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Work-distribution mechanisms within a workflow management system

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Heerlen, November 2009

Work-distribution mechanisms within a workflow management system

by
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in partial fulfillment of the requirements for the degree of

Master of Science
in Operations Management and Logistics

Supervisors:
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Preface

This report is a Master Thesis for the study Operations Management and Logistics. The study was conducted at the Information Systems group within the Faculty of Industrial Engineering & Innovation Sciences at the University of Technology in Eindhoven (TU/e). The Master Thesis has been conducted in cooperation with the TU/e and the All Pensions Group (APG) in Heerlen.

My personal objective for this report is to gain experience in conducting academic research. Both the university and APG have contributed a lot, however a master thesis has to be carried out on your own. To tackle an organizational project in an open environment is challenging me and with support of the supervisors, the results are of more value.

During my master thesis preparation and master thesis project, I was supervised by dr. M.H. Jansen-Vullers (1st supervisor) and dr.ir P.A.M. Kleingeld (2nd supervisor). I would like to use this opportunity to thank them for all their help and support with my master thesis project. I owe much gratitude to both of them.

In addition, I would like to thank supervisor dr.ir. I. Vanderfeesten and the vice-supervisor dr.ir B. de Bruin from APG for giving me the opportunity to conduct my master thesis project and for supporting and advising me. Next to this, I would like to thank the people who contributed to this research: colleagues of APG who always make some time for answering questions or unplanned visits. Without them, this project had not come this far.

Finally, I would like to thank my family and friends for their support throughout my study. Special thanks for my parents, who always said: divide your time well; study receives the highest priority in busy times. This helps me in realizing my dream.

Johan Sturkenboom
Heerlen, November 2009

Management summary

This report describes the final project I performed to end my study Operation Management and Logistics at Eindhoven University of Technology. The project was performed at department Concern Information Management and department Pension of All Pensions Group (APG) located in Heerlen.

Due to the replacement of the workflow management system of APG (GPS1 to GPS2) and the distribution of work items is executed manually, the possibilities for the distribution of work items could be improved. This resulted in the following research question:

How to support the distribution of work items to employees within the new workflow management system of APG?

A number of teams of department Pensions are interviewed (Chapter 3). Those teams are classified into groups based on their performance, and different scenarios are designed for one of those groups. One of the scenarios is chosen and is tested in a team (Chapter 4). Beside this, there is investigated what the possibilities are to implement the scenario in GPS2 (Chapter 5).

Results

The interviews revealed that each team is unique. Those teams differ in the workflow models, the decision factors, and the performance criteria. Still, the different teams are classified into two groups, which are quantity and quality.

- Quantity teams are more focused on performing the work items within a specific time. Examples of teams are KTD, CBV-GBA and Partner registration of SPS.
- Quality teams perform work items but taking into account the quality of work. Teams that belong to this group are e.g. SBO/SAN, GVP, and KVI.

The quantity teams were further researched in this project and four scenarios are designed. The selected scenario is push-push based and allocates the work items taking into account four different decision factors:

1. work item properties
2. authorization
3. presence of the employee
4. the items in the individual stock

The work items are allocated to the employee who has the most available time. The result is an equal distribution in which the items are executed within a specific time. The selected scenario is tested in team SVP. In total for 5 days the test is executed, which resulted in:

- The selected scenario is feasible, since the work items are distributed during the test.
- A significant improvement of the wait time of the work items is reached for 3/8 processes. In total, those three processes form 57% of the distributed work items.

The implementation of the scenario is investigated in GPS2. Two of the four decision factors are not fully supported, which are

1. authorization
2. presence of the employee

In total, three additional applications are required for a correct distribution of the work items. For the non-supported decision factors, two applications are required and the last is needed for the distribution itself.

Conclusions

The distribution of the work items to employees could be supported on different ways, but still depends on the team. Despite of the differences in teams, the teams could be classified into groups to provide per group targeted support. The selected scenario divides the work items to employees based on a number of decision factors. The results are consistency and an equal distribution among the employees based on the available time. From the executed test is concluded that the lead time is improved for a number of processes within one team. Besides this, GPS2 does not fully support the selected scenario. Tailor made applications are needed for a correct distribution. The advantages of the selected scenario have to outweigh the costs.

Recommendations

To support the distributor and for user acceptance, an implementation plan is determined that consists of the next three steps:

1. An additional test has to be executed in team SVP that verified the obtained results during the executed test. Since the pilot was executed for 5 days, a test of a period of (e.g., 2 months) is recommended.
2. The scenario is implemented into a service, which could be called by GPS1 and GPS2. In order to ensure continuity to the service, when GPS1 is replaced, the service could be used by GSP2. The current interface is used, and will be extended with a column in which for each work item an employees' name is presented with the most available time.
3. As final step, the distributor could be replaced by the system, when the system provides the distribution without overrule actions of the distributor.

Management samenvatting

Dit rapport is een beschrijving van wat ik heb uitgevoerd om de studie Operation Management and Logistics op de Technische Universiteit te Eindhoven af te ronden. Het project is uitgevoerd op de afdeling Concern Information Management en de afdeling Pensioenen bij de Algemene Pensioen Groep (APG) te Heerlen.

Door een vervanging van het workflow beheerssysteem van APG (van GPS1 naar GPS2) en omdat de werkverdeling handmatig wordt uitgevoerd, zijn er mogelijkheden om de verdeling van het werk te verbeteren. Dit leidt tot de volgende onderzoeksvraag:

Hoe is de verdeling van werkitems naar medewerkers te ondersteunen binnen het nieuwe workflow beheerssysteem van APG?

