for a major renovation.

#### 4.5.2.4 Demolition

If the OVG-application involves full demolition, the property's status is changed to "Sloopvergunning verleend". To account for this, the VIB'er can use the brondocumentnummer of the OVG to full demolition, which has been put into Corsa by the permit department. After this, the VIB'er can wait for "Melding sloop afgerond", or wait until the VIB'er himself signals that demolition is complete. The status of the property and any VBO('s) and number designation(s) must now be changed to "Pand gesloopt" and if necessary "Verblijfsobject ingetrokken" and "Naamgeving ingetrokken". To account for these changes in Key2BAG, the VIB'er can save the mail of the notification in Corsa and create an Ambtelijke verklaring Wet BAG referring to the brondocumentnummer of the saved mail. If the VIB'er signalled the completed demolition himself, the VIB'er can create an Ambtelijke verklaring Wet BAG and explain in it that the status change was signalled by the VIB'er himself.

Finally, the "Melding voornemen tot sloop". The VIB'er picking up this notification first assesses whether it is a small, medium or large demolition. If the demolition is so small that no changes occur in Key2BAG, the process stops. If the demolition is medium-sized and leads to relevant changes in Key2BAG, it is processed as renovation (see for the continuation of this process section 4.5.2.1 or 4.5.2.2). If the demolition is so large that the property disappears, it can be processed as complete demolition. In this case, the process is continued as written out above in this subsection.

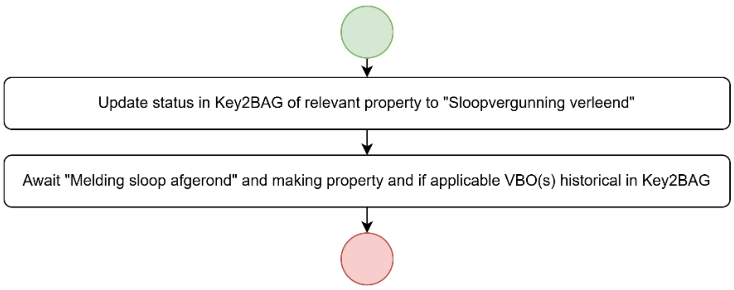



*Figure 21: simplified process full demolition*

## 4.6 Additional measurement tasks

Finally, the additional measurement tasks that come in at the GEO team email address (geoinformatie@enschede.nl). The process that a VIB'er goes through for performing an additional measurement assignment is written out below.

### 4.6.1 Measurement task via shared email adress

This process starts with a notification from the Design and Realization department. They make the notification that reconstructions or other types of mutations have occurred in the public space. These mutations mainly concern road, green and water objects. The city engineers/project managers who are responsible for the modification to the public space communicate this mutation through the shared email address.

The incoming mail is distributed to the VIB'ers by three VIB'ers who administer this email adress. If it turns out that the measurement does not fit into the planning of all the VIB'ers, the measurement is outsourced by the team coordinator of the GEO-team.

If the measurement is not outsourced, both the measurement and data processing will be done by a VIB'er. To perform the measurement, the VIB'er will go to the location of the application with measuring equipment. If the measurement involves mutations in the geometry, it will have to be registered in TopoCAD so that it is registered in the BGT.

If the measurement is outsourced, the delivered result will arrive at the team coordinator of the GEO team. The team coordinator will send the result to the city engineer/project manager who submitted the request. If the delivered measurement results involve changes in geometry, it will be assigned to a VIB'er. This VIB'er will assess the measurement and then register it in TopoCAD so that it is registered in the BGT.

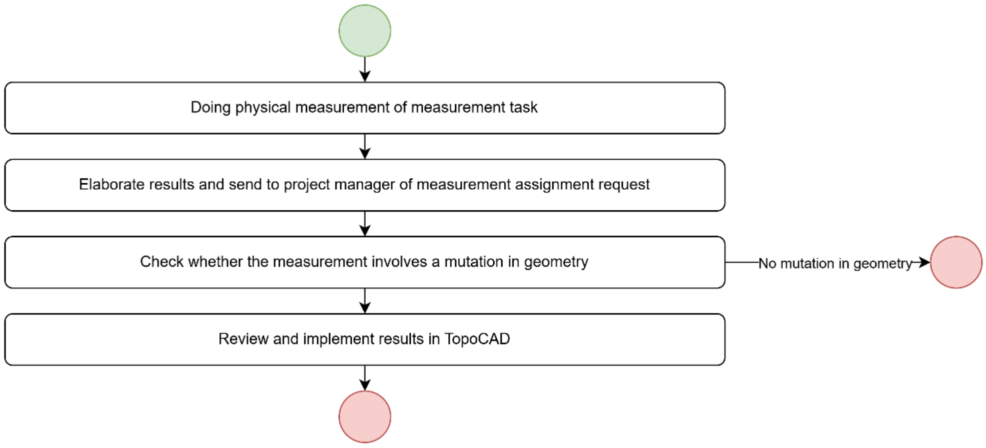



*Figure 22: simplified process additional measurement tasks*

## 4.7 Takeaway

This fourth chapter investigated how the VIB'ers of the GEO-team (key stakeholders in this study) work. This focused on what systems they use to process mutations and what processes are behind the processing of each mutation. In doing so, Section 4.1 answered the following sub-question: *"How are the entry, distribution, and processing of mutations managed by the VIB'ers?"*

This showed that the VIB'ers receive information through various sources. Permit-free mutations come in via annual aerial photo files from an external company, the permit-required mutations via notifications via the Centric Living Environment (CLO) program, and other measurement tasks via a shared email address (geoinformatie@enschede.nl) to which three VIB'ers have access. Regarding the distribution of incoming mutations, it has become clear that permit-free mutations are distributed according to a neighborhood distribution. In distributing these neighborhoods among the VIB'ers, the building density of surface areas was taken into account; as a result, VIB'ers with neighborhoods in the city center have a smaller surface area than VIB'ers with neighborhoods on the outskirts of Enschede. However, the question here is whether this neighborhood classification actually ensures a fair distribution of permit-free mutations, this will therefore be investigated further in Subsection 5.2.1. Finally, it became clear in Section 4.1 that, for the digital registration of mutations, the VIB'ers use the program TopoCAD to registrate data in the Basisregistratie Grootschalige Topografie (BGT) and the program Key2BAG to registrate data in the Basisregistratie Adressen en Gebouwen (BAG).

Next, Sections 4.2 and 4.3 examined in more detail the BGT and the BAG and the systems TopoCAD and Key2BAG that VIB'ers use for registrations in the BGT and the BAG, respectively. This involved answering the following sub-question: *"What are the BGT and the BAG, and through what systems is data recorded within these databases?"*

This revealed that the BGT is a digital map of the Netherlands in which all physical objects in outdoor space are recorded in detail. With regard to physical objects, this refers to buildings, roads, water and greenery that are unambiguously recorded in the BGT. For registration of data in the BGT, the VIB'ers use the TopoCAD system. This is a stand-alone CAD system without other CAD systems, and from the literature found and information from the manual of the makers of TopoCAD, it has become clear that the system also includes GIS standards. Furthermore, it was revealed that TopoCAD is a 3D CAD system, which allows the Solid modeling described by Zeid (2014). This means that based on the 3D models in TopoCAD, all kinds of calculations (mass, volume, etc.) can be done by connecting points and vectors. Finally, TopoCAD is connected to the NedGeodataWarehouse (NGdW), which is a central database in which all BGT data must be stored. Using TopoCAD to process BGT data allows VIB'ers to connect to the BAG by linking data from the BGT with data from the BAG via ID numbers.

The BAG turned out to be a database containing the data of all addresses and buildings in the Netherlands. This means that all buildings are registered in the BAG with year of construction, area, purpose of use and location on the map. For registration in the BAG, VIB'ers use the Key2BAG system. Regarding the relationships of the Key2BAG system to CAD and GIS systems, it has become clear from an article by Key2BAG's creators, Centric, that Key2BAG includes an integrated GIS component and standardized interfaces with CAD systems as well.

Finally, the processes for processing permit-free mutations, permit-required mutations and additional measurement tasks have been written out in Sections 4.4, 4.5 and 4.6 respectively. These written out processes gave an answer to the last sub-question of this Chapter:

*“What are the detailed processing procedures for permit-free mutations, permit-required mutations, and other measurement tasks?”*

While writing out the processes, attention was paid to how to distinguish between mutation processes within the three main categories: permit-free mutations, permit-required mutations and other measurement tasks. This showed that for the mutations requiring a permit, a significant distinction can be made in the processes behind the processing of these mutations.

Initially, for the permit-required mutations, a distinction was made between OVG new building, OVG renovation, OVG splitting/merging and OVG demolition. However, while writing out the processes, it was soon discovered that there was also a difference in processes for a small renovation and a major renovation. Furthermore, it was also found that a distinction could be made between small, medium and major demolition. Important to note is that small demolition does not require registration in the systems and was therefore not considered.

Having discovered these differences in permit-required mutations applications, certain similarities in the processing processes were considered and this led to the processes as shown in Table 3. This table shows in the left column the three main categories, in the middle column all the different processes identified in Sections 4.5, 4.5 and 4.6, and in the right column shet number of the process model in which each process will be included during modelling in Chapter 5.

*Table 3: Identified processes*

| Category | Process | Process model |
|---|---|---|
| Permit-free mutations | Mutation signalization aerial photos | 1 |
| Permit-required mutations | OVG new building | 2 |
| | OVG minor renovation/medium-sized demolition | 3 |
| | OVG major renovation/splitting/merging/ medium-sized demolition | 3 |
| | Demolition | 3 |
| Other measurement tasks | Measurement tasks via shared email adress | 4 |

For additional clarity, the patterns discovered in the processes of the different types of permitting mutations are written out below:

- A medium-sized demolition notification is processed as a small or major renovation
- A split and a merge both follow the same process steps as a major renovation

These identified similarities will be seen in the process model of the OVG renovation, splitting/merging or demolition and can help classify these processes in (where necessary) process versions for assigning process times.

# 5. Design & Development

In this fifth chapter, the processes presented in table 3 will be modelled in the EngageProcess modelling tool. Section 5.1 will first elaborate on this particular modelling tool by explaining the icons for indicating process steps. This section will answer sub-question:
*"What is important to consider when modelling the processes in EngageProcess?"*

Then, in section 5.2, four process models will be created incorporating all processes described in Chapter 4. Additionally, process times will be attached to the processes in these process models. Where necessary, this will involve the use of multiple versions of a process for linking process times. Based on the information in this Section, the following sub-question will be answered:
*"What times can be assigned to each (version of each) process based on the input of the VIB'ers?"*

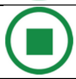
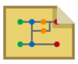
Next, in section 5.3 the artefact will be introduced and an implementation plan will be given. The information in this section will answer the sub-question:
*"What are the key functionalities of the developed artifact, and how can it facilitate insight into work distribution for VIB'ers?"*

Finally, section 5.4 will conclude the chapter by answering the research questions and previewing chapter 6.

## 5.1 EngageProcess

In order to model the written-out processes in EngageProcess, research was first conducted on this modelling tool. To understand EngageProcess, both the Engageprocess manual and instructional videos were thoroughly studied (Engage Process Modeler Handleiding). From this, it became clear which process steps could be used for the processes in this study. The icons of the process steps used are listed below (with explanations):

*Table 4: EngageProcess icons*

| Process step (icon) | Description |
|---|---|
|  | Start of a process |
|  | End of a process |
|  | Implementation of the process continues at the process step to which this icon points |
|  | A waiting moment in a process, such as having to wait for a response from an external service |
|  | A connection between the tasks of different departments within a process |
|  | A decision moment in a process, this decision moment is a role-dependent activity in which a choice is made |
|  | A collection of process steps in the main process that belong together, you can unfold these subprocesses to see each intermediate step |
|  | Email message |
|  | An activity performed automatically |
|  | An activity that uses digital tools but also requires some manual labor |

| | |
|---|---|
|  | An activity indicating that something is being figured out/something is being examined |
|  | A critical bottleneck in a process. Execution of this activity should be avoided |

## 5.2 Modelled processes & Time indications

Now that it is clear which icons EngageProcess uses to represent process steps, the research can continue with the process models. The processes shown in Table 3 are incorporated into four process models in this Section. In the right column of Table 3, the process model number is associated with each process. In this regard, the four numbers represent the following four process models:

1. Mutation signalization aerial photos
2. OVG new building
3. OVG renovation, splitting/merging or demolition
4. Additional measurement tasks

The images of these process models will show the icons presented in table 4. Good to note here is that in process 1 and 4 there will not be made use of process links, since in these processes all steps are carried out by the VIB'ers and therefore the GEO-department. However, for process 2 and 3, several departments are involved and therefore process links will be found in these process models. Here all process steps below the process links are carried out by the permit department and everything above the process links is carried out by the VIB'ers.

In requirement three of the final requirement list of Chapter 3, a prioritization of ways in which process times can be identified was made. These ways were based on what was found in the literature in Subsection 2.1.1 about obtaining process times. The first option was to find process times in the way described by De Murillas et al. (2015), which was to use timestamps maintained by Redo logs in databases. Therefore, to obtain the process times, Redo logs in the databases used by the VIB'ers were investigated first, but were not found. The only thing found in the databases as a time was a "Start editing time", i.e., a time at which a VIB'er started making changes in the database. Hence, there was no stop time of editing, therefore these times could not be used within this study.

Therefore, the search for process times continued with a second way found in the literature for obtaining process times. This involved Expert Judgment as described by Meyer and Booker (2001). According to Meyer and Booker (2001), Expert Judgment can be conducted through three techniques, namely structured interviews, group sessions and the Delphi method. In order to obtain process times through Expert Judgment, a group session was done with VIB'ers in which all VIB'ers were present. First, the processes were where necessary divided into several versions in order to distinguish between easier and more difficult mutations of the same kind. Once these process versions were made, the process steps of all processes were discussed on the spot with all VIB'ers in order to assign times. In doing so, the VIB'ers arrived at an estimate of the process time of each process step based on their experience, sometimes after having some discussion.

In Subsections 5.2.1 through 5.2.4 the process models will now be shown one by one, each with a detailed explanation of how process times were arrived at for each process (version).

## 5.2.1 Mutation signalization aerial photos

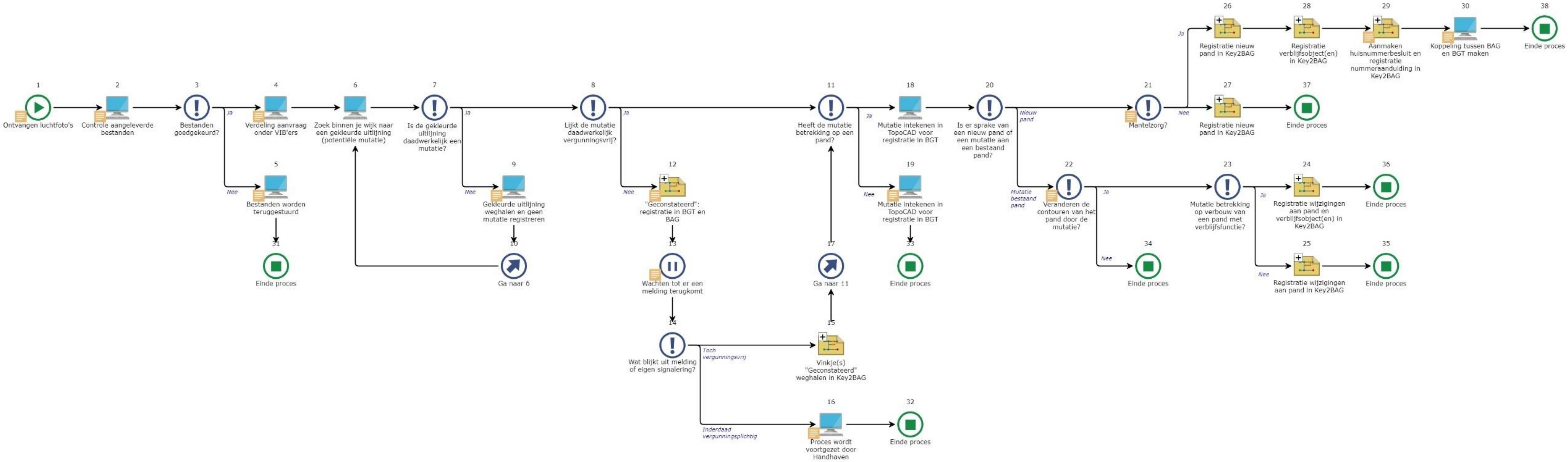



*Figure 23: process model Mutation signalization aerial photos*

As described earlier, all mutations from the mutation signalization aerial photos are distributed through the neighbourhood classification. These mutations can relate to any property in the outdoor area. To examine the extent to which the neighbourhoods are actually fairly distributed according to the neighbourhood distribution, the numbers of mutations per neighbourhood are compared below in Table 5. To arrive at these numbers, is with the VIB'ers looked at the aerial photo files received at the beginning of this calendar year. Here the number of mutations in each neighbourhood could be selected, and in this selection a distinction could be made between the number of mutations to properties and the number of mutations to other objects in the outdoor space. As can be seen in the process model in Figure 23, mutations to properties (provided that there are contour changes to the property) require registration in both the BGT and the BAG, and thus the processing of these mutations takes more time than the other mutations. To see whether this distribution in each VIB'ers neighbourhood share is also fair, these numbers are included separately in columns 2 and 3, and column 5 calculates the ratio of how often property mutations relative to other mutations occur in a neighbourhood share.