Een aantal teams van de afdeling Pensioenen zijn geïnterviewd (Hoofdstuk 3). De teams zijn in groepen geclassificeerd op basis van hun performance, en scenario's zijn bedacht voor een van deze groepen. Een scenario is gekozen en getest in een team (Hoofdstuk 4). Daarnaast is bekeken of het scenario geïmplementeerd kan worden in GPS2 (Hoofdstuk 5).

Resultaten
Uit de interviews is gebleken dat elk team uniek is. De teams verschillen in de workflow models, de beslissingsfactoren en prestatiecriteria. Toch kunnen de verschillende teams in twee groepen verdeeld worden, namelijk kwantiteit en kwaliteit.

- Kwantiteits-teams zijn meer gefocust op de uitvoering van werkitems binnen een bepaalde tijd. Voorbeelden van teams die tot deze classificatie horen zijn: KTD, CBV-GBA, en Partnerregistratie van team SPS.
- Kwaliteits-teams voeren werkitems uit maar nemen daarbij kwaliteit van het werk meer in acht. Teams die tot deze groep behoren zijn bijvoorbeeld SBO/SAN, GVP, en KVI.

Voor de kwaniteits-teams zijn er 4 scenario's bedacht. Het gekozen scenario is gebaseerd op een push strategie en wijst de werkitems toe aan de medewerkers. Hierbij wordt rekening gehouden met vier verschillende beslissingsfactoren:

1. werkitem eigenschappen
2. autorisatie
3. aanwezigheid van de medewerker
4. de voorraad van de medewerker

Het werkitem wordt toegewezen aan de medewerker met de meest beschikbare tijd. Het resultaat is een eerlijke verdeling waarin de items uitgevoerd zijn binnen de gestelde tijd. Het gekozen scenario is getest in team SVP. Gedurende vijf dagen is de test uitgevoerd wat resulteerde in:

- Het gekozen scenario is uitvoerbaar gezien het feit dat de werkitems verdeeld zijn tijdens de test.
- Een significante verbetering van de wachttijd van de werkitems voor 3/8 processen. x

De implementatie van het scenario in GPS2 is onderzocht en twee van de vier beslissingsfactoren worden niet volledig ondersteund, namelijk

1. autorisatie
2. aanwezigheid van de medewerker

In totaal zijn er drie extra applicaties nodig om de verdeling juist te laten verlopen, namelijk twee voor de niet volledig ondersteunde factoren en 1 voor de verdeling zelf.

Conclusies
Het verdelen van het werkitem naar medewerkers kan op verschillende manieren ondersteund worden, maar blijft afhankelijk van het team. Ondanks de verschillen in teams, zijn ze toch te verdelen in groepen zodat er gerichte ondersteuning naar de teams geleverd kan worden. Het gekozen scenario verdeelt de werkitems naar de medewerkers op basis van een aantal beslissingsfactoren. Het scenario is hierbij consistent en verdeelt het werk gelijk onder de medewerkers op basis van de beschikbare tijd. Uit de uitgevoerde test blijkt dat de doorlooptijd van een werkitem is verkleind voor een aantal processen binnen één team. Daarnaast ondersteunt GPS2 het gekozen scenario niet volledig. Er dient maatwerk gemaakt te worden voor een juiste verdeling. De voordelen van het scenario moeten uiteindelijk de kosten overtreffen.

Aanbevelingen
Om de werkverdeler te ondersteunen en voor gebruikersacceptatie is een implementatieplan opgesteld dat uit de volgende drie stappen bestaat:

1. Een extra test dient uitgevoerd te worden in team SVP, zodat de verkregen resultaten tijdens de uitgevoerde test worden geverifieerd. De test is uitgevoerd gedurende 5 dagen, terwijl een periode van bijvoorbeeld 2 maanden wordt aanbevolen.
2. Het scenario is geïmplementeerd in een service. Deze service kan aangeroepen worden door GPS1 en GPS2. Om de continuïteit te waarborgen kan - als GPS1 wordt vervangen - de service worden gebruikt door GPS2. De huidige gebruikersomgeving wordt gebruikt en uitgebreid met een kolom waarin per werkitem de naam weergegeven wordt van de medewerker met de meest beschikbare tijd.
3. Als laatste stap kan de werkverdeler vervangen worden door het systeem. Dit kan alleen als het systeem de verdeling verzorgt zonder tussenkomst van de werkverdeler.

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1 Introduction

In the field of workflow management (WFM), several suggestions are made to improve the performance on criteria such as time, quality, flexibility, and cost dimensions [Reijers & Mansar, 2005]. In this master thesis, factors that influence the performance of a WFM system are analyzed and a design is made to improve the performance on one of these criteria.
The topic that is treated in the master thesis is about work distribution in a WFM: *"work items that are offered or allocated to the right person at the right time in a WFM,"* according to [van der Aalst, 1998]. Research has been conducted to discover how teams execute the distribution of work, what the influence is of this distribution on the performance criteria and if an automatic distribution could be supported by a WFM system.

This chapter introduces the master thesis, starting with an introduction of the company (APG) where the project is conducted. In the second section, the project is introduced including the goals of this project. In the third section, the research questions are described supported with the methodology that is used. The outline of the report is described in the fourth and last section.