Important to note about Table 5 is that the names in the left column are arbitrary and do not match the real names of the VIB'ers.

*Table 5: Number of mutations in each neighbourhood share*

| | Mutations to property | Other mutations | Total | Ratio Property/Other |
|---|---|---|---|---|
| Piet | 1052 | 1123 | 2175 | 0.936 |
| Kees | 994 | 1048 | 2042 | 0.948 |
| Willem | 614 | 650 | 1264 | 0.944 |
| Anton | 439 | 459 | 898 | 0.956 |
| Bart | 633 | 670 | 1303 | 0.945 |
| Dirk | 821 | 863 | 1684 | 0.951 |
| Frank | 791 | 843 | 1634 | 0.938 |

As can be seen from Table 5, the frequency of property mutations relative to other mutations is very close for each neighbourhood share. Therefore, in the remainder of this study, the neighbourhood distributions will not distinguish between the number of property mutations and other mutations. However, the total numbers of mutations are much further apart, so this difference will certainly be included. For example, the neighbourhood distribution shows that Anton has to process a lot fewer permit-free mutations than Piet (898 versus 2175). This will mean that Anton will spend less time processing these permit-free mutations. As a result, there will be more time for Anton to process permit-required mutations and other measurement tasks.

In order to arrive at a time estimate of how long each VIB'er spends processing the mutations in his neighbourhood share, a way was sought to determine the time a VIB'er needs to process a permit-free mutation.

Initially, the idea was to distinguish between different types of permit-free mutations in the process model in figure 23 by looking at various decision moments and process steps in the process that are crucial to the overall processing time of a mutation. This is also how the required process times for processing permit-required mutations and other measurement tasks are determined in Section 5.2.2 through section 5.2.4. However, the ratios in column 5 of table 5 show that the ratio of property mutations to other mutations is about the same for each of the VIB'ers' neighbourhoods share. Since this is so close, it is assumed, that this ratio is the same for each VIB'ers' neighbourhood share. This means that for the calculation of how long it takes a VIB'er on average to process a permit-free mutation, no distinction needs to be made in degrees of mutations; after all, the ratio of "time-consuming mutations” (property mutations)/“less time-consuming mutations” (other mutations), is almost the same for all VIB'ers.

Obtaining an average time of how long a VIB'er generally takes to process a permit-free mutation can therefore be used to obtain a time estimate of how long each VIB'er takes to process all permit-free mutations in their neighbourhood share. This average time can be obtained from a timekeeping system that GEO team staff use for the department's budget: Microsoft OEPS. In this system, the VIB'ers distinguish between hours worked on mutation signalization, BGT work/BAG work of permit-required mutations, measurement assignments and other things like meetings. Since the hours for mutation signalization per VIB'er represent the time spent processing permit-free mutations, this number of hours can be used to calculate the average time a VIB'er needs to process a permit-free mutation.

Now it would seem obvious to do the same for the process times of permit mutations and other measurement assignments, but this is not convenient for two reasons. First, because these mutations and assignments vary very widely in processing time and the VIB'ers in OEPS do not distinguish between what type of application/assignment they have processed, but instead designate these mutations/tasks in OEPS with “permit work,” “measurement,” or other umbrella terms. Second, these permit-required mutations and measuring assignments are not distributed according to a neighbourhood distribution as in the case of permit-free mutations, exactly because of the strong variation in size and because this would result in too much work if a new housing development were placed in a neighbourhood share.

As previously announced, insight into the numbers of hours spent on mutation reporting per VIB'er was obtained through the OEPS program. By dividing the total number of hours of a VIB'er by the total number of permit-free mutations that were in the VIB'er's neighbourhood shares, the average time per permit-free mutation could be calculated. Thus, using the numbers of mutations per neighbourhood share from the aerial photo files received last year and the hours worked processing permit-required mutations per neighbourhoods share of VIB'ers from last year, an average processing time of **16.4 minutes** per permit-free mutation has been calculated.

Assuming that the VIB'ers work as hard this year as they did last year, this average time can be used to calculate the total time required to process permit-free mutations in each VIB'ers' neighbourhood share. Here, the average time of 16.4 minutes per permit-free mutation can be multiplied by the total number of permit-free mutations in each VIB'ers' neighbourhoods (for these numbers, see column 4 of Table 5). This calculation yields the times shown in Table 6. Assuming there are 48 work weeks in a year, the average processing time required per VIB'er per work week for processing permit-free mutations is shown in column 4 (to 3 decimals).

*Table 6: Process time per VIB'er for permit-free mutations*

| | Expected processing time required (min) | Expected processing time required (hours) | Expected time per work week (hours) |
|---|---|---|---|
| Piet | 35670 | 594,5 | 12,385 |
| Kees | 33489 | 558,15 | 11,628 |
| Willem | 20730 | 345,5 | 7,198 |
| Anton | 14727 | 245,45 | 5,114 |
| Bart | 21369 | 356,15 | 7,420 |
| Dirk | 27618 | 460,3 | 9,599 |
| Frank | 26798 | 446,63 | 9,305 |

### 5.2.2 OVG new building

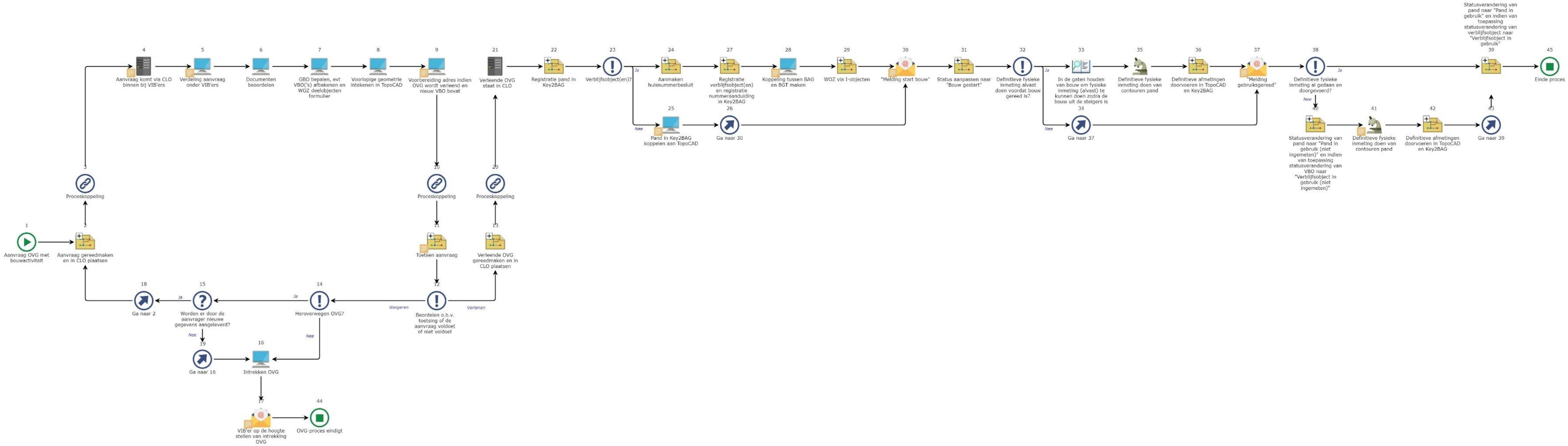



*Figure 24: process model OVG new building*

When it comes to an OVG new building, there are a number of process steps that strongly influence the total processing time required. These process steps will be highlighted below (using the process step numbers of the process model):

- 7: The time required for determining the area of use of the VBO's depends on the number of VBO's involved in the application
- 8: The time required for drawing in the geometry depends on the size of the property and the complexity of the contours
- 9: the time required for preparing addresses to be assigned depends on the number of VBO's involved in the application
- 23: this decision moment is crucial for the time required in this process. If VBO's are involved, each VBO must be registered in Key2BAG and assigned a number designation through a huisnummerbesluit. In addition, in the case of a VBO, its sub-objects must be registered in the Wet waardering onroerende zaken (WOZ).
- 35/41: the time required for doing a final physical measurement depends on the size and complexity of the contours of the property
- 36/42: the time required for entering the final dimensions in TopoCAD and Key2BAG depends on the size and complexity of the property contours

The time required for some of the other process steps may also be affected by the size of the application, but this difference in not as significant as for the above process steps.

Table 2 shows all process steps of this process for which the VIB'ers are responsible and which have a time link. Here a distinction is made between the required processing times (in minutes) per process step per version. The versions have been classified (in consultation with the VIB'ers) in such a way that version 1 (third column) is an application without a VBO, version 2 (fourth column) is an application with one VBO and version 3 (fifth column) is an application with more than one VBO.

*Table 7: process times OVG new building*

| Process step number | Process step description | Process time (no VBO) | Process time (1 VBO) | Process time (>1 VBO) |
|---|---|---|---|---|
| 6 | Reviewing documents | 15 | 15 | 15 |
| 7 | Determine GBO, possibly delineate VBO('s) and WOZ partial objects form | 10 | 15 | 15 + 10 * VBO |
| 8 | Enter preliminary geometry in TopoCAD | 10 | 10 | 10 |
| 9 | Preparation address if OVG is granted and contains new VBO | X | 10 | 10 |
| 22 | Registration property in Key2BAG | 5 | 5 | 5 |
| 24 | Create huisnummerbesluit | X | 15 | 15 |
| 27 | Registration VBO('s) and registration nummeraanduiding in Key2BAG | X | 15 | 15 + 5 * VBO |
| 28 | Creating a link between BAG and BGT | X | 5 | 5 |
| 29 | WOZ via I-objecten | X | 5 | 5 |
| 25 | Linking property in Key2BAG to TopoCAD | 5 | X | X |
| 31 | Status change to "Bouw gestart" | 10 | 10 | 10 |
| 35/41 | Final physical measurement of contours property | 60 | 60 | 60 |

| | | | | |
|---|---|---|---|---|
| 36/42 | Registrate final dimensions in TopoCAD | 30 | 30 | 30 |
| 39 | Status change of property to "Pand in gebruik" and when necessarily status change of VBO to "Verblijfsobject in gebruik" | 10 | 10 | 10 |
| **Total number of minutes per version** | | 155 | 205 | 205 + (15 * VBO amount) |

## 5.2.3 OVG minor renovation, major renovation/splitting/merging and demolition

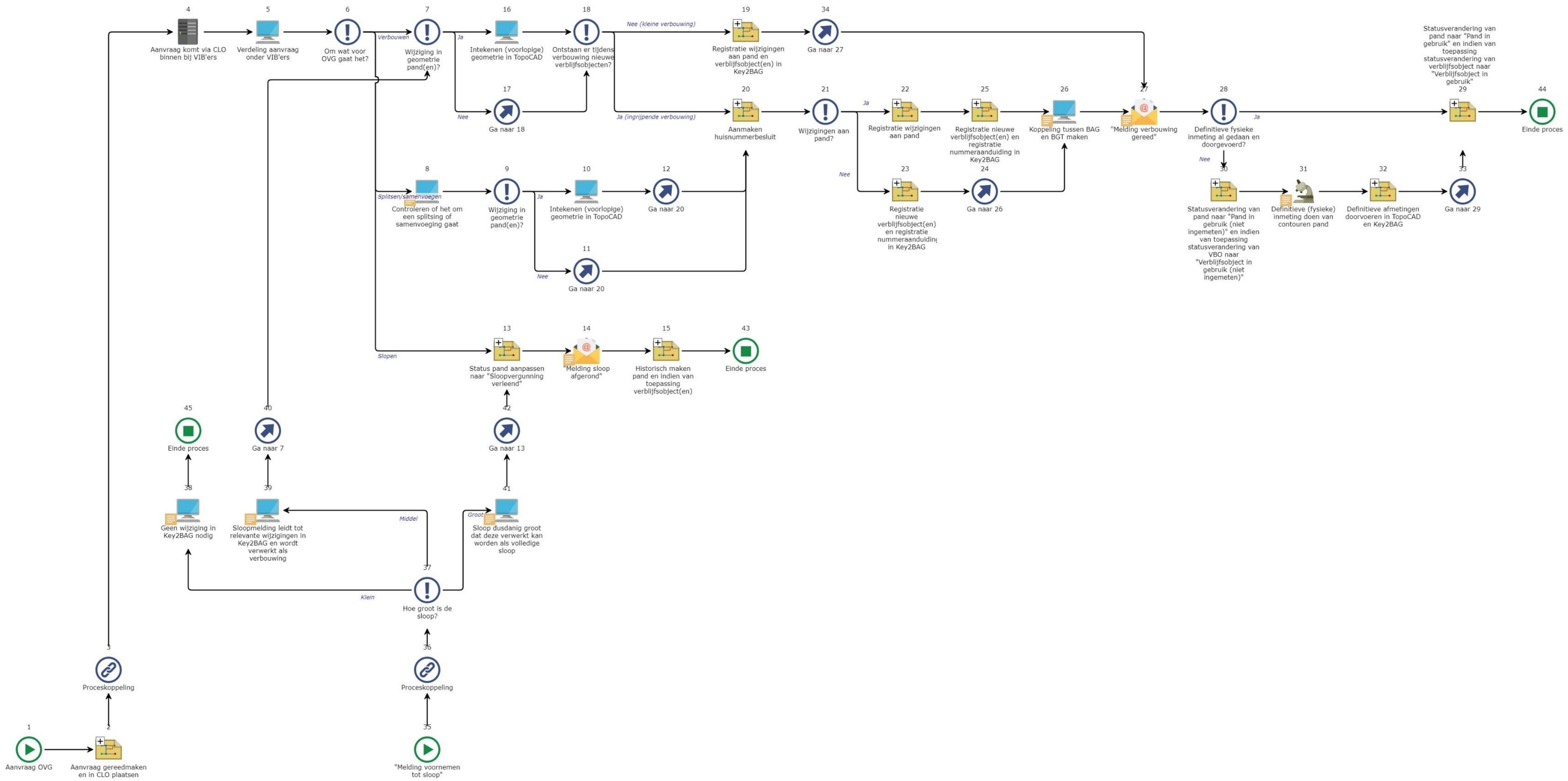



*Figure 25: process model OVG renovation, splitting/merging or demolition*

When it comes to the modelled process of OVG renovation, splitting/merging or demolition, for the purpose of assigning time indications, a distinction can be made between the process of a minor renovation, the process of a major renovation/splitting/merging and the process of a large demolition.
As described in the discovered patterns at the beginning of this chapter, a medium-sized demolition can be processed as a renovation, therefore some of these notifications are processed as minor renovation and some as major renovation. Furthermore, a minor demolition is not included in any of the processes because it does not lead to relevant changes in both the BGT and the BAG.

Minor renovation (including middle-sized demolition notifications)
First, the process of a minor renovation (which includes some of the medium-sized demolition notifications) will be examined. In this process, the time required for a number of process steps may vary somewhat based on the complexity of the minor renovation. However, these differences are small, which is why multiple versions were not used for the time link of the minor renovation process.