1.1 Introduction of APG

APG is a specialist of collective pensions in the public sector and carries out the pension administration and communication, and manages the pension's capital for the educational and government sectors. With 2500 staff, APG administers the pensions of 2.7 million Dutch citizens. An organizational chart of APG is presented in Appendix A. APG has assets under management of approximately €180 billion 30 June 2009, [APG].

Pensions are calculated according to regulations of the Pensions act. In 2007, this act was changed to improve the security and to provide transparency of the calculated pension value. Most clients did not know how their pension was calculated; hence, since 2008 it is compulsory to deliver a Uniform Pension Overview (UPO) to the clients, according to [Bol-Zuidema, 2009]. A UPO is an overview of the accrued pension according to a standardized classification of different pension administrators.
In addition, special legislations are applicable (e.g. for police and military). These clients form a separate group and their pension administration is performed by specialized staff.

To carry out the different tasks with respect to the pensions of the 2.7 million clients, a workflow management system is used at APG. All the clients are unique and have personal variables, such as date of birth, income, address, a partner (if any), or other personal characteristics. Important are the data such as start and end date to determine the participation time of the client. This information is needed to deliver the service to the client and to compute the pension value for the client. All this information is stored in databases and is compared with several organizations (e.g. SVB or GBA) to verify or complete the information.
Although the personal characteristics and legislations are once called, both are more complex than described here. Every client has his/her own history and is therefore different from the previous or next client. Despite of all the differences, there is one department involved with the pensions at APG, which is the Pensions department.
The Pensions department consists of three business units (BUs); see Figure 1. Within one BU several teams exist which execute the requests of clients for a specific product. Employees within these teams carry out the requests and deliver an answer to the client.

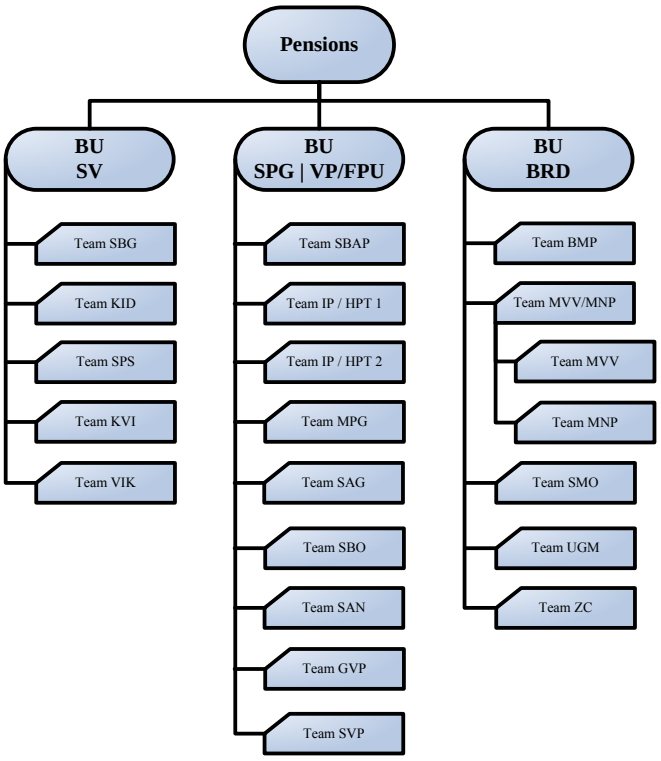


Figure 1: Organization chart: Pensions department

The relevant abbreviations of Figure 1 are explained in the List of Abbreviations.

All the teams in Figure 1 have their own contribution in determining the pension value for the client. Administration is needed to register personal information. The knowledge of the different products (i.e. services, like different kinds of pensions) is present with the right employees and is used to compute difficult calculations for the clients.
Although clients' requests are carried out by employees in a team, the teams are linked to stages (i.e. clusters), see Figure 2. A cluster is a group of clients that has a homogeneous character during a specific time. In Figure 2, the different teams of the department Pensions are placed by their corresponding cluster.