The table below shows all steps of the process for a minor renovation for which the VIB'ers are responsible and which have a time link. In the left column are these process steps, in the middle column the descriptions and in the third column the average times (in minutes). These times have been established in consultation with the VIB'ers.

*Table 8: process times OVG minor renovation*

| Process step | Process step description | Process time |
|---|---|---|
| 16 | Draw (provisional) geometry in TopoCAD | 10 |
| 19 | Registration of adaptations to property and VBO(‘s) in Key2BAG (including status change to “Verbouwing pand” and/or “Verbouwing verblijfsobject”) | 10 |
| 30 | Status change of property to "Pand in gebruik (niet ingemeten)" and when necessarily status change of VBO to "Verblijfsobject in gebruik (niet ingemeten)" | 10 |
| 31 | Final (physical) draw of contours property | 45 |
| 32 | Registrate final dimensions in TopoCAD and Key2BAG | 15 |
| 29 | Status change of property to "Pand in gebruik" and when necessarily status change of VBO to "Verblijfsobject in gebruik" | 10 |
| **Total number of minutes** | | 100 |

Major renovation/splitting/merging (including middle-sized demolition notifications)
Now to the process for a major renovation (which includes some of the medium-sized demolition notifications), splitting or merging. In this process, the variation of the time required to perform (some) process steps does vary so much that multiple versions are needed. The process steps that have a strong influence on the total processing time of this process will be highlighted below:

- 10/16: the time required for registering the geometry depends on the size of the renovation/division/merger and the complexity of the renewed contours
- 20: this decision moment determines whether, in addition to registration of the new VBO’s, registration must also be made of changed property attributes
- 24: the time required for assigning number designation(s) depends on how many VBO’s are newly created

- 30: the time required for doing a final (physical) measurement depends on the size and complexity of the changes to the VBO's and whether there are changes to the property involved
- 31: the time required for entering the final dimensions in TopoCAD and Key2BAG depends on the size and complexity of the changes to the VBO's and whether any changes occur to the property.

The time required for some of the other process steps can also be affected by the size of the application, but this difference in not as significant as for the above process steps.

In the table below, the process for a major renovation/division/merger shows all steps for which the VIB'ers are responsible and to which there is a time link. Here a distinction is made between the required processing times (in minutes) per process step per version. The versions (in consultation with the VIB'ers) are arranged in such a way that version 1 (third column) is an application without changes to the property and one new VBO, version 2 (fourth column) is an application without changes to the property and several new VBO's and version 3 (fifth column) is an application with changes to the property and several new VBO's.

*Table 9: process times OVG major renovation/splitting/merging*

| Process step | Process step description | Process time (no property contourchange and 1 new VBO) | Process time (no property contourchange and multiple new VBO's) | Process time (property contourchange and multiple new VBO's) |
|---|---|---|---|---|
| 10/16 | Drawing (provisional) geometry in TopoCAD | X | X | 10 |
| 20 | Create huisnummerbesluit | 15 | 15 | 15 |
| 22 | Registration of contour changes to property | X | X | 10 |
| 25 | Registration of new VBO('s) and registration of nummeraanduiding in Key2BAG | X | X | 15 + 5 * VBO |
| 23 | Registration of new VBO('s) and registration of nummeraanduiding in Key2BAG | 15 | 15 + 5 * VBO | X |
| 26 | Create the link between the BAG and BGT | 5 | 5 | 5 |
| 30 | Status change of property to "Pand in gebruik (niet ingemeten)" and when neccesarily status change of VBO to "Verblijfsobject in gebruik (niet ingemeten)" | 10 | 10 | 10 |
| 31 | Doing final (physical) measurement of contours property | X | X | 60 |
| 32 | Registrate final dimensions in TopoCAD and Key2BAG | X | X | 30 |
| 29 | Status change of property to "Pand in gebruik" and when neccesarily | 10 | 10 | 10 |

| | | | | |
|---|---|---|---|---|
| | status change of VBO to "Verblijfsobject in gebruik" | | | |
| **Total number of minutes per version** | | 55 | 55 + (5 * number of VBO) | 165 + (5 * number of VBO) |

Demolition

The process of an OVG to full demolition or a demolition notification does not require multiple versions. An OVG to full demolition is, just like a large demolition notification, always processed as a large demolition and therefore requires only a few (small) steps. In addition, a small demolition notification does not result in any changes in the BGT/Key2BAG and therefore does not need to be processed and a medium-sized demolition notification (as described earlier) is processed as a small/intensive renovation.

The table below therefore shows one version of the process from OVG to complete demolition and a major demolition notification. The left column shows these process steps, the middle column shows the descriptions, and the third column shows the indicated times (in minutes). These times were arrived at in consultation with the VIB'ers.

*Table 10: process times OVG full demolotion or large demolition notification*

| Process step | Process step description | Process time |
|---|---|---|
| 13 | Status pand aanpassen naar "Sloopvergunning verleend" | 15 |
| 15 | Historisch maken pand en indien van toepassing verblijfsobject(en) | 10 |
| **Total number of minutes** | | 25 |

### 5.2.4 Additional measurement tasks

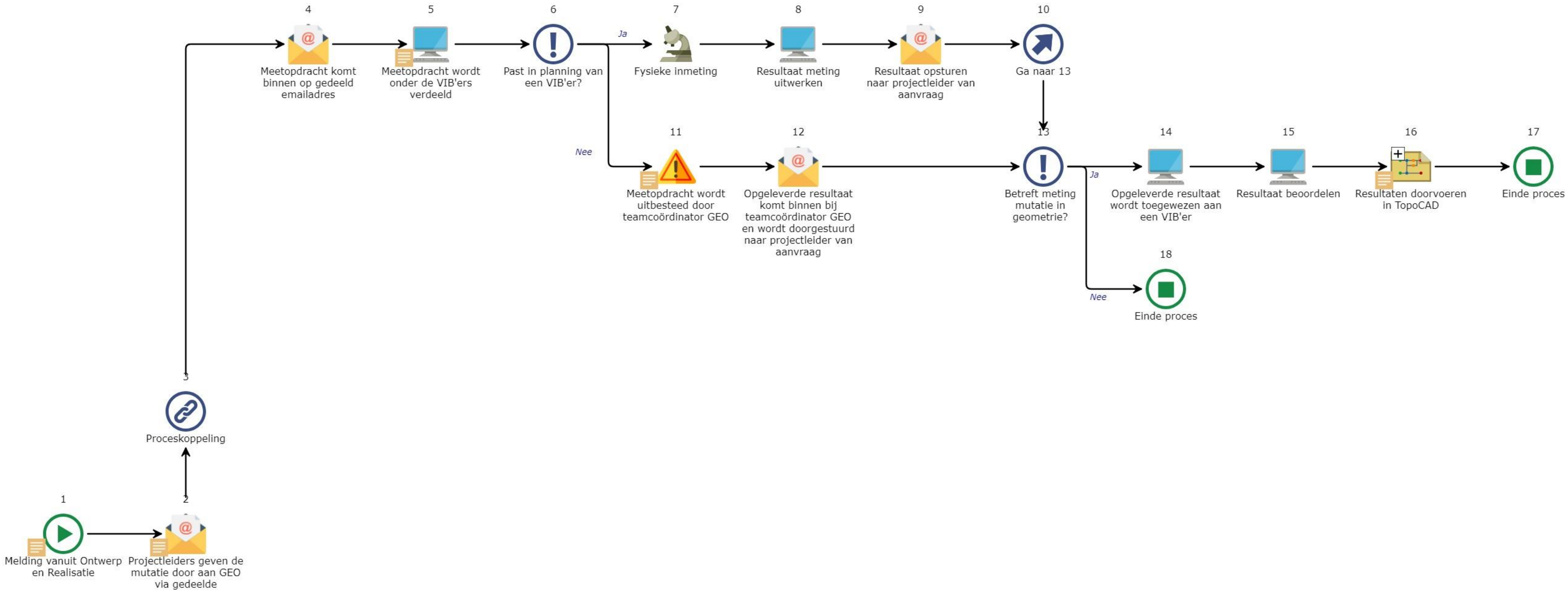



*Figure 26: process model Additional measurement tasks*

Finally, there are the additional measurement tasks. The process steps that have a strong influence on the overall processing time of this process will be briefly highlighted below:

- 6: the time required for physical measuring strongly depends on the size, complexity and level of detail required for the measuring task
- 7: the elaboration of the results also depends on the size, complexity and required level of detail of the measurement task
- 8: this decision moment determines whether the results are relevant for the BGT and therefore whether the results should be implemented in TopoCAD.

The time required for some of the other process steps can also be affected by the size of the request, but this difference in not as significant as for the above process steps.

The table below shows all the steps of the process of an additional measurement task for which the VIB'ers are responsible and which have a time link. The process is divided into three versions, with the indicated time required (in minutes) per process step for each version (based on input from the VIB'ers). The versions are divided (in consultation with the VIB'ers) in such a way that version 1 is a measurement task for a measurement of a completed property, version 2 is a BGT measurement of a newly realized situation and version 3 is a measurement of an existing situation. The reason that a BGT measurement of a new situation takes less time than a measurement of an existing situation is because a measurement of an existing situation needs to take into account more objects than just the BGT objects that need to be taken into account in a new situation.

*Table 11: process times Additional measurement tasks*

| Process step | Process step description | Process time (measurement of finished property) | Process time (BGT-measurement of new situation) | Process time (measurement of an existing situation) |
|---|---|---|---|---|
| 7 | Physical measurement | 60 | 180 | 360 |
| 8 | Elaborate result measurement | 30 | 60 | 90 |
| 9 | Send result to project manager of application | 10 | 10 | 10 |
| 15 | Review result | 10 | 10 | X |
| 16 | Registrate result in TopoCAD | 30 | 30 | X |
| **Total number of minutes** | | 140 | 290 | 460 |

## 5.3 Artifact: Planning tool

The process times obtained for each permit-free mutation, permit-required mutation and other measurement task are used in the tool. Exactly how these times are used in the tool and what insights this can lead to for the VIBs of the GEO team will become clear in this section. Subsection 5.3.1 will first briefly introduce the tool and then in Subsection 5.3.2 the reference will be made to the implementation plan of the tool.

### 5.3.1 Introduction

A brief introduction of the tool is necessary to clearly address the implementation plan of the tool in the next subsection and to better follow the demonstration of the tool in Chapter 6. Figure 27 shows an image of the tool, this figure will be used to explain the most important information regarding the tool.

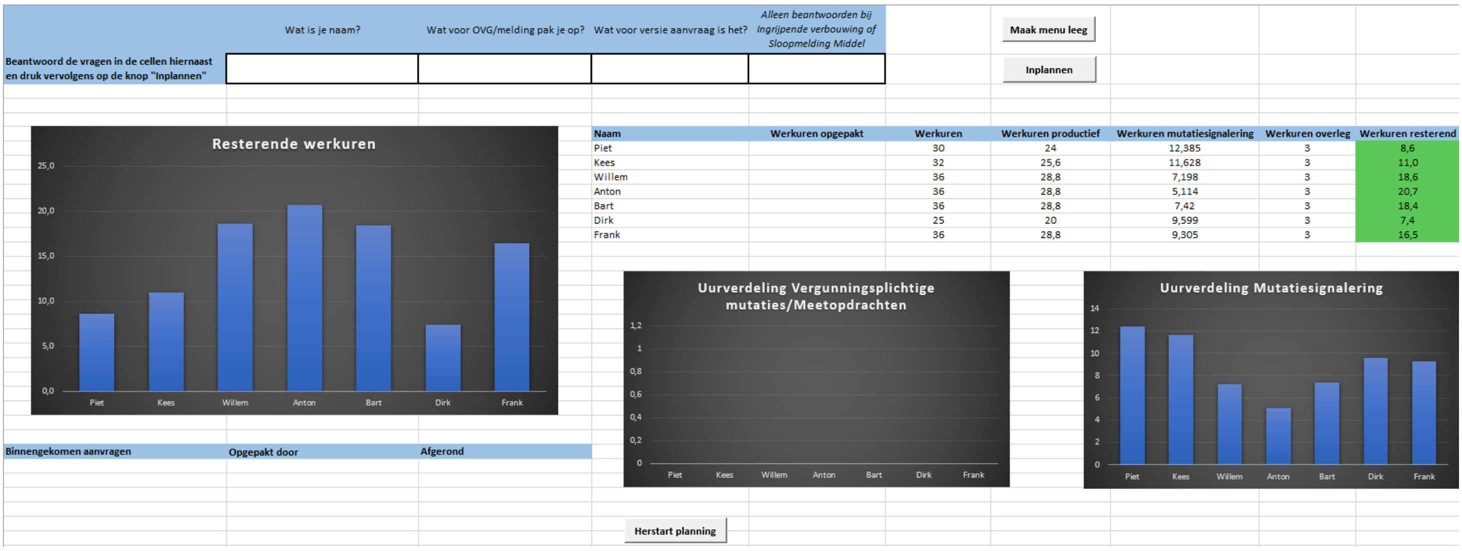



*Figure 27: Tool*

The tool (as presented in Figure 27) can provide insight into the division of labor among the VIB'ers. Here, the tool is set to the hourly distribution of a work week. Thus, the tool takes into account the weekly number of working hours of the VIB'ers based on their contracts, these hour numbers can be found under the column “Working hours.” The column “Working hours productive” is filled with the weekly number of working hours of each VIB'er times the factor 0.80. This was done in consultation with the VIB'ers because about 20% of their working time is spent on other things like training and breaks etc. The column “Working hours of mutation reporting” is filled with the calculated hours of each VIB'er on processing permit-free mutations according to the neighbourhood distribution (for calculation see tables 5 and 6). Furthermore, the hours in the column “Consultation work hours” represent the weekly number of hours of consultation/meetings, e.g. every Monday morning there is a consultation with only the VIB'ers and every Monday afternoon a consultation with the entire department.

In addition to these columns with numbers that are fixed and do not change (weekly), there are also the columns “Work hours picked up” and “Work hours remaining.” These numbers in these columns are dynamic and therefore can change all the time. The numbers that appear in the “Work hours picked up” column are the number of hours spent processing permit-required mutations and/or other measurement tasks picked up by the VIB'ers. These times are based on the process times calculated in section 5.2 and shown in tables 7 through 11. The “Work hours remaining” column shows the remaining number of work hours for each VIB'er. This number of hours for each VIB'er depends on the following formula:

$$\text{Productive work hours per week} - \text{work hours mutation signalization} - \text{work hours consultation} - \text{work hours picked up}$$

The tool thus provides insight into which VIB'er has the least/most time to pick up a permit-free mutation/other measurement task and thus these can be distributed fairly. To gain insight into which permit-required mutations and other measurement tasks are received, it is important that the tool is “fed” with new requests by placing incoming permit-required mutations and other measurement tasks in the column “Incoming requests”. In the columns next to it, a VIB'ers name can be selected and it can be selected whether the picked up application has already been completed or not.

### 5.3.2 Implementation

To effectively implement the process models and the tool, the VIB'ers of the GEO team will have to take a number of things into account. Therefore, an implementation plan has been written for the VIB'ers explaining how the tool was developed, what design choices were made, and how the tool can be implemented in practice. This implementation plan can be found in Appendix A3.

## 5.4 Takeaway

A great deal of information was provided in Chapter 5, with several sub-questions being answered. First, the following sub-question has been answered in Section 5.1: *“What is important to consider when modelling the processes in EngageProcess?”*

This revealed that EngageProcess uses several icons to indicate process steps. All of these icons were defined based on information from an EngageProcess manual so that they could then be used in the process models of Subsection 5.2.