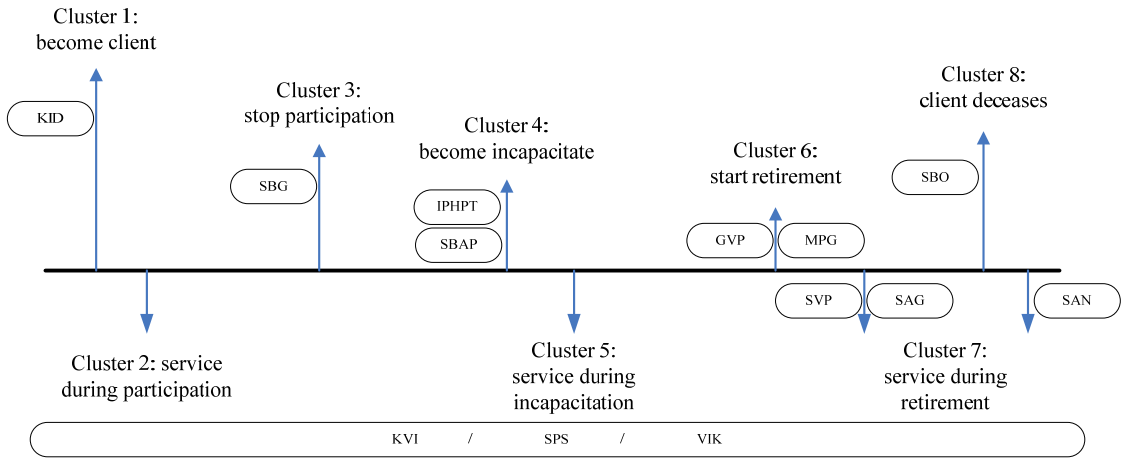


Figure 2: Clusters and teams at APG

Eight clusters are determined, in which a client could be assigned. The first cluster is to become a client. A client could decide for another job and stop the participation. The time between the start and stop (i.e. cluster 1 and cluster 3) is called service during participation (cluster 2). In addition, clients could become incapacitate and for those clients special service is present in cluster 5. Clients could choose for a Flexible Early Retirement Pension (before 65 year) or at the age of 65 choose for the Multi-option Pension. Clients of both pension products are in cluster 6. At a given time a client deceases (cluster 8) and the time between cluster 6 and 8 is the service during retirement (cluster 7).
Most teams of the department Pensions are concerned with a specific cluster. The teams KVI, VIK and SPS carry out the service during all clusters. The teams of BU BRD are not depicted in Figure 2, because this BU is only concerned with clients who have special regulations, such as police or military.

1.2 Introduction of the project

In order to fulfill the requests of the clients, a complex system is used by the staff. This system is called GPS1 (in Dutch: Generiek Pensioen Systeem). The requests arrive at APG and are processed at the right department by the right team, by the right person. The distribution of the requests (i.e. the work items) has to be executed without any hesitations and within a specific time.
For the primary processes of APG, (i.e. provide services related to pensions to the clients), the requests of clients are distributed among employees in a specific team. All requests of these primary processes are executed at the department Pensions. In addition, some other processes are needed to carry out the primary processes such as support and control activities (e.g. compliance). This project deals only with the primary processes.

At this moment, APG replaces their WFM system for a new version. The GPS1-system is outdated and support for development has been stopped by the supplier of the development environment. The new version of the WFM system is called GPS2 and is based on SOA (Service Oriented Architecture). Within a Java environment, GPS2 is placed and for the workflow management component is chosen for the IBM-Websphere suite. Business processes are modeled (design-time) with Business Modeler and executed (run-time basis) by the Process Server (BPEL).
Forthcoming with GPS2 is additional support for the users of the system. One kind of users of this system, are the distributors who distribute work items to the employees.
Moreover, at this moment the distribution of work is executed by a distributor (i.e. an employee of a team who is authorized to divide the work items among the employees within a team). Since the allocation of work items is performed manually, the idea is raised to investigate in which way distributors divide the work items and whether the distribution could be executed automatically via GPS2.

This project is set up to identify the support for the distributors in the new WFM system. It contains (i) research in the field of work distribution mechanisms and (ii) comparing the theoretical findings with the distribution mechanisms used at APG. In addition, the result of the analysis is used to support the distributors during the execution of work distribution with the WFM system at APG.
The project consists of technical as well as organizational aspects. The organizational side is considered by use of the involvement of distributors at the department Pensions. The technical side is taken into account by investigating an automatic way of work distribution.

1.2.1 Project scope

This project is executed at two departments: CIS/CIM and Pension department. CIS (Concern Information systems) is the IT department, executes projects concerned with IT, and is the initiator of the project GPS2. GPS2 is a WFM system that replaces GPS1, at first for just one product (AKP), but in future for other products as well. AKP is dealt with by a sub-team of team SVP, which is part of the Pensions department see Appendix A and Figure 1.
In cooperation with the Pension department, several distributors are analyzed to determine the current situation, and a design for automatically distribution in the new WFM system is described for the CIS/CIM department. As indicated in Figure 1, the Pension department consists of three business units, however only two of them will be examined during this project: BU SV and BU SPG.
Nearly all teams of BU SV and BU SPG are taken into account in this project, since at those teams work items are arrived and distributed among the employees of a team.
Due to the complex regulations, time limitations, and the expectation that no additional distribution mechanisms are found, BU BRD is out of scope. In addition, the teams VIK and SBAP are also not treated in this project, because team VIK is not concerned with distribution of work whereas team SBAP is a very small team, and hence the results of the project are less influenced by SBAP.

1.2.2 Project goals

The main goal of this project is to identify whether and how the distributor could be supported during the execution of work distribution. The distributor could be replaced by an automatic way of work distribution, called an algorithm.
To reach this main goal, sub goals are defined that are limited by the scope of the project. The sub goals are:

- describe a link between the literature and APG in the field of (i) workflow management systems and (ii) distribution of work to the employees;
- create an overview of the distribution mechanisms used in the different teams within the business units at APG;
- support the distribution function or/and to design an algorithm for automatic distribution that runs on the WFM system of APG, and
- suggest a plan of action how to implement the designed algorithm in the WFM system of APG

These sub goals form the center of this project and for each sub goal, a research question is defined. With use of the research questions and the method per research question, the main goal is achieved.

1.3 Research questions & Methodology

In order to present an advice to APG, the different sub goals are taken into account in formulating the research questions. The main question that plays a central role in this project is:

How to support the distribution of work items to employees within the new workflow management system of APG?

This main question is divided in three parts: '*the distribution of work items to employees*' and the '*support*' of this distribution '*within the new workflow management system of APG*' as suggested by [Verschuren & Doorewaard, 1995].
This first part deals with the distribution of work items, and questions came up how these work items are distributed at this moment, by which resource and on which decisions.