After answering the first sub-question, Subsection 5.2 continued to answer the next sub-question: *“What times can be assigned to each (version of each) process based on the input of the VIB’ers?”*

This question has been answered by attaching times to all processes in subsections 5.2.1 through 5.2.4. In section 5.2.1, this was done for permit-free mutations. This involved first looking at the ratio of premises mutations to other mutations that fell within the districts of each VIB'er. This ratio was so close for each neighbourhood share that the assumption was made that it was the same. Based on this assumption, it could be said that the number of (permit-free) property mutations relative to other (permit-free) mutations is the same for each VIB'er. However, the total numbers of permit-free mutations do vary greatly in the neighbourhood shares, so one VIB'er has to process more permit-free mutations than the other. To express this difference in time, the VIB'ers' time records in Microsoft OEPS were used. Using this system, the VIB'ers have been keeping track of their hours since a number of years. They distinguish between hours spent on “ Mutation signalization”, “Permit work”, “Measuring” or other umbrella terms. Since mutation signalization (permit-free mutations) does not require taking into account different types of mutations (due to the equal ratio just described for each VIB'er), these mutation signalization hours were used to calculate the average processing time for a permit-free mutation.

To arrive at this average processing time, a number of VIB'ers' total hours of mutation signalization from last year were divided by the number of permit-free mutations in their neighbourhood shares based on last year's aerial photo file. From this calculation came an average processing time of 16.4 minutes per permit-free mutation.

Using the numbers of permit-free mutations from this year's aerial photo files and the average processing time of 16.4 minutes, the total expected processing time for permit-free mutations in the neighbourhood share of each VIB'er was then calculated. Assuming that the VIB'ers work as fast as last year and that there are 48 working weeks in a year, this yielded the expected weekly number of hours spent by each VIB'ers processing permit-free mutations in their neighbourhoods.

Then in subsection 5.2.2 through 5.2.3, processing times were calculated for the permit-required mutations. To arrive at these times, four process models were used in which each process is represented with time links to each process step. A distinction was made between different mutation processes requiring a permit, namely: OVG new building, OVG minor renovation/medium-sized demolition, OVG major renovation/splitting/merging/medium-sized demolition and Demolition. Processing times were assigned to each of these four permitting mutation processes, using multiple process versions where appropriate.

Then, in subsection 5.2.4, the process model of the remaining measurement tasks is presented and time indications are given to the process steps of this process. This process is hereby divided into three versions to distinguish between assignments that take less/more time.

In table 12, all process times for a permit-free mutation, all permit-required mutations and the other measurement tasks are presented:

*Table 12: Overview of all process times*

<table>
<tr><th colspan="3">Type of application</th><th>Process time (min)</th></tr>
<tr><td colspan="3">Permit-free mutation</td><td>16.4</td></tr>
<tr><td rowspan="8">Permit-required mutation</td><td rowspan="3">OVG new building</td><td>No VBO</td><td>155</td></tr>
<tr><td>1 VBO</td><td>205</td></tr>
<tr><td>>1 VBO</td><td>205 + (15 per VBO)</td></tr>
<tr><td colspan="2">OVG minor renovation</td><td>100</td></tr>
<tr><td rowspan="3">OVG major renovation/ splitting/merging</td><td>Property changes and 1 VBO</td><td>55</td></tr>
<tr><td>No property changes and >1 VBO</td><td>55 + (5 per VBO)</td></tr>
<tr><td>Property changes and >1 VBO</td><td>165 + (5 per VBO)</td></tr>
<tr><td colspan="2">Demolition</td><td>25</td></tr>
<tr><td rowspan="3">Additional measurement task</td><td colspan="2">Measurement of finished property</td><td>140</td></tr>
<tr><td colspan="2">BGT-measurement of new situation</td><td>290</td></tr>
<tr><td colspan="2">Measurement of existing situation</td><td>360</td></tr>
</table>

That leaves answering the last sub-question of this chapter, namely: *"What are the key functionalities of the developed artifact, and how can it facilitate insight into work distribution for VIB'ers?"*

As for the main functionalities of the artifact created, it can be said that it allows VIB'ers to distribute incoming permit-required mutations and other measurement assignments among themselves. Moreover, the artifact can provide insight into how many hours of permit-required mutations and other measurement assignments each VIB'er has picked up. Together with the (calculated) fixed hours that each VIB'er spends on processing permit-free mutations, on consultation moments, and other matters such as breaks, in this way the hour distribution of each VIB'er can be tracked on a weekly basis.

# 6. Demonstration

In this demonstration chapter, the artifact will be used to solve the VIB'ers' problem. Using the process times obtained in Chapter 5 (for an overview of this, see Table 12), this chapter will demonstrate whether the tool can serve as a solution to the lack of transparency. In doing so, the tool will be used to try to gain insight into whether the current outsourcing of work is necessary or not. To demonstrate this, not only process times will be used, but also the frequencies of incoming permit-required mutations and other measurement orders will be investigated. This investigation of frequencies will be done in Section 6.1 and then in Section 6.2 it will be demonstrated how and if the tool can be used for a division of labour. Important to note in the demonstration of the tool is that the names shown in the tool's images are arbitrary and do not match the VIB'ers' real names.

The sub-question that will be answered at the end of this chapter is: *"Can the developed artifact provide insight into the necessity of the current work outsourcing practices?"*

## 6.1 Insight into workload

The problem of the VIB'ers in the GEO team is that there is currently no overview of the current processes and processing times. Because of this missing overview there is little to no transparency between the VIB'ers because they do not know (well) from each other what they are working on and how long it takes. This complicates the distribution of permit-required mutations and other measurement tasks and, as a result, measurement tasks are regularly outsourced.

To determine whether the tool provides the necessary insight into the work distribution of VIB'ers so that all work can be distributed as efficiently as possible without outsourcing, this Section examines whether workloads are higher or lower than capacity.

It became clear in Chapter 5 that the time a VIB'er has for processing permit-required mutations and other measurement tasks differs based on their weekly contract hours and the time they spend processing permit-free mutations (according to the neighbourhood distribution). This difference in the number of hours available for processing permit-required mutations and other measurement tasks, was previously shown in the "Work hours remaining" column of Figure 27 and will be shown again in table 13 below:

*Table 13: Number of weekly working hours per VIB'er for processing permit-required mutations and other measurement tasks*

| Piet | Kees | Willem | Anton | Bart | Dirk | Frank | Total |
|---|---|---|---|---|---|---|---|
| 8.6 | 11.0 | 18.6 | 20.7 | 18.4 | 7.4 | 16.5 | **101.2** |

To investigate whether the total of 101.2 weekly available hours is lower than the processing times of incoming permit-required mutations and measurement orders, it is important to get an understanding of the frequency in which each permit-required mutation and measurement order comes in each week. To get the frequencies of permit-required mutations and other measurement orders, the number of incoming applications for each type was measured over weeks 18 through 27 of this year. This was done by doing the following with one of the VIB'ers for each of these 10 weeks:

- Counting the numbers of each type of permit-required mutation received by the VIB'ers through CLO
- Counting the numbers of each type of other measurement orders received by the VIB'ers through the shared mailbox

This resulted into the following frequencies:

| Soort aanvraag | | Week 18 | Week 19 | Week 20 | Week 21 | Week 22 | Week 23 | Week 24 | Week 25 | Week 26 | Week 27 | Gemiddeld Wk 18 - 27 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OVG nieuwbouw | Geen VBO | 3 | 4 | 5 | 4 | 5 | 3 | 3 | 4 | 2 | 3 | **3,6** |
| | 1 VBO | 3 | 5 | 7 | 4 | 5 | 6 | 4 | 5 | 4 | 3 | **4,6** |
| | >1 VBO | 3 | 2 | 2 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | **2,1** |
| OVG Kleine verbouwing | | 7 | 8 | 6 | 8 | 10 | 6 | 7 | 9 | 7 | 6 | **7,4** |
| OVG Ingrijpende verbouwing/splitsen/ samenvoegen/sloop-melding middel | Geen pandwijzigingen en 1 nieuw VBO | 4 | 3 | 2 | 2 | 3 | 2 | 4 | 4 | 3 | 4 | **3,1** |
| | Geen pandwijzigingen en meerdere nieuwe VBO's | 3 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 2 | 3 | **2,7** |
| | Pandwijzigingen en meerdere nieuwe VBO's | 3 | 4 | 5 | 3 | 2 | 3 | 4 | 4 | 3 | 5 | **3,6** |
| Volledige sloop | | 5 | 6 | 4 | 6 | 3 | 4 | 5 | 4 | 2 | 4 | **4,3** |
| Inmeting gereedgemeld pand | | 2 | 0 | 2 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | **0,9** |
| BGT-meting nieuwe situatie | | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 1 | **1** |
| Meting bestaande situatie | | 2 | 2 | 1 | 3 | 2 | 1 | 2 | 1 | 1 | 2 | **1,7** |

*Figure 28: Frequencies permit-required mutations and additional measurement tasks*

Then by multiplying the averages for each type of application by the process time for each type of application and adding the results together, the average number of hours of permit-required mutations and other measurement assignments per week can be found .

In total, an average number of 93.55 hours of permit-required mutations and other measurement assignments per week was arrived at over these ten weeks. As shown in Table 13, a sum of the available hours numbers gives a number of 101.2 hours. So based on the productive hours of each VIB'er, the hours a VIB'er spends on average on mutation signalization, the hours on consultation moments and the hours on permit-required mutations/other measurement tasks, it can be said that the VIB'ers have an average of 101.2 - 93.55 = 7.65 hours left per week.

To examine whether there were no weeks in the period from week 18 to week 27 in which more than the capacity of 101.2 hours came in, the processing time of incoming permit-required mutations and measurement tasks was also calculated separately for each week. These processing times of incoming permit-required mutations and other measurement orders from each of the 10 weeks, are shown below in Figure 29:

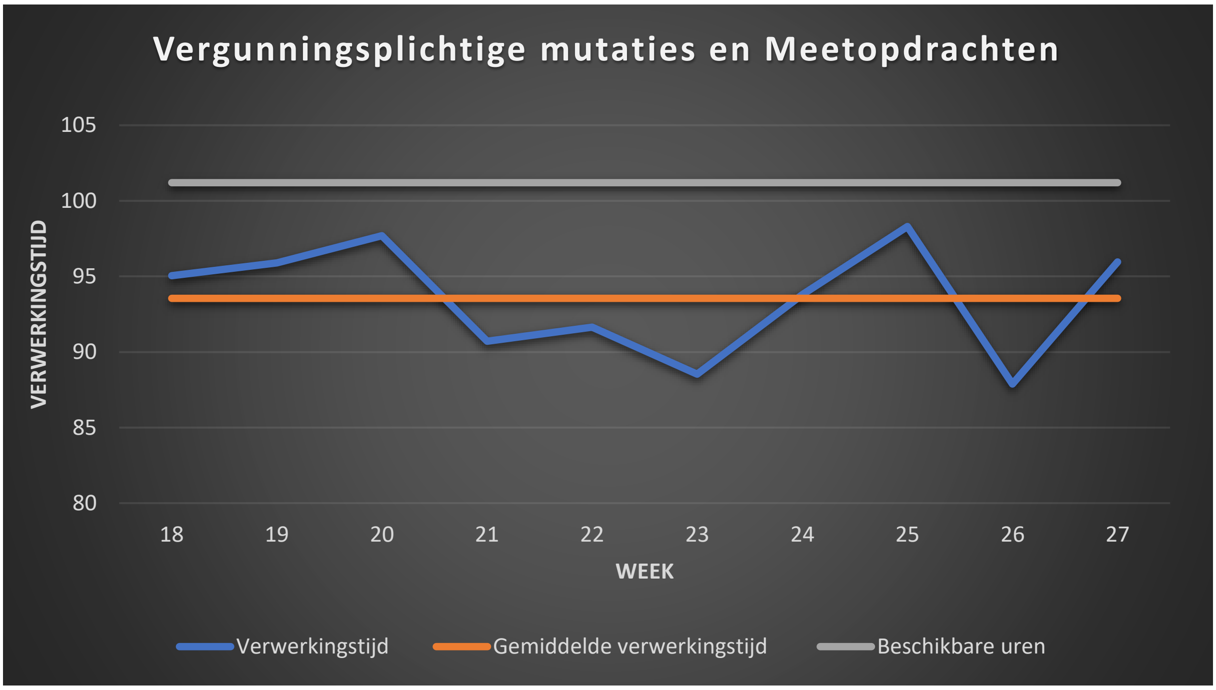



*Figure 29: Weekly processing times permit-required mutations and additional measurement tasks VS capacity*

Figure 29 shows that in none of the weeks 18 - 27 was the capacity of 101.2 hours exceeded. However, in a number of weeks the total processing time of permit-required mutations and measurement orders does come close to this limit. For example, in week 20 this number of hours is 97.7 and in week 25 it is 98.3 hours. Thus, although the number of hours over the measured period is very close to capacity on a number of occasions, it has not exceeded it. This means that, based on the calculated process times from this study and the number of incoming mutations, if the work were properly distributed, no outsourcing of work would have been necessary over these ten weeks.

## 6.2 Tool as a solution to the problem

This section will demonstrate how the tool can be used for the (weekly) distribution of incoming permit-required mutations and other measurement tasks. This demonstration will be done using the incoming applications of week 25 (for the numbers of each type see table TABLENR). In the measured 10-week period, the total time required to process mutations in this 25th week was closest to capacity. Distributing incoming requests to VIB'ers through the tool can prevent overwork and outsourcing, the demonstration in this section will show this.

In the first sheet of the tool ("Overview"), the incoming work will need to be placed under the "Incoming Requests" column. Here the title of the request and/or the request number of the request can be copied to the cells in this column. Without considering the order in which applications were received and the actual application numbers, this will look like figure 30 for the applications of week 25[5]:

| Binnengekomen aanvragen | Opgepakt door | Afgerond |
|---|---|---|
| OVG nieuwbouw zonder VBO [ ] | | |
| OVG nieuwbouw zonder VBO [ ] | | |
| OVG nieuwbouw zonder VBO [ ] | | |
| OVG nieuwbouw zonder VBO [ ] | | |
| OVG nieuwbouw 1 VBO [ ] | | |
| OVG nieuwbouw 1 VBO [ ] | | |
| OVG nieuwbouw 1 VBO [ ] | | |
| OVG nieuwbouw 1 VBO [ ] | | |
| OVG nieuwbouw 1 VBO [ ] | | |
| OVG nieuwbouw >1 VBO [ ] | | |
| OVG nieuwbouw >1 VBO [ ] | | |
| OVG kleine verbouwing [ ] | | |
| OVG kleine verbouwing [ ] | | |
| OVG kleine verbouwing [ ] | | |
| OVG kleine verbouwing [ ] | | |
| OVG kleine verbouwing [ ] | | |
| OVG kleine verbouwing [ ] | | |
| OVG kleine verbouwing [ ] | | |
| OVG kleine verbouwing [ ] | | |
| OVG kleine verbouwing [ ] | | |
| OVG Ingrijpende verbouw GPW en 1 VBO [ ] | | |
| OVG Ingrijpende verbouw GPW en 1 VBO [ ] | | |
| OVG Ingrijpende verbouw GPW en 1 VBO [ ] | | |
| OVG Ingrijpende verbouw GPW en 1 VBO [ ] | | |
| OVG Ingrijpende verbouw GPW en >1 VBO [ ] | | |
| OVG Ingrijpende verbouw GPW en >1 VBO [ ] | | |
| OVG Ingrijpende verbouw GPW en >1 VBO [ ] | | |
| OVG Ingrijpende verbouw GPW en >1 VBO [ ] | | |
| OVG Ingrijpende verbouw PW en >1 VBO [ ] | | |
| OVG Ingrijpende verbouw PW en >1 VBO [ ] | | |
| OVG Ingrijpende verbouw PW en >1 VBO [ ] | | |
| OVG Ingrijpende verbouw PW en >1 VBO [ ] | | |
| Volledige sloop [ ] | | |
| Volledige sloop [ ] | | |
| Volledige sloop [ ] | | |
| Volledige sloop [ ] | | |
| BGT-meting nieuwe situatie | | |
| BGT-meting nieuwe situatie | | |
| Meting bestaande situatie | | |

*Figure 30: Distribution of incoming applications*

[5] Between the [ ] after each request is now nothing, but here a VIB'er can put the document's request number

Once applications are listed under the column “Incoming applications”, VIB'ers can select their name in the cell next to an application, under the column “Picked up by”, from a drop-down menu containing the seven names. Furthermore, in the “Completed” column, VIB'ers can select yes or no from another drop-down menu, indicating whether they have already completed the application they picked up. In case Kees picks up the top application this will look like figure 31:

| Binnengekomen aanvragen | Opgepakt door | Afgerond |
|---|---|---|
| OVG nieuwbouw zonder VBO [ ] | Kees | Nee |