APG replaces the old system by the new workflow management system. This is a motivation to identify the possibilities of 'support' of the distribution of work items in the new WFM system. Since the support of the WFM system is investigated, new (i.e. different than the current) distribution systems could be designed in such a way that it supports the distributor.

Four research questions are defined to support the main goal of the project, and form the structure of this report.

1. ***Which information is available in the literature to support work distribution mechanisms in workflow management systems?***

To answer the first research question, literature is reviewed to gain more insight in the topics (e.g. how work items are distributed within a workflow management system and which factors play a role.
The result is an overview of the literature with respect to (i) workflow management, (ii) distribution mechanisms to resources, (iii) distribution treated in case studies and finally (iv) decision variables taken into account during distribution.

2. ***What are the current mechanisms to offer or allocate work by the distributors and what are the decision factors?***

This research question focuses on the actual situation of APG. With use of interviews, the information how distributors distribute (i.e. offer or allocate) work and why to that specific employee are gained. These decision factors are probably different per distributor and thus per team.
The result of the gained information are different mechanisms that are currently in use for distributing work (the as-is situation). In addition, the decision variables of the distributors are identified. To support the distributor with the allocation or offering work items to the employees, this result is taken into account for answering the next research question:

3. ***What are possible mechanisms that can be used to distribute work in the workflow management system and how does the design work?***

Possible scenarios of mechanisms are designed and are compared with the as-is situation. Literature is used as input for the different scenarios and a selection is made by different stakeholders. A pilot is set up to check the feasibility of the selected scenario in practice and to determine if the goal of improvement in time is reached.
The result is a description of the scenarios and an explanation of the selection. In addition, the pilot is described with an explanation of how the design works (i.e. the algorithm) and the results of the pilot-run are presented to show if the goal is achieved.

4. ***How will the designed algorithm be implemented in the workflow management system of APG?***

The workflow management system is investigated to identify the technical possibilities and restrictions and what components belong to the distribution mechanism. The organizational aspect is examined to identify the adaptability to changes. Both aspects are taken into account in a plan of action how to implement the design in the WFM of APG.
The results of this research question are of the technical side the system properties and a link with the GPS2 products, whereas of the organizational side the results are a description of the adaptability and the time aspects. Both aspects are combined and a plan of action is described how to implement the designed algorithm.

1.3.1 Methodology

To investigate the research questions and so to provide an answer on the main question, this report describes the exploratory study in a couple of phases, following the regulative cycle of [van Strien, 1997], which is also described in the book of [van Aken et al., 2007] see Figure 3.

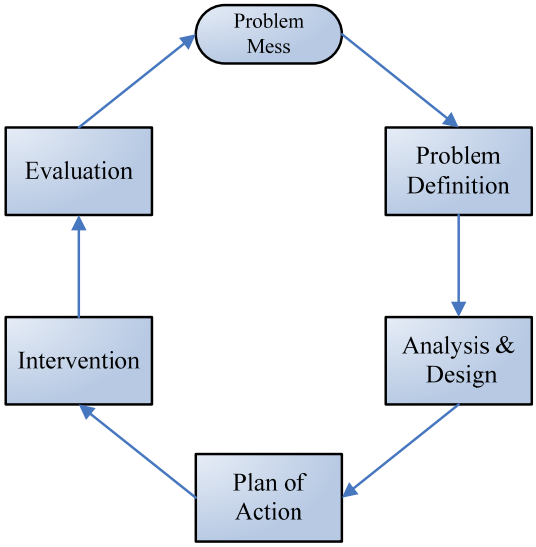


Figure 3: Regulative cycle of [van Strien, 1997] - [van Aken et al., 2007]

The problem mess is the start of the project, which is followed by the problem definition phase. In this phase, the project plan (i.e. research proposal) is described and has been executed at the start of this project. In the research proposal, the research questions and the method used per question are described. The research questions described in section 1.3 are defined to support the main goal of the project. This step is followed by the analysis and design phase: "*it is the analytical part of the project"* according to [van Aken et al., 2007]. It produces the specific knowledge on the context and nature of the problem and when it is finished, a plan of action is created that describes the plan of the solution.
The intervention step is started when the solution is implemented. It is the step of "*learning to work within the new system and to realize the intended performance improvement*", [van Aken et al., 2007]. Finally, the evaluation phase is achieved to determine if the improvement is reached.

1.4 Report outline

In this chapter, the introductions of the project and APG are given. Chapter 2 presents the findings of the literature that may increase the understanding of the topic. The literature is linked to APG. Chapter 3 presents the analysis of the current distribution mechanisms (the as-is situation) used at APG. In Chapter 4 the as-is situation is used to design scenarios for the distribution of work items within the workflow management system and the execution of a pilot-run is described for the selected scenario. Chapter 5 elaborates the findings of the implementation possibilities and a plan of action is described. In the last chapter, Chapter 6 the conclusions are drawn and suggestions for future research are proposed.

2 Background: literature vs. APG

In this project, a literature review is conducted to gather information about the distribution of work. In addition, this literature is linked to the definitions used at APG, to check consistency. In this chapter, the first research question is answered:

Q1: which information is available in the literature to support work distribution mechanisms in workflow management systems?

To answer this research question, the information gathered from the literature review is aggregated into the following groups:

- background information of workflow management
- distribution of work items to resources
- case studies performed in work distribution
- decision factors and consequences taken into account by distributors
- model for a workflow management system

These five groups are in this sequence treated and per group first the literature is summarized and the linkage to the definition used at APG is described. The last section of this chapter provides a summary of the literature found.

2.1 Workflow management

Workflow management refers to the domain that focuses on the business processes. The goal of a workflow management system is to make sure that the proper activities are executed by the right person at the right time, according to [van der Aalst, 1998]. The Workflow Management Coalition [WfMC, 1995] defines a workflow management system as follows: *"a system that completely defines, manages, and executes workflows through the execution of software whose order of execution is driven by a computer representation of the workflow logic."*

2.1.1 Workflow, cases, tasks, items

2.1.1.1 Literature

Workflows are case-based, that means that in such a workflow management system, all the cases have their own lifecycle. Some are small and can be executed in minutes or seconds, others have a lifetime of days. Cases are treated by executing tasks in a specific order. A flow diagram or procedure describes the route a case will follow through the system, (i.e. which tasks will be executed and in which order). Each task has pre- and post conditions, where the former should hold before a task is executed and the latter should hold after execution of the task.
Cases can be executed in the same specific order of tasks and consequently a task can be executed for many cases. A task that is executed for a specific case is called a work item and is executed by a resource. An activity is a work item that is executed by a specific resource. In Figure 4, an overview of the different words used in this paragraph is presented.

In the case dimension, cases are executed without directly influencing the others, but only indirectly on data and resources. In the process dimension, the workflow process is specified for tasks and the routing along the tasks. In the resource dimension, the resources are grouped in roles and organization units.
The different terms used in a workflow are represented with different dots in the form of a cube see Figure 4, where a case and a task forms together a work item and an activity is an aggregation of a case, task and a resource.

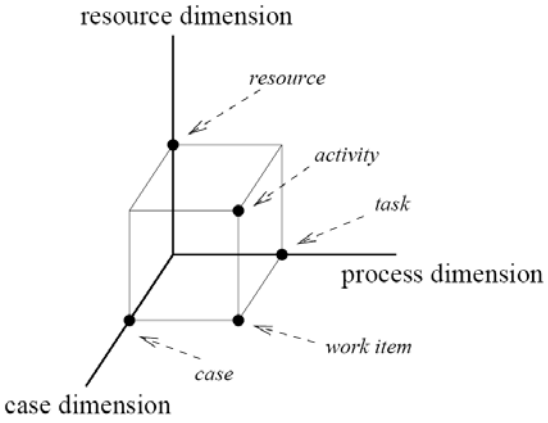


Figure 4: 3D view of a workflow – [van der Aalst, 1998]

2.1.1.2 Link to APG

At APG, two WFM systems are used: GPS1 and GPS2. In both WFM systems, different concepts are used. I.e. at GPS1, the distribution of work items is actually the distribution of processes. In addition, the employees determine the further steps of the process. It is based on WMM-processes, which are chains of processes. On the other side, at GPS2 the distribution of work items is actually the distribution of tasks. Employees only perform the tasks without controlling the workflow since that is performed by the BPEL-process executed by the process server, see Figure 5.

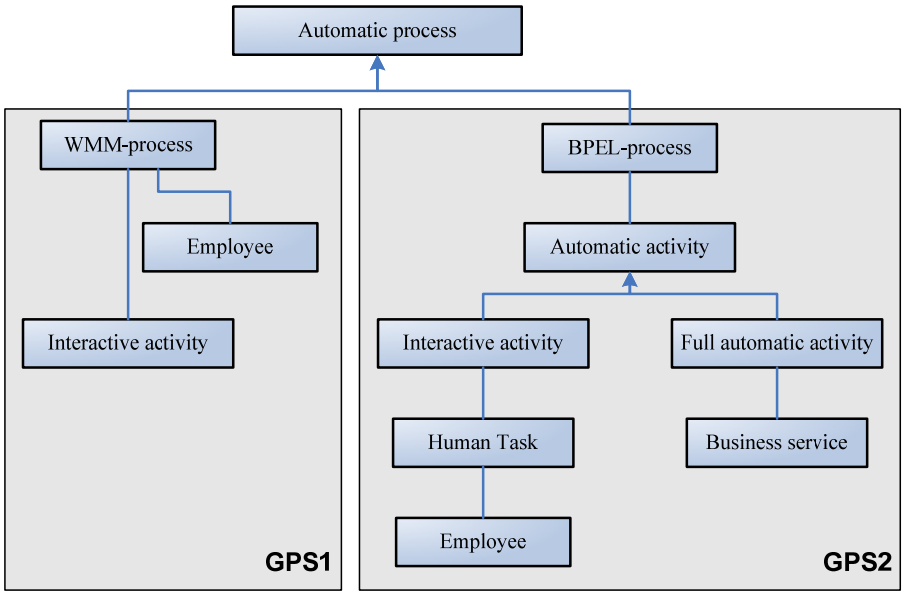


Figure 5: Difference between GPS1 and GPS2 in the process layer - [APG, 2009]

At APG, the definitions used for the concepts differ which lead to confusion. Investigated is the architecture of GPS2, and so for these (new) WFM system, the definitions are given. On of the layers of the architecture of GPS2 is the process layer in which the following concepts are important: business process, process, and activity.
"The business process consists of all the activities necessary for execution of a work item about an event to the intended target of the client (result)," [APG 2009]. The business process consists of manual processes and automatic processes, of which the latter is depicted in Figure 5.