*Figure 31: Picking up incoming application*

Next, Kees must enter the selected application in the menu at the top of the “Overview” sheet, in this case this will look like this:

| | Wat is je naam? | Wat voor OVG/melding pak je op? | Wat voor versie aanvraag is het? | *Alleen beantwoorden bij Ingrijpende verbouwing of Sloopmelding Middel* | Maak menu leeg |
|---|---|---|---|---|---|
| **Beantwoord de vragen in de cellen hiernaast en druk vervolgens op de knop "Inplannen"** | Kees | Nieuwbouw | Geen VBO | | **Inplannen** |

*Figure 32: Menu selection of incoming application*

Next, Kees presses the “Schedule” button (see bottom right in Figure 32). After Kees has pressed this button the process time that belongs to this specific request is retrieved from the sheet “Process times”. How exactly this sheet works and looks is described in detail in the implementation plan in Appendix A3 and will therefore not be discussed here.
Then, on the sheet “Overview” a number of things change. An image of how the sheet looks after Kees presses the “Schedule” button is shown in figure 33 below:

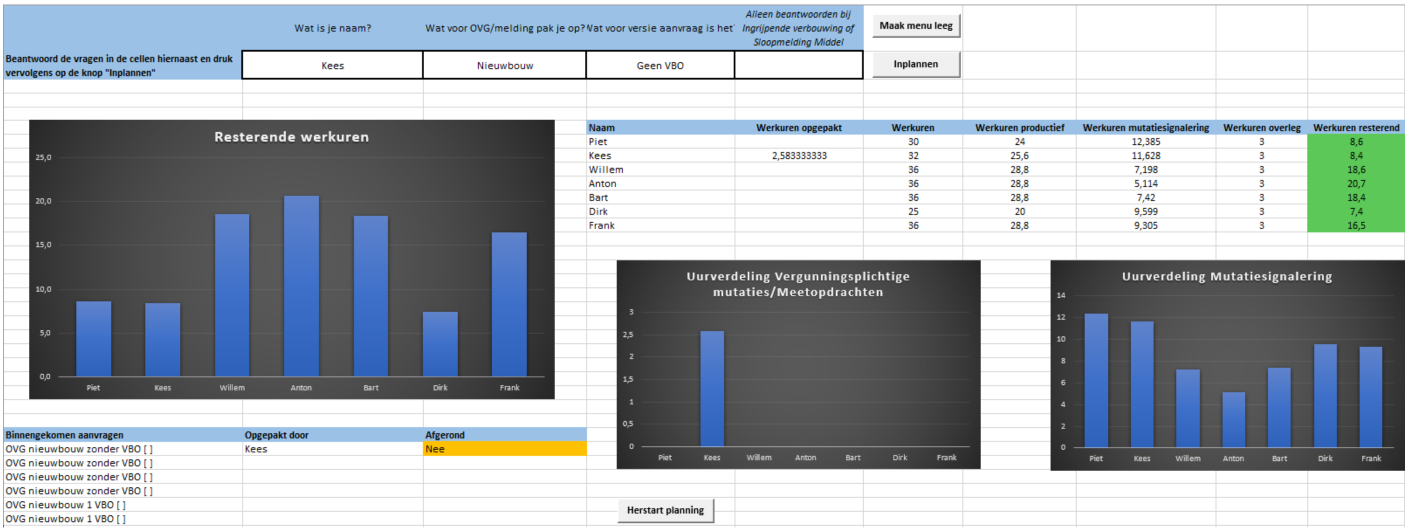


*Figure 33: Overview sheet tool after submitting an application*

As shown in Figure 33, in the column “Work hours picked up” and in the middle diagram there is now a process time by the name Kees, this is the process time of the application picked up by Kees. Furthermore, his remaining work hours number under the column “Work hours remaining” and in the large diagram on the left has decreased with the process time of the picked up request.

By similarly distributing all applications under the “Incoming Applications” column to the VIB'ers, insight can be created into the distribution of work and whether overtime/outsourcing is needed to get everything completed. Figure 34 shows what the “Overview” sheet looks like when all requests under the “Incoming Applications” column (i.e., all requests from week 25) are divided among the VIB'ers.

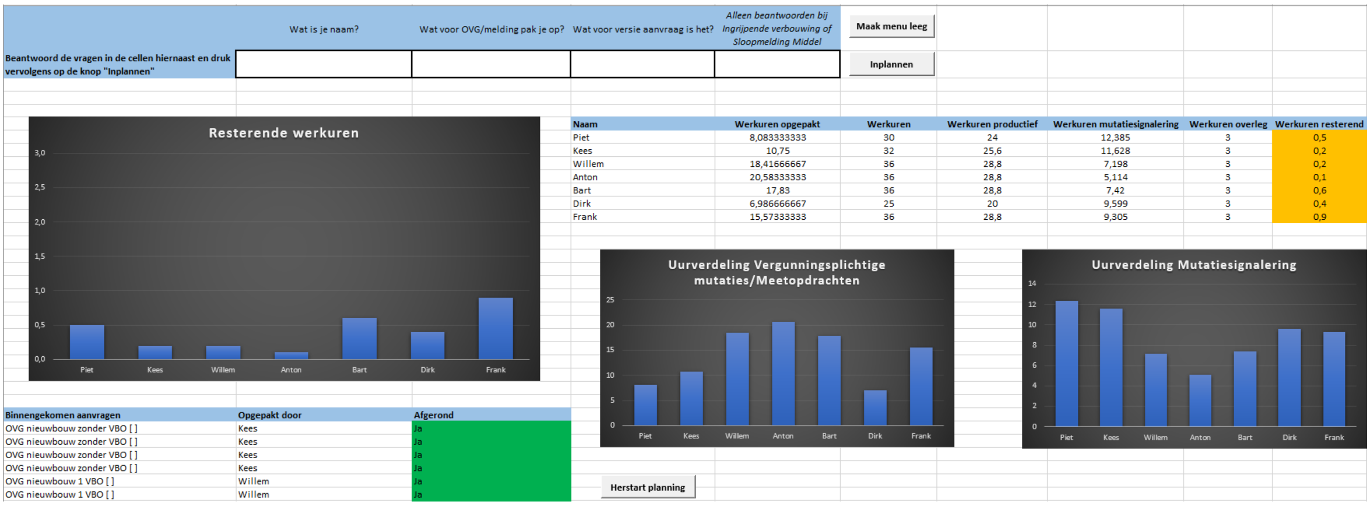



*Figure 34: Overview sheet after submitting all applications of week 25*

All the requests of week 25 are distributed among the VIB'ers in Figure 34 and in the sheet “Overview” it can now be seen that under the column “Work hours remaining” each VIB'ers has almost no hours left. When added together, these remaining hours amount to 2.9 hours and this is exactly the difference between the hours that the VIB'ers had available at the beginning of the week (101.2) and the total number of hours for mutations and other measurement assignments in week 25 (98.3). Thus, it can be said that using the identified processing times, the tool gives the insight that the permit-required mutations, permit-required mutations and other measurement assignments of week 25, although just barely at, are within capacity.

Finally, there is also the sheet “Analysis” which tracks how often each request is scheduled through the menu. In the current demonstration all applications of week 25 are processed, the analysis sheet of figure 35 below will therefore show the numbers of week 25 as they also appear in figure 28 [6].

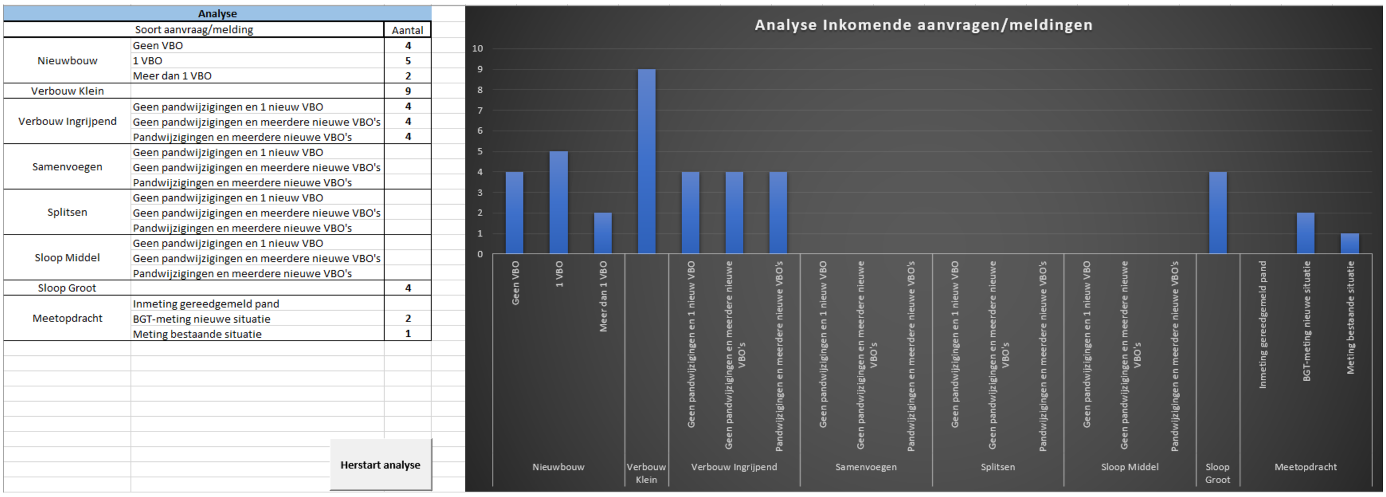



*Figure 35: Analysis sheet after submitting all applications of week 25*

[6] In the demonstration of this chapter, no distinction was made between major conversion, division, merger and demolition notification means, because the frequencies were not counted separately for each of these types. The reason is that these applications follow the same process steps and thus making a distinction would not have affected the process time, hence in figure 35 behind merging/splitting and middle-sized demolition is stated that the frequency is zero.

# 7. Evaluation

This chapter will evaluate the process models and tool created in this thesis. This evaluation will be used as validation for whether or not the requirements set forth in Chapter 3 of this thesis have been met. This will be done by sending the VIB'ers an evaluation form in which they are indirectly asked for their opinion on whether or not the set requirements have been met.

By the end of this Section, the next sub-question will have been answered:
*“What conclusions can be drawn from the results of a questionnaire completed by the VIB'ers asking about their views on whether or not the requirements set forth in Chapter 3 have been met?”*

A total of four VIB'ers completed the evaluation form, answering 6 questions each. In doing so, some of these questions addressed only one requirement and some of these questions addressed multiple requirements. The questions and the answers given will be addressed one at a time by first presenting the question each time, then a graphic representation of the answers, and finally evaluating on the answers given. Good to note here is that each time the VIB'ers were given a question where they could answer on a scale of 1 to 10 (where 1 was the worst possible and 10 was the best possible).

**Question 1**
The first question of the questionnaire was: *“To what extent do the process models correspond to the processes that you perform?”*

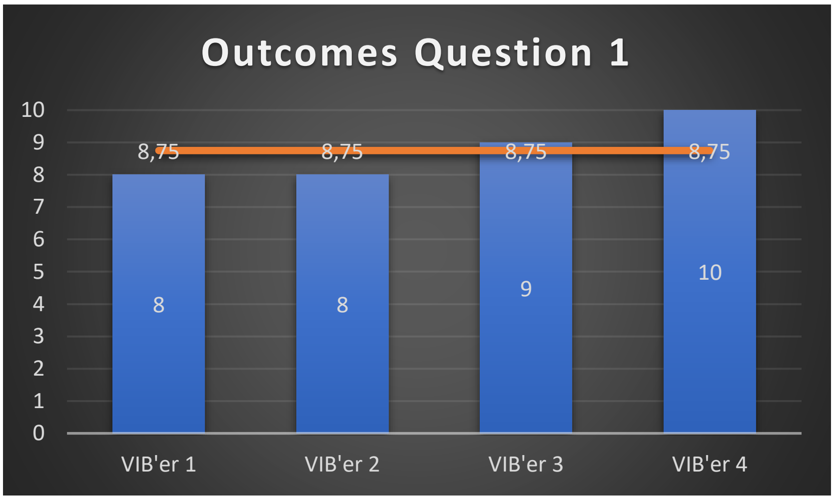



*Figure 36: Questionnaire - results question 1*

Based on the answers to question 1, it can be said that, according to the VIB'ers, the process models match the processes quite well. The range is between 8 and 10 and the average is a score of 8.75. This question relates to requirements 1 and 2 of the requirements list and thus it can be stated that these requirements have been met. In fact, these requirements are about writing out the processes and then modelling the processes. A possible cause of the fact that not every VIB'er gave the maximum score of 10 could be that the some small sub-steps in the process model were taken together in one process step.

**Question 2**
The second question of the questionnaire was: *“To what extent is the method used for obtaining process times and assigning process times to the process models accurate?”*

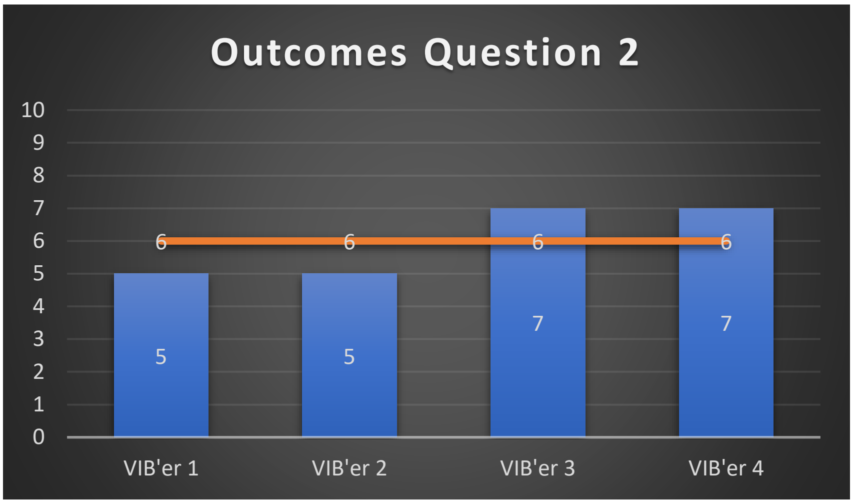



*Figure 37: Questionnaire - results question 2*

Based on the answers to question 2, it can be said that, according to the VIB'ers, the way of collecting process times is evaluated with a not so high mark. The range is between marks 5 and 7 and the average is at a score of 6.

This question relates to requirement 3 (and a little to requirement 4) and with the average score of 6 it could be said that the requirement has been met, but there is definitely a lot of room for improvement. The method used to obtain the process times: Expert Judgment, is questionable in terms of reliability. These doubts can be seen in the VIB'ers' answers. Therefore, this is also definitely a point that can be included in the further research Subsection of the next Chapter.

**Question 3**

The third question of the questionnaire was: *"To what extent does the tool provide an overview of your work?"*

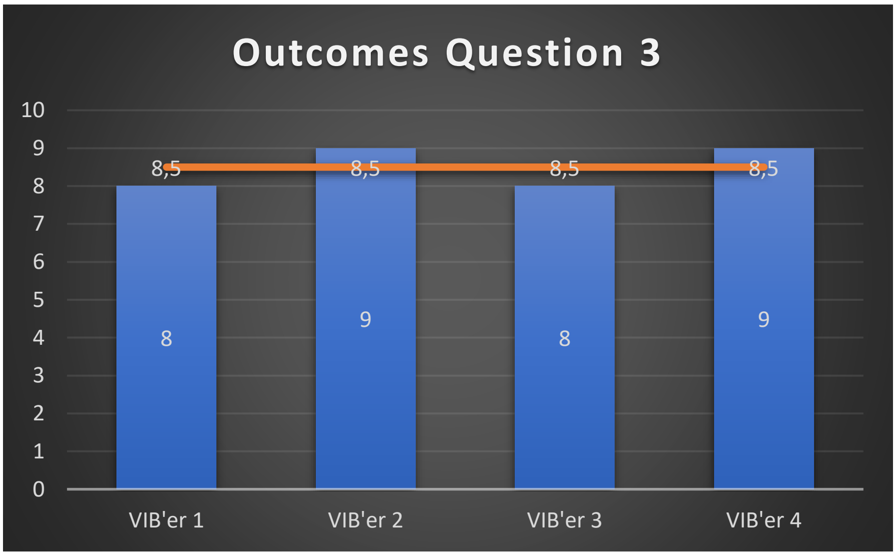



*Figure 38: Questionnaire - results question 3*

Based on the answers to question 3, it can be said that, according to the VIB'ers, the tool provides good insight into their work. The range is between 8 and 9 and the average is 8.5.

This question relates to one of the most important requirements, namely requirement 5. This requirement is about getting a digital overview of the VIB'ers' work/hours distribution. Despite the high rating, there is also room for improvement here. For example, in the current overview a new request has to be manually put into the Overview sheet of the Excel overview each time. If this could be done automatically, the VIB'ers would be continuously aware of the incoming work via the overview without having to do this manually.

**Question 4**

The fourth question of the questionnaire was: *"How user-friendly do you find the scheduling tool in Excel?"*

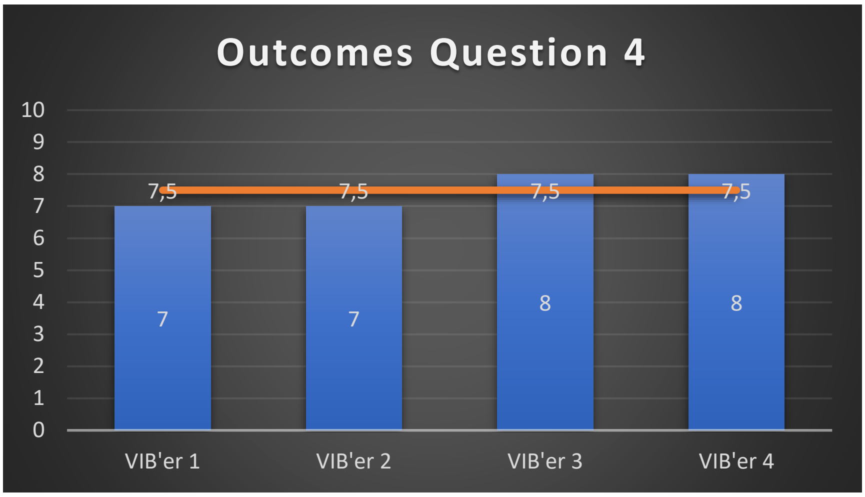



*Figure 39: Questionnaire - results question 4*

Based on the answers to question 4, it can be said that according to the VIB'ers, the tool scores well on user-friendliness. The range is between 7 and 8 and the average is 7.5.
This question relates to requirement 6. This requirement is about making sure the artifact created is easy for the VIB'ers to use and not based on software/systems that the VIB'ers are not familiar with. The score of 7.5 is fine but could obviously be better. Possible reasons for the score not being higher are the use of macros in Excel that the VIB'ers have not worked with before and working with a menu with many different options, which does not necessarily make the selection of an application very easy.

**Question 5**

The fifth question of the questionnaire was: *"To what extent can the tool help in doing analysis on the distribution of applications and on how much workload each application takes up?"*

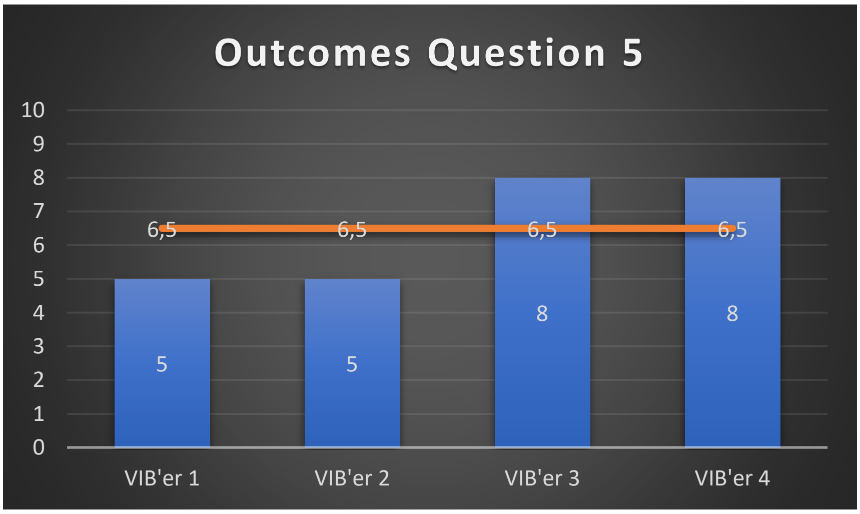



*Figure 40: Questionnaire - results question 5*

Based on the answers to question 5, it can be said that according to the VIB'ers, the tool scores reasonably well on the ability to do analysis on the numbers of requests. The range is quite wide, namely between 5 and 8 and the average is 6.5.
The reason for the wide range is probably due to the fact that although analysis can be done on the numbers through the analysis sheet, when the reset button ("Restart planning") is pressed, all data is lost. In order to collect data in the longer term and thus in large numbers, the data should actually be stored somewhere when the reset button is pressed. This is also something that could be included in the recommendations for further research. Furthermore, the option to also be able to budget using the tool is missing because currently no analysis is done on the salary costs of work hours, this is also something that can be included in the recommendations of the next chapter.

**Question 6**
The sixth question of the questionnaire was: *"To what extent do you think the planning tool in Excel could be of value?"*

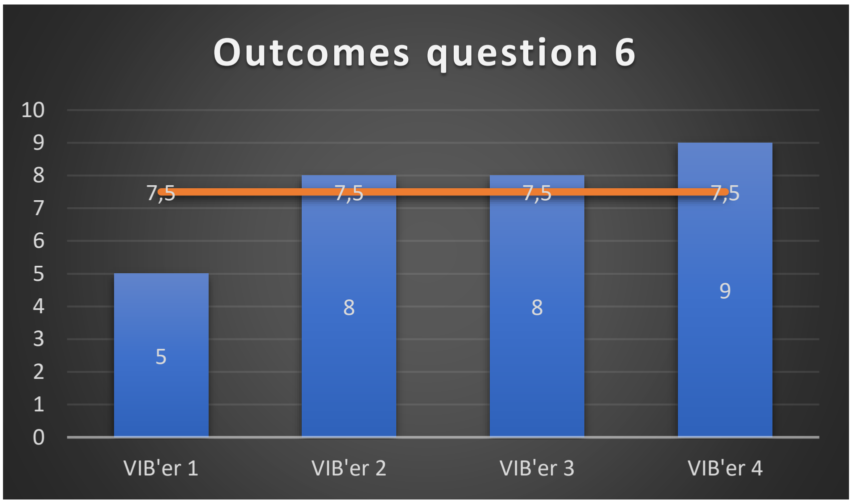



*Figure 41: Questionnaire - results question 6*

Based on the answers to question 6, it can be said that according to the VIB'ers, the tool generally scores well in terms of practicality. The range is wide, namely between 5 and 9 and the average is 7.5. This last question relates to multiple requirements and is thus overarching. The reason for the large variation in the score, is probably because a number of VIB'ers already indicated during the process that the process times of all mutations vary too far to use them for a workload estimation. A number of VIB'ers have come back to this and now rate the tool very well, however, some other VIB'ers maintain their position. Initially it also seemed very difficult to link process times to all mutations, but by initially distinguishing between the three categories of mutations/tasks and then also distinguishing between types of mutations within these categories, the linking of process times already became more specific. The distinction in process versions which was done next for some processes made the approach even more specific. This eventually led to all the different process times in which a number of VIB'ers do see potential. In order to convince other VIB'ers as well, more process distinctions and/or other ways of collecting process times could be examined. Both of these points will be included in the recommendations and further research Sections of the next Chapter.

# 8. Conclusions, Recommendations and Discussion

In this final chapter, the conducted research performed at the Municipality of Enschede is concluded. In order to do so, this Chapter is divided into multiple Sections. Section 8.1 will answer the main research question that was formulated in Section 1.3.1. Then Section 8.2 will discuss the recommendations for the Municipality of Enschede. In Section 8.3 the limitations of the research will be discussed. And finally Section 8.4 will go into further research that can be conducted at the Municipality of Enschede.

## 8.1 Conclusions

This Section will answer the main research question that was established based on the identified core problem. This core problem was "*No insights into the current work processes and their durations for the VIB'ers within the GEO-department*". To research this problem and arrive at solutions, the following main research question was drafted:

*"How can a process analysis create insight into mutation processing times to enhance transparency within the GEO-department of the Municipality of Enschede?"*

Through the problem-solving approach described in Section 1.3, various sub-questions have been addressed and answered to create an artifact to answer the main research question of this research. First of all, in the theoretical framework of Chapter 2, several ways to obtain process times and to utilize process times were reviewed. In addition to this literature about CAD and GIS-systems was reviewed. Using the problem statement from Section 1.2 and the main results from this theoretical framework, seven requirements were then drafted in Chapter 3, all following entirely the Requirements Engineering approach of Rehman et al. (2013). In short, this was the following set of requirements:

1. Written-out version of all processes;
2. Process models of all processes;
3. Time linkage to process models;
4. Link between calculated process times and incoming requests;
5. Creating overview for work/hour distribution VIB'ers (artifact);
6. User-friendly artifact, i.e. use of software/systems with which VIB'ers are familiar;
7. Analysis capability artifact related to numbers of incoming applications;

Based on the above set of requirements, a comprehensive context analysis was then continued in Chapter 4. All processes of the three categories - permit-free mutations, permit-required mutations and other measurement tasks - were written out in detail, with special attention to the differences and similarities of mutations within the same category. Within the category of permit-free mutations, the only thing that came out of this was the mutation signalization process in which annual aerial photos are provided with coloured alignments of permit-free mutations. With regard to permit-required mutations, a distinction was initially made between a new building application, a renovation, a splitting/merging and a demolition. However, while writing out these processes, the differences in process between a small and large renovation and a small, medium and complete demolition were discovered. These differences, combined with some patterns, led to the identification of the following four permit-required mutation processes: OVG new building, OVG minor renovation/medium-sized demolition, OVG major renovation/splitting/merging/medium-sized demolition and Demolition.

Finally, within the category of other measurement tasks, only one process was identified, namely incoming tasks through the shared email address.

Next, the six different processes written out in Chapter 5 were divided into four process models. Times were then assigned to the process steps of each process in these process models. Several ways to obtain process times were found in the theoretical framework of Chapter 2. Two of these ways, in consultation with stakeholders and based on prioritization, were included in the requirements list of Chapter 3. The first way was based on literature by De Murillas et al. (2015) that emphasized that so-called Redo logs in databases track processing times. However, no such Redo logs could be detected in the VIB'ers' databases, only a “Start editing time” could be found. Subsequently it was proceeded with another way to identify process times, namely Expert Judgment as described by Meyer and Booker (2001). For this, one of the three techniques of Expert Judgment was used to obtain process times: group sessions. In a group session with all VIB'ers, the process steps of each process were gone through in order to first distinguish process versions for a number of processes and then assign a process time to all process steps of each process (version). From this a total process time was calculated for five of the just named six identified processes (and where necessary process versions).

Only for the permit-free mutation process was processing times arrived at in a different way. These permit-free mutations are currently not distributed like all other applications on the basis of who has time, but distributed according to a neighbourhood distribution. Here, aerial photo files with coloured alignments indicate permit-free mutations from each past year. Each VIB'er then knows by the neighbourhood distribution how many permit-free mutations to process. For this process, it was discovered that VIB'ers track their hours in a simple spreadsheet program Microsoft OEPS. Then by dividing the number of hours VIB'ers took last year to process permit-free mutations in their neighbourhoods by the number of permit-free mutations that were in each VIB'er's neighbourhood share last year, an average processing time of 16.4 minutes per mutation was arrived at for this process.

Finally, in Chapter 6, using the artifact created in Microsoft Excel and the times obtained from Chapter 5, it was examined whether there was under- or overcapacity over a ten-week period, and thus whether it was necessary to outsource work during this period. This was done by comparing the total number of weekly available hours of all VIB'ers for processing permit-required mutations and other measurement tasks with the expected total number of incoming work hours for this processing.

Here the total number of weekly available hours of all VIB'ers could be calculated by taking into account their weekly number of productive hours, working hours on permit-free mutations, and working hours on consultations. To calculate the number of productive weekly working hours of all VIB'ers, this involved multiplying the weekly number of working hours of each VIB'er by a factor of 0.80. To calculate the weekly number of work hours of permit-free mutations, the average processing time of 16.4 minutes for all VIB'ers was multiplied by the number of permit-free mutations within the neighbourhood shares of each VIB'er for this year.
In this way, the formula below was arrived at:

$$Productive\ work\ hours\ per\ week\ -\ work\ hours\ mutation\ signalization\ -$$
$$work\ hours\ consultation -\ work\ hours\ picked\ up$$

By completing this formula for each VIB'er in the manner just described and adding the answers together, a total number of weekly available hours of 101.2 for processing permit-required mutations and other measurement tasks was found. Then, for each of the ten weeks, the total number of incoming work hours for processing permit-required mutations and other measurement tasks was calculated by multiplying the total frequency of each type of permit-required mutation and measurement task by the corresponding process time.

From this, the week with the highest total number of hours came to a total of 98.3. Since this is lower than the available number of 101.2 hours, it can be concluded that no outsourcing was necessary over the measured period of ten weeks.

## 8.2 Recommendations

After conducting this research and creating the artifact, a number of recommendations can be made to the GEO team of the Municipality of Enschede. In this Subsection these recommendations will be given.

First, the possibility to track all the hours of the VIB'ers and to budget based on this data can be examined. For this it is important that after a restart of the planning (by pressing the reset button) the data is stored somewhere, now the data disappears as soon as the reset button is pressed.

Second, the processes could be further broken down into process versions. For example, where three versions are now used for the remaining measurement tasks, dividing them into even more versions would lead to more accurate approximations of the process times.

Finally, other options could be looked at for data visualization. In this study this overview was made with the program Microsoft Excel, but in a follow-up study programs with more advanced options could also be used.

## 8.3 Discussion

This Section will discuss the limitations of this study. The limitations are hereby divided into two Subsections. First, Subsection 8.3.1 will address data limitations and then Subsection 8.3.2 will address assumptions made in this thesis.

### 8.3.1 Data limitations

Regarding data, it is debatable how reliable the process times are. Initially the desire was to obtain process times through Redo logs: files in databases that keep track of editing times. However, only a “Start editing time” could be found in the databases in terms of timestamps, so this way could not be used to obtain process times. Therefore it was decided to obtain the process times by means of Expert Judgment, by discussing with the VIB'ers in a group session about the classification of the processes and the linking of process times. In this way, the expertise of the VIB'ers was used. However, it is debatable how reliable this way of collecting process times is. It can lead to unreliability for a number of reasons. First, peer pressure may play a role. For example, VIB'ers might feel uncomfortable assigning relatively high process times to process steps because they are afraid of how the others will react to them. Second, although the VIB'ers are experts in mutation processing and are most likely to be able to provide the most accurate time estimates, their input also remains qualitative. Finally, out of fear for their position, VIB'ers may link slower times to process steps than they actually take. Providing slower times will give a higher workload in the calculation of the total workload, thus making overcapacity less likely to occur.

Furthermore, the categorization of the processes of the additional measurement tasks distinguished between three versions of measurement tasks. This makes the time estimates for these measurement tasks much more accurate, but this could be even more accurate by dividing each of these three versions as well. For example, 360 minutes is now written out for a physical measurement of an existing situation, because these measurements are very large and often take hours. However, the VIB'ers told that these measurements can also be a lot shorter or longer. By linking categories to this in some way, this variation could also be included in the tool. For reasons of time, this has not been implemented in this study.

### 8.3.2 Assumptions

Two assumptions were made in this study, and these assumptions can both affect the reliability of this study. First, in calculating the total processing times of VIB'ers to permit-free mutations, an average processing time per mutation based on last year's data was assumed. This makes the assumption that VIB'ers are working as hard this year as they did last year.

Second, the calculation of the ratio of property mutations to other mutations assumes that it is the same for each VIB'er. This assumption was made because the differences in ratios among VIB'ers were very small and the study became a lot more complex without making this assumption.