The remaining two concepts have the following definition [APG, 2009]:

- *"Process: group of consecutive activities of one type (manual or automatic)"*
- *"Activity: smallest group of acts and has units of time, place and acts (OTOPOP: one time, one place one person)"*

Another layer of the architecture is the case management layer, in which three concepts are important: case, activity instance and task [APG, 2009]:

- *"A case is an instance of a process and could have different states such as : started, finished or cancelled"*
- *"An activity instance is a super-type for the instance of an activity"*
- *"A task is an interactive activity (for a specific case) and is also called a work item. It could have different states such as: initial, to allocate, allocated, offered, cancelled, in execution, or suspended."*

We will come later to these states of a 'task' in section 2.2.

Because the definitions of the literature (see Figure 4) and the definitions of APG differ and because of the definitions differ within both WFM systems of APG, it is chosen to use the definitions of the literature in this report.

2.1.2 Resource classification

2.1.2.1 Literature

Work items are allocated to resources by use of the workflow management system. Resources can be either a human who does the activity manually or a system that automatically executes the activity. A resource is permitted to carry out a number of work items. A work item can be performed by a limited number of people with use of resource classes. A resource class is a group of resources and resources can be allocated to more than one resource class. According to [van der Aalst & van Hee, 2002] two forms of resource classification are present by a: (i) functional properties and (ii) position in the organization. In the former, the resource class is known as a role (i.e. a function or qualification that a group of resources can have). When allocate a task to a role, a specific resource in that role is qualified and authorized. In the latter case, the resource is classified depending on their place in the organization. Classification of these resources leads to perform the task at the right department.

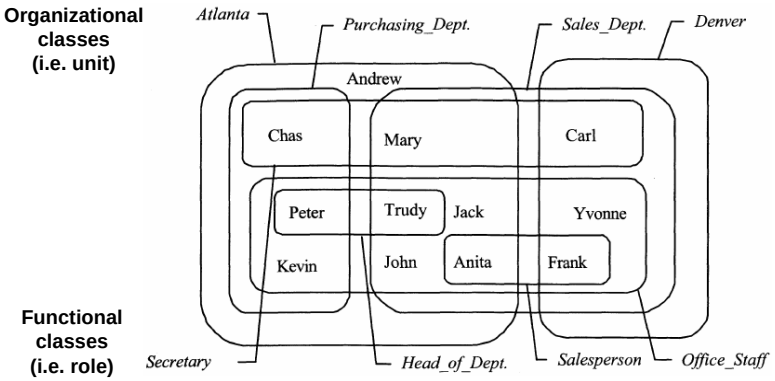


Figure 6: Resource classification – [van der Aalst & van Hee, 2002]

In Figure 6, a resource classification is depicted in which several resources are classified in functional and organizational classes. Classes can overlap, and can be part of a greater one (i.e. Peter and Trudy are head of departments both located in Atlanta and are also classified as functional office staff which is in turn divided on two locations). Hierarchy has also an impact on the allocation of work items" (e.g. a head of a department can perform all the work items of a resource in the sub-department).

2.1.2.2 Link to APG

Authorization of employees is presented in the security layer of the architecture of GPS2 and looks like the classification of Figure 6. Within the authorization, three concepts are important [APG, 2009]: function, unit, and role.

- *"a function (list of responsibilities) which one person fills"*
- *"a unit is an organizational part and"*
- *"a role, which is a combination of a function and a unit"*.

Authorization is based on roles and is linked to (initiated) processes or interactive activities. In GPS2, authorization is created using Lightweight Directory Access Protocol (LDAP), a network protocol that programs use to look up information from a server.

2.1.3 Build-time vs. run-time

2.1.3.1 Literature

The resource perspective concentrates on the way the system distributes work based on the structure of the organization and capabilities or qualifications of people, according to [Pesic & van der Aalst, 2006]. Build-time or design-time is the time in which the processes are defined and an administrative tool is used to define the organization. In the process definer, specific roles are linked to the process (i.e. the resource classification). In run-time, the processes are executed by the workflow engine and actual work items are distributed to the resources. When human resource receives a work item, it is executed with the worklist handler (i.e. *"a software component that manages the interaction between the user (or group of users) and the worklist maintained by a workflow engine"*, according to WfMC, 1995]. In Figure 7, both stages (design and run-time) are depicted graphically:

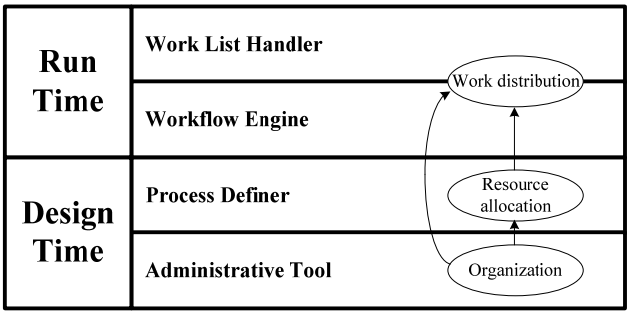


Figure 7: Resource perspective sub-models - [Pesic & van der Aalst, 2006]

The different models in both time sections are elaborated in [Pesic & van der Aalst, 2006]:

- *"The Organization model shows how an organizational structure can be defined in a workflow management system. This can, for example, be done by defining users, their organizational roles and departments;"*
- *"The Resource Allocation model shows how resource allocation is specified in a process definition in a workflow management system. For every task that has to be executed by a user, the resource allocation mechanism determines the user(s) who can execute the task. The allocation can be specified using the organization model elements (e.g., user-names, roles, departments, etc.);"*
- *"The Work Distribution module shows how a workflow management system distributes work to employees (resources). The distribution of work to people is done based on the resource allocation specifications for tasks and the current organizational structure."*

2.1.3.2 Link to APG

At APG, the three above-mentioned modules are also used. The organizational model (i.e. the resource classification) is described in LDAP. The resource allocation is performed during

design-time, in a modeler tool. Per work item, a specific role is linked that depends on the function and unit (as described in the resource classification).
Finally, the work distribution module is in the run-time phase and is currently executed by distributors who allocate work among the different employees in a team.