## 8.4 Further research directions

In this research, an artifact was developed to provide the VIB'ers of the GEO team with a better overview of the work/hour distribution. It was found that this artifact can act as an overview for the VIB'ers' work distribution. However, improvements can still be made in other ways to solve the VIB'ers problem, some suggestions for further research directions will be given in this Section.

First, more ways to measure process times could be researched. One idea could be for VIB'ers to measure their own work times very accurately over a period of time. The more accurate the process times the more accurate the tool's estimate of whether or not outsourcing work is needed.

Second, follow-up research could be conducted on the work of the entire department. Whereas this study focused on the work of specifically the VIB'ers of the GEO team, a follow-up study could also focus on other specialists within the team.

Third, the possibility of integrating the BGT and BAG databases could be explored. During this study, the BGT and BAG were frequently discussed and much overlap between the two databases was noted. Currently, some changes are recorded in the BGT, some in the BAG and some in both the BGT and BAG. Using just the BGT, just the BAG or just another application that combines both would be much easier for VIB'ers. Side note here is that the municipality of Enschede cannot have its own policy in this, but is dependent on government policy.

Fourth, the link between smart documents and Key2BAG could also be looked at. Currently, brondocumenten are created via smartdocuments, but instead of the brondocumentnummer being copied directly from smartdocuments to Key2BAG, these brondocumentnummers first appear in Corsa.

Finally, further study could be made on how other departments of the municipality of Enschede operate within mutation processing processes. In many of the processes, the Permits Department plays a role in preparing and checking applications and the Building and Environment Enforcement Department in passing on notifications. Currently, these notifications from this department often do not come in, creating additional work for the VIB'ers. When the notifications do come in, the VIB'er receives them by mail and cannot use them directly as brondocumenten, improvements could also be made here.

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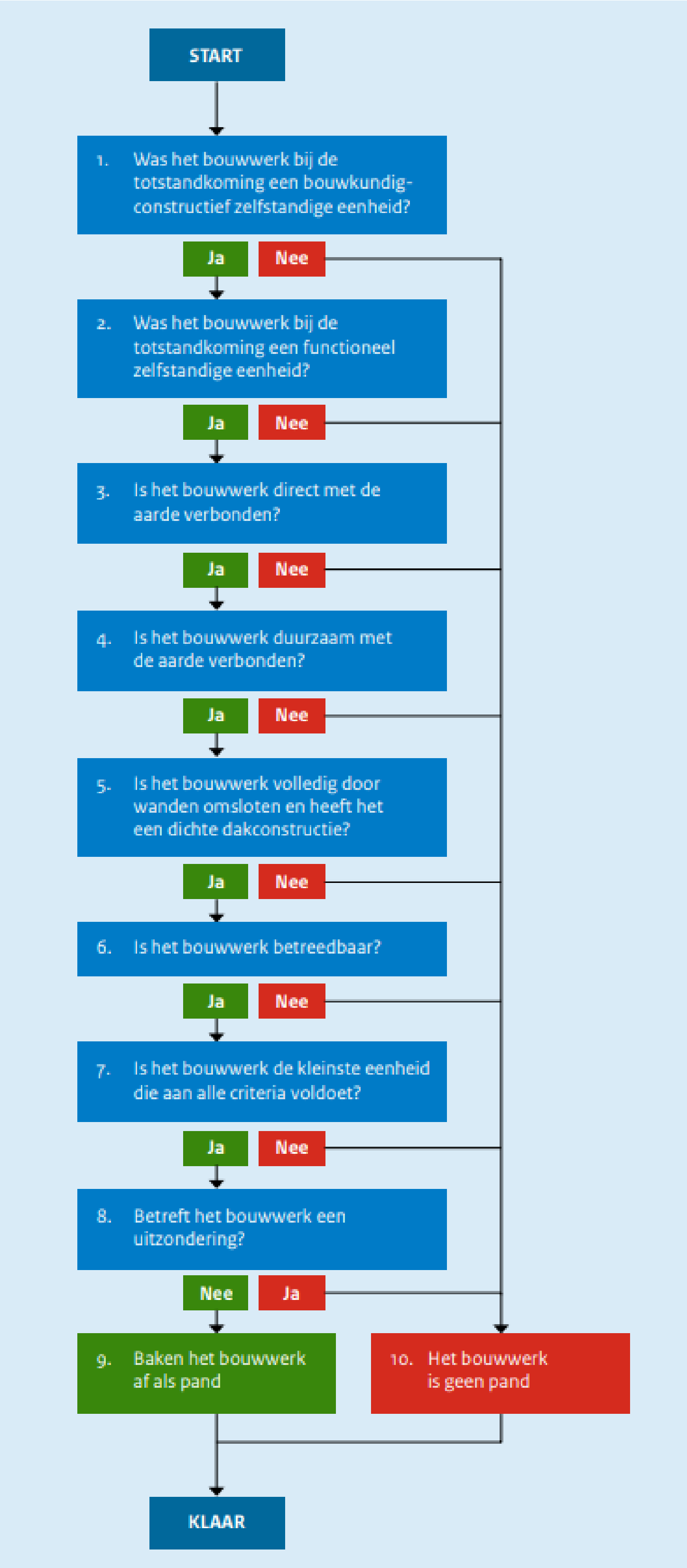
# Appendices

## Appendix A1 Decision tree for delineating properties




(Ministerie van Binnenlandse Zaken, 2018)

# Appendix A2 VBA-code Toolmenu

```
Sub FillCell()
    Dim ws As Worksheet
    Dim procestijdenWs As Worksheet
    Dim analyseWs As Worksheet
    Dim cell2 As Range
    Dim cell3 As Range
    Dim cell4 As Range
    Dim targetCell As Range
    Dim userInput As Variant
    Dim additionalValue As Double

    Set ws = ThisWorkbook.Sheets("Overzicht")
    Set procestijdenWs = ThisWorkbook.Sheets("Procestijden")
    Set analyseWs = ThisWorkbook.Sheets("Analyse")
    Set cell2 = ws.Range("C2")
    Set cell3 = ws.Range("D2")
    Set cell4 = ws.Range("E2")

    Select Case selectedName
        Case "John"
            Set targetCell = ws.Range("E7")
        Case "Niek"
            Set targetCell = ws.Range("E8")
        Case "Albert Jan"
            Set targetCell = ws.Range("E9")
        Case "Okke"
            Set targetCell = ws.Range("E10")
        Case "Dennis"
            Set targetCell = ws.Range("E11")
        Case "Sjoerd"
            Set targetCell = ws.Range("E12")
        Case "Niels"
            Set targetCell = ws.Range("E13")
        Case Else
            MsgBox "Maak een keuze in het eerste menu.", vbExclamation
            Exit Sub
    End Select

    Select Case cell2.Value
        Case "Nieuwbouw"
            Select Case cell3.Value
                Case "Geen VBO"
                    targetCell.Value = targetCell.Value + procestijdenWs.Range("E2").Value
                    analyseWs.Range("C3").Value = analyseWs.Range("C3").Value + 1
                Case "1 VBO"
                    targetCell.Value = targetCell.Value + procestijdenWs.Range("E3").Value
                    analyseWs.Range("C4").Value = analyseWs.Range("C4").Value + 1
                Case "Meer dan 1 VBO"
                    userInput = InputBox("Voer hieronder het aantal VBO's in:", "Aanvullende waarde")
                    If IsNumeric(userInput) Then
                        additionalValue = CDbl(userInput) * 0.25
                        targetCell.Value = targetCell.Value + additionalValue + procestijdenWs.Range("E4").Value
                        analyseWs.Range("C5").Value = analyseWs.Range("C5").Value + 1
                    Else
                        MsgBox "Ongeldige invoer. Voer een numerieke waarde in.", vbExclamation
                    End If
                Case Else
                    MsgBox "Je hebt nieuwbouw geselecteerd, maak nu een keuze in het derde menu.", vbExclamation
                    Exit Sub
            End Select

        Case "Verbouw"
            Select Case cell3.Value
                Case "Klein"
                    targetCell.Value = targetCell.Value + procestijdenWs.Range("E5").Value
                    analyseWs.Range("C6").Value = analyseWs.Range("C6").Value + 1
                Case "Ingrijpend"
                    Select Case cell4.Value
                        Case "Geen pandwijzigingen en 1 nieuw VBO"
                            targetCell.Value = targetCell.Value + procestijdenWs.Range("E6").Value
                            analyseWs.Range("C7").Value = analyseWs.Range("C7").Value + 1
                        Case "Geen pandwijzigingen en meerdere nieuwe VBO's"
                            userInput = InputBox("Voer hieronder het aantal VBO's in:", "Aanvullende waarde")
                            If IsNumeric(userInput) Then
                                additionalValue = CDbl(userInput) * 0.083
                                targetCell.Value = targetCell.Value + additionalValue + procestijdenWs.Range("E7").Value
                                analyseWs.Range("C8").Value = analyseWs.Range("C8").Value + 1
                            Else
                                MsgBox "Ongeldige invoer. Voer een numerieke waarde in.", vbExclamation
                            End If
                        Case "Pandwijzigingen en meerdere nieuwe VBO's"
                            userInput = InputBox("Voer hieronder het aantal VBO's in:", "Aanvullende waarde")
                            If IsNumeric(userInput) Then
                                additionalValue = CDbl(userInput) * 0.083
                                targetCell.Value = targetCell.Value + additionalValue + procestijdenWs.Range("E8").Value
                                analyseWs.Range("C9").Value = analyseWs.Range("C9").Value + 1
                            Else
                                MsgBox "Ongeldige invoer. Voer een numerieke waarde in.", vbExclamation
                            End If
                        Case Else
                            MsgBox "Je hebt ingrijpende verbouwing geselecteerd, maak nu een keuze in het vierde menu.", vbExclamation
                            Exit Sub
                    End Select
                Case Else
                    MsgBox "Je hebt verbouwen geselecteerd, maak nu een keuze in het derde menu.", vbExclamation
                    Exit Sub
            End Select
```

```
        Case "Splitsen"
            Select Case cell3.Value
                Case "Geen pandwijzigingen en 1 nieuw VBO"
                    targetCell.Value = targetCell.Value + procestijdenWs.Range("E6").Value
                    analyseWs.Range("C13").Value = analyseWs.Range("C13").Value + 1
                Case "Geen pandwijzigingen en meerdere nieuwe VBO's"
                    userInput = InputBox("Voer hieronder het aantal VBO's in:", "Aanvullende waarde")
                    If IsNumeric(userInput) Then
                        additionalValue = CDbl(userInput) * 0.083
                        targetCell.Value = targetCell.Value + additionalValue + procestijdenWs.Range("E7").Value
                        analyseWs.Range("C14").Value = analyseWs.Range("C14").Value + 1
                    Else
                        MsgBox "Ongeldige invoer. Voer een numerieke waarde in.", vbExclamation
                    End If
                Case "Pandwijzigingen en meerdere nieuwe VBO's"
                    userInput = InputBox("Voer hieronder het aantal VBO's in:", "Aanvullende waarde")
                    If IsNumeric(userInput) Then
                        additionalValue = CDbl(userInput) * 0.083
                        targetCell.Value = targetCell.Value + additionalValue + procestijdenWs.Range("E8").Value
                        analyseWs.Range("C15").Value = analyseWs.Range("C15").Value + 1
                    Else
                        MsgBox "Ongeldige invoer. Voer een numerieke waarde in.", vbExclamation
                    End If
                Case Else
                    MsgBox "Je hebt splitsen geselecteerd, maak nu een keuze in het derde menu.", vbExclamation
                    Exit Sub
            End Select

        Case "Samenvoegen"
            Select Case cell3.Value
                Case "Geen pandwijzigingen en 1 nieuw VBO"
                    targetCell.Value = targetCell.Value + procestijdenWs.Range("E6").Value
                    analyseWs.Range("C10").Value = analyseWs.Range("C10").Value + 1
                Case "Geen pandwijzigingen en meerdere nieuwe VBO's"
                    userInput = InputBox("Voer hieronder het aantal VBO's in:", "Aanvullende waarde")
                    If IsNumeric(userInput) Then
                        additionalValue = CDbl(userInput) * 0.083
                        targetCell.Value = targetCell.Value + additionalValue + procestijdenWs.Range("E7").Value
                        analyseWs.Range("C11").Value = analyseWs.Range("C11").Value + 1
                    Else
                        MsgBox "Ongeldige invoer. Voer een numerieke waarde in.", vbExclamation
                    End If
                Case "Pandwijzigingen en meerdere nieuwe VBO's"
                    userInput = InputBox("Voer hieronder het aantal VBO's in:", "Aanvullende waarde")
                    If IsNumeric(userInput) Then
                        additionalValue = CDbl(userInput) * 0.083
                        targetCell.Value = targetCell.Value + additionalValue + procestijdenWs.Range("E8").Value
                        analyseWs.Range("C12").Value = analyseWs.Range("C12").Value + 1
                    Else
                        MsgBox "Ongeldige invoer. Voer een numerieke waarde in.", vbExclamation
                    End If
                Case Else
                    MsgBox "Je hebt samenvoegen geselecteerd, maak nu een keuze in het derde menu.", vbExclamation
                    Exit Sub
            End Select

        Case "Sloop"
            Select Case cell3.Value
                Case "Middel"
                    Select Case cell4.Value
                        Case "Geen pandwijzigingen en 1 nieuw VBO"
                            targetCell.Value = targetCell.Value + procestijdenWs.Range("E6").Value
                            analyseWs.Range("C16").Value = analyseWs.Range("C16").Value + 1
                        Case "Geen pandwijzigingen en meerdere nieuwe VBO's"
                            userInput = InputBox("Voer hieronder het aantal VBO's in:", "Aanvullende waarde")
                            If IsNumeric(userInput) Then
                                additionalValue = CDbl(userInput) * 0.25
                                targetCell.Value = targetCell.Value + additionalValue + procestijdenWs.Range("E7").Value
                                analyseWs.Range("C17").Value = analyseWs.Range("C17").Value + 1
                            Else
                                MsgBox "Ongeldige invoer. Voer een numerieke waarde in.", vbExclamation
                            End If
                        Case "Pandwijzigingen en meerdere nieuwe VBO's"
                            userInput = InputBox("Voer hieronder het aantal VBO's in:", "Aanvullende waarde")
                            If IsNumeric(userInput) Then
                                additionalValue = CDbl(userInput) * 0.25
                                targetCell.Value = targetCell.Value + additionalValue + procestijdenWs.Range("E8").Value
                                analyseWs.Range("C18").Value = analyseWs.Range("C18").Value + 1
                            Else
                                MsgBox "Ongeldige invoer. Voer een numerieke waarde in.", vbExclamation
                            End If
                        Case Else
                            MsgBox "Je hebt middelgrote sloop geselecteerd, maak nu een keuze in het vierde menu.", vbExclamation
                            Exit Sub
                    End Select
                Case "Groot"
                    targetCell.Value = targetCell.Value + procestijdenWs.Range("E9").Value
                    analyseWs.Range("C19").Value = analyseWs.Range("C19").Value + 1
                Case Else
                    MsgBox "Je hebt grote sloop geselecteerd, rond je selectie af door op de knop Inplannen te drukken.", vbExclamation
                    Exit Sub
            End Select

        Case "Meetopdracht"
            Select Case cell3.Value
                Case "Inmeting gereedgemeld pand"
                    targetCell.Value = targetCell.Value + procestijdenWs.Range("E10").Value
                    analyseWs.Range("C20").Value = analyseWs.Range("C20").Value + 1
                Case "BGT-meting nieuwe situatie"
                    targetCell.Value = targetCell.Value + procestijdenWs.Range("E11").Value
                    analyseWs.Range("C21").Value = analyseWs.Range("C21").Value + 1
                Case "Meting bestaande situatie"
                    targetCell.Value = targetCell.Value + procestijdenWs.Range("E12").Value
                    analyseWs.Range("C22").Value = analyseWs.Range("C22").Value + 1
                Case Else
                    MsgBox "Je hebt meetopdracht geselecteerd, maak nu een keuze in het derde menu.", vbExclamation
                    Exit Sub
            End Select

        Case Else
            MsgBox "Je hebt je naam geselecteerd, maak nu een keuze in het tweede menu.", vbExclamation
            Exit Sub
    End Select
End Sub
```

## Appendix A3 Implementation plan Tool

First, the software used to create the tool. The tool was created in Microsoft Excel by using Visual Basic for Applications (VBA), VBA being the coding function in Excel. There are a number of reasons for choosing Excel. First, Microsoft Excel is not a new program for the VIB'ers because the GEO team already works with Microsoft software. Using Microsoft Excel will not lead to the need to download new software and will not incur additional costs such as buying a license. Second, from the modeling program used, EngageProcess, process times can be exported to Excel. This makes integrating (changed) process times into the tool very easy. Third, there is the added advantage that the tool can be used in Excel as a shared file. This makes it possible for the VIB'ers themselves to make changes in the tool and at the same time see the changes of the other VIB'ers.

However, in order to use the file shared, the VIB'ers must keep in mind that it is an Excel file with macros (i.e., an Excel file with VBA code). Therefore, the file must be saved and shared with the extension '.xlsm' (Excel Macro-Enabled Workbook). For sharing, the collaboration tool Microsoft Teams is the most obvious, since it is already used by employees. Furthermore, each VIB'er must have the appropriate security settings in Excel to run macros, otherwise the VIB'ers cannot access the VBA code of the Excel document. The security settings can be adjusted in Excel under 'Options' > 'Trust Center' > 'Trust Center Settings' > 'Macro Settings' > 'Enable all macros'.

However, the VIB'ers may also choose to have one of them manage the tool. In this case, this administrator will have to keep the data in the tool up-to-date by, for example, subdividing the work using the tool in the weekly consultation meeting. The administrator in this case will have to be the one who subdivides the work, because otherwise work may be duplicated or not picked up. The disadvantage of this option is that not every VIB'er has continuous access to the division of work, which is the case when sharing the Excel file. Moreover, in this case the VIB'ers are highly dependent on the tool administrator, if he drops out due for example illness this can immediately lead to problems in the work distribution.

Regardless whether a shared file or a tool manager is chosen, it is important for the VIB'ers to know what design choices have been made and how the tool can be used. At the bottom left of figure 27, the tool must be “fed” with the incoming permit-required mutations coming in through CLO and new measurement tasks coming in through the shared email address. Important here is therefore that the request numbers/titles are copied from CLO/the shared email address and placed under the column “Incoming requests”. Then, to the right of the request number, in the cell of the “Picked up by” column, the name of the VIB'er who picks up the request can be selected. Finally, the “Completed” column for each application can indicate whether it has been completed or not.

It is therefore essential for the operation of the tool that new requests are placed under the column “Incoming requests”, here the VIB'ers must make clear agreements on who does this. You can choose that one VIB'er is responsible for this or that all VIB'ers arrange this together. However, the VIB'ers must take into account that in the current situation only three of the seven VIB'ers have access to the shared email address through which the measurement assignments are received, so (one of) these three VIB'ers will have to place the measurement assignments in the tool or all VIB'ers will have to gain access to this shared mailbox.

Furthermore, the top of Figure 27 shows a menu with four cells that need to be filled. The filling of this menu depends on the incoming requests and who picks them up. As soon as a VIB'er picks up a request by selecting his name in one of the cells under the “Picked up by” column, he will have to go through the menu. Here the VIB'er must fill in at least three cells using drop-down menus, the fourth cell must be filled in only in the case of a major renovation or medium-sized demolition notification.

Completing the menu begins for the VIB'er by selecting his own name from the seven options in the leftmost white cell. Then, in the second white cell, the VIB'er enters the type of OVG or the type of notification. Here the VIB'er can choose from the following six options: new building, renovation, splitting, merging, demolition or measurement task. Depending on the choice the VIB'er makes in the second drop-down menu, the options in the third and, if applicable, fourth drop-down menu are determined.

The choice options in the third and, if applicable, fourth menus are based on the previously created process layouts with process versions (see table 14). Table 14 below shows all menu options based on these process layouts:

*Table 14: Menu options tool*

| Menu 2 | Menu 3 | Menu 4 |
|---|---|---|
| Nieuwbouw | • Geen VBO;<br>• 1 VBO;<br>• Meer dan 1 VBO | N.v.t. |
| Verbouw | • Klein<br>• Ingrijpend | • Geen pandwijzigingen en 1 nieuw VBO<br>• Geen pandwijzigingen en meerdere nieuwe VBO's<br>• Pandwijzigingen en meerdere nieuwe VBO's |
| Splitsen | • Geen pandwijzigingen en 1 nieuw VBO<br>• Geen pandwijzigingen en meerdere nieuwe VBO's<br>• Pandwijzigingen en meerdere nieuwe VBO's | N.v.t. |
| Samenvoegen | • Geen pandwijzigingen en 1 nieuw VBO<br>• Geen pandwijzigingen en meerdere nieuwe VBO's<br>• Pandwijzigingen en meerdere nieuwe VBO's | N.v.t. |
| Sloop | • Middel<br>• Groot | • Geen pandwijzigingen en 1 nieuw VBO<br>• Geen pandwijzigingen en meerdere nieuwe VBO's<br>• Pandwijzigingen en meerdere nieuwe VBO's |
| Meetopdracht | • Inmeting gereedgemeld pand<br>• BGT-meting nieuwe situatie<br>• Meting bestaande situatie | N.v.t. |

If in the third or fourth menu an option is chosen that contains more than 1 VBO, the VIB'er receives an additional question with how many new VBO's are involved in the application:

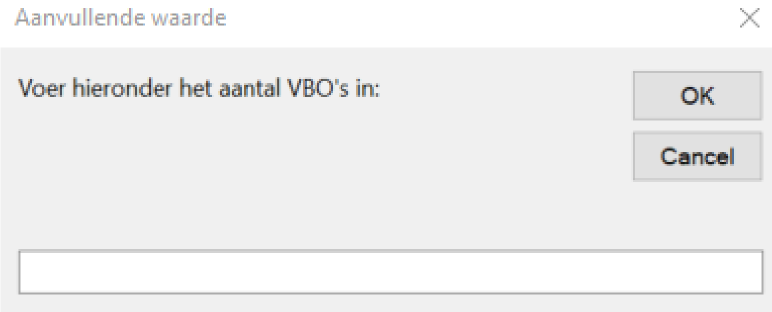



*Figure 42: Selection of amount of VBO's*

After entering the menu, the "Schedule" button can be pressed. When this button is pressed, a process time is retrieved from the worksheet "Process times" based on what type of process and version is entered in the menu. This worksheet looks like presented in figure 43:

| Soort aanvraag | | | Procestijd (min) | Procestijd (uren) |
|---|---|---|---|---|
| Vergunningsplichtige mutatie | OVG nieuwbouw | Geen VBO | 02:35:00 | 2,58 |
| | | 1 VBO | 03:25:00 | 3,42 |
| | | >1 VBO | 03:25:00 | 3,42 |
| | OVG Kleine verbouwing | | 01:40:00 | 1,67 |
| | OVG Ingrijpende verbouwing/splitsen/ samenvoegen/sloop-melding middel | Geen pandwijzigingen en 1 nieuw VBO | 00:55:00 | 0,92 |
| | | Geen pandwijzigingen en meerdere nieuwe VBO's | 00:55:00 | 0,92 |
| | | Pandwijzigingen en meerdere nieuwe VBO's | 02:45:00 | 2,75 |
| | Volledige sloop | | 00:25:00 | 0,42 |
| Overige meetopdrachten | Inmeting gereedgemeld pand | | 02:20:00 | 2,33 |
| | BGT-meting nieuwe situatie | | 04:50:00 | 4,83 |
| | Meting bestaande situatie | | 07:40:00 | 7,67 |
| Variabele procestijd per extra VBO bij nieuwbouw | 0,250 | | | |
| Variabele procestijd per extra VBO overig | 0,083 | | | |

*Figure 43: Process times worksheet tool*

On the left in this process times worksheet you see the processes shown according to the process classifications and each provided with a process time. Furthermore, at the bottom of Figure 43 you also see the variable process time for one additional VBO. This variable time differs for a VBO in the case of new building (0.250 hours) and for a VBO in the case of a major reconstruction/splitting/merging/demolition notification means (0.083). This difference exists because processing a new building VBO requires additional process steps (see time calculations in sections 5.2.2 and 5.2.3). The number of VBOs a VIB'er enters in the empty bar of Figure 42 is hereby multiplied by this processing time of a VBO and added from to the fixed time of the specific process.

The process times just named in Figure 43, are summations of the process step times of each (version of a) process (for the calculations of these, see section 5.2). By assigning to the models in EngageProcess the calculated times to process steps, these process step times can be exported from EngageProcess to Excel. The export of these processes in Excel contain lists of process step times as shown in figure 44 . Copying the lists of process times for each process under the corresponding column in the right-hand section of the "Process Times" worksheet fills the cells under the "Process Time (min)" column of Figure 43. In fact, these cells add up the process step times by summation.

In the example of Figures 44 and 45, the process of an OVG new building with 1 VBO is provided with process times in EngageProcess and then exported to Excel. The list of export times (highlighted in yellow) is then copied into the cells in the column of OVG new building with 1 VBO (see yellow highlighted cells in Figure 45).

| Processtapnummer | OVG nieuwbouw met 1 VBO | Bewerkingstijd |
|---|---|---|
| | | |
| 1 | Aanvraag OVG met bouwactiviteit | 0:00:00 |
| 2 | Aanvraag gereedmaken en in CLO plaatsen | 0:00:00 |
| 5 | Verdeling aanvraag onder VIB'ers | 0:00:00 |
| 6 | Documenten beoordelen | 0:15:00 |
| 7 | GBO bepalen, evt VBO('s) afbakenen en WOZ deelobjecten formulier | 0:15:00 |
| 8 | Voorlopige geometrie intekenen in TopoCAD | 0:10:00 |
| 9 | Voorbereiding adres indien OVG wordt verleend en nieuw VBO bevat | 0:10:00 |
| 11 | Toetsen aanvraag | 0:00:00 |
| 13 | Verleende OVG gereedmaken en in CLO plaatsen | 0:00:00 |
| 16 | Intrekken OVG | 0:00:00 |
| 17 | VIB'er op de hoogte stellen van intrekking OVG | 0:00:00 |
| 22 | Registratie pand in Key2BAG | 0:05:00 |
| 24 | Aanmaken huisnummerbesluit | 0:15:00 |
| 25 | Pand in Key2BAG koppelen aan TopoCAD | 0:00:00 |
| 27 | Registratie verblijfsobject(en) en registratie nummeraanduiding in Key2BAG | 0:15:00 |
| 28 | Koppeling tussen BAG en BGT maken | 0:05:00 |
| 29 | WOZ via I-objecten | 0:05:00 |
| 30 | "Melding start bouw" | 0:00:00 |
| 31 | Status aanpassen naar "Bouw gestart" | 0:10:00 |
| 35 | Definitieve fysieke inmeting doen van contouren pand | 1:00:00 |
| 36 | Definitieve afmetingen doorvoeren in TopoCAD en Key2BAG | 0:30:00 |
| 37 | "Melding gebruiksgereed" | 0:00:00 |
| 39 | Statusverandering van pand naar "Pand in gebruik" en indien van toepassing | 0:10:00 |
| 40 | Statusverandering van pand naar "Pand in gebruik (niet ingemeten)" en indien | 0:00:00 |
| 41 | Definitieve fysieke inmeting doen van contouren pand | 0:00:00 |
| 42 | Definitieve afmetingen doorvoeren in TopoCAD en Key2BAG | 0:00:00 |
| 44 | OVG-proces eindigt | 0:00:00 |
| 45 | Einde proces | 0:00:00 |

*Figure 44: EngageProcess export example*

| OVG nieuwbouw | | | OVG verbouwen, splitsen/samenvoegen of slopen | | | | | Overige meetopdrachten | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingrijpende verbouwing/splitsen/samenvoegen | | | | | | |
| Geen VBO | 1 VBO | >1 VBO | Kleine verbouwing | Geen pandwijzigingen en 1 nieuw VBO | Geen pandwijzigingen en meerdere nieuwe VBO's | Pandwijzigingen en meerdere nieuwe VBO's | Volledige sloop | Inmeting gereedgemeld pand | BGT-meting nieuwe situatie | Meting bestaande situatie |
| 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 |
| 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 |
| 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 |
| 0:15:00 | 0:15:00 | 0:15:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 |
| 0:10:00 | 0:15:00 | 0:15:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:10:00 | 0:00:00 | 1:00:00 | 3:00:00 | 6:00:00 |
| 0:10:00 | 0:10:00 | 0:10:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:15:00 | 0:30:00 | 1:00:00 | 1:30:00 |
| 0:00:00 | 0:10:00 | 0:10:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:10:00 | 0:10:00 | 0:10:00 |
| 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:10:00 | 0:00:00 | 0:00:00 | 0:00:00 |
| 0:00:00 | 0:00:00 | 0:00:00 | 0:10:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 |
| 0:00:00 | 0:00:00 | 0:00:00 | 0:10:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 |
| 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:15:00 | 0:15:00 | 0:15:00 | 0:00:00 | 0:10:00 | 0:10:00 | 0:00:00 |
| 0:05:00 | 0:05:00 | 0:05:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:10:00 | 0:00:00 | 0:30:00 | 0:30:00 | 0:00:00 |
| 0:00:00 | 0:15:00 | 0:15:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 |
| 0:05:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:15:00 | 0:15:00 | 0:15:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 |
| 0:00:00 | 0:15:00 | 0:15:00 | 0:00:00 | 0:05:00 | 0:05:00 | 0:05:00 | 0:00:00 | | | |
| 0:00:00 | 0:05:00 | 0:05:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | | | |
| 0:00:00 | 0:05:00 | 0:05:00 | 0:10:00 | 0:10:00 | 0:10:00 | 0:10:00 | 0:00:00 | | | |
| 0:00:00 | 0:00:00 | 0:00:00 | 0:10:00 | 0:10:00 | 0:10:00 | 0:10:00 | 0:00:00 | | | |
| 0:10:00 | 0:10:00 | 0:10:00 | 0:45:00 | 0:00:00 | 0:00:00 | 1:00:00 | 0:00:00 | | | |
| 1:00:00 | 1:00:00 | 1:00:00 | 0:15:00 | 0:00:00 | 0:00:00 | 0:30:00 | 0:00:00 | | | |
| 0:30:00 | 0:30:00 | 0:30:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | | | |
| 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | | | |
| 0:10:00 | 0:10:00 | 0:10:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | | | |
| 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | | | |
| 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | | | |
| 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | | | |
| 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | | | |

*Figure 45: Inserting EngageProcess export into tool*

Because the total process times are summations of the process step times in the columns in the right-hand section of the "Process Times" worksheet, changes in process step times can easily be made in the tool. In the case of a process change that causes process step time(s) to change, the VIB'er must delete/add process steps in EngageProcess and link the new process step times to them. If the VIB'er then exports the process models from EngageProcess and copies the lists with the new process times to the appropriate column in the right-hand section of the "Process Times" worksheet, the total process times used in the tool are automatically updated. Thus, should a process change (slightly) due to, for example, a change in use of Key2BAG, the impact of this change on the process time can be quickly calculated and implemented in the tool.

## Appendix A4 Evaluation form

In hoeverre komen de procesmodellen overeen met de processen die je uitvoert?

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Helemaal niet | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | Volledig overeen |

In hoeverre is de gebruikte methode voor het verkrijgen van procestijden en het toewijzen van procestijden aan de procesmodellen accuraat?

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Helemaal niet | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | Volledig accuraat |

In hoeverre geeft de tool een overzicht van je werk?

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Helemaal niet | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | Volledig overzicht |

Hoe gebruiksvriendelijk vind je de planningstool in Excel?

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Helemaal niet | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | Volledig gebruiksvriendelijk |

In hoeverre kan de tool helpen bij het analyseren van de verdeling van applicaties en hoeveel werkbelasting elke applicatie in beslag neemt?"

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Helemaal niet | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | Volledig |

In hoeverre denk je dat de planningstool in Excel waardevol kan zijn?

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Helemaal niet | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | Volledig |