2.2 Distribution to resources

2.2.1.1 Literature

From a resource perspective, it is interesting in which manner work items are distributed to a specific resource for execution by the workflow management system. A work item has a lifecycle in the form of a state transition diagram see Figure 8. The lifecycle starts with the state created, meaning that the preconditions required are fulfilled and can be executed. At this state, the work item is not allocated to a resource for execution however, the item can follow multiple paths via other states to one of the final states: failed or completed.

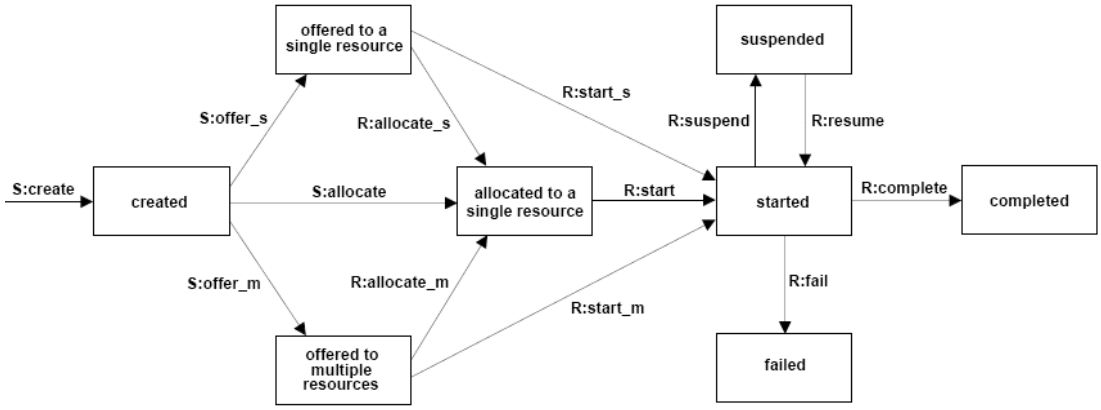


Figure 8: Work item lifecycle - [Russell et al., 2004]

The arcs in Figure 8 have either an 'S' or 'R' as prefix in the description. This represents the transition is initiated by either the workflow system (S) or a resource (R). The transitions after the state 'created' are all initiated by the workflow system. From that point, the work items can be offered to a single resource, offered to multiple resources, or allocated to a single resource. In the first option, one resource is informed about availability of the work item by sending a message of put it on the worklist of the resource. The workflow system determines beforehand to which resource it can be offered, meaning: select the right resource based on e.g. specific properties of the work item, the cheapest, or a qualified resource. Then the workflow system ranks the available resources and selects the most appropriate one.
The second option is to offer the work item to multiple resources, where the system informs multiple resources of the existence of the work item. Again the system has selected the most appropriate resources and offers the work item e.g. to a group of resources.
The third and last option is the allocation to a single resource through the workflow system. The resource has to execute the work item at some time. This state is also reached when a resource or a group of resources has volunteered to do the offered work item. When the work item is distributed to the resource either voluntary (offered) or forced (allocated), the work item becomes an activity and will be started.
Once started, the work item can be suspended "*which denotes that the resource has elected cease execution of the work item for a period, but does intend to continue working on it at a later time*" [Russell et al., 2004]. Next to suspending of a work item, the resource can either complete or fail the work item. In the former, the work item is successfully finished by the resource whereas in the latter, the resource failed.

The mechanism of distributing work items depends on the organizational preferences. According to [Kumar et al., 2001] there are two basic mechanisms for work distribution in a workflow system:

- *"Push mechanism: a work item is pushed to a single resource"*
- *"Pull mechanism: a resource pulls work items from a view of a common pool of work items."*

Moreover, the authors further noted that a push mechanism is a special case of the pull mechanism: just one resource can view a given (offered) work item.
In the work item lifecycle, the work items could be allocated or offered to one or multiple resources. The former is based on a push mechanism, whereas the latter resources are able to select the offered work item to their own.
[Russell et al., 2004] described a series of workflow resource patterns "*that aim to capture the various ways in which resources are represented and utilized in workflows*". They identified 43 resource patterns, aggregated into 7 groups:

Table 1: Resource patterns grouped - [Russell et al., 2004]

Group pattern	Description
Creation patterns	specified with the workflow statically and set constraint that leave some variation up to runtime
Push patterns	situations in which a workflow system actively offer or allocate work items to resources
Pull patterns	relate to the situation where individual resources are notified of specific work items that need to be executed
Detour patterns	situations where work allocations that have been made for resources are interrupted either by the workflow system or at the instigation of the resource
Auto start patterns	work items are triggered by specific events in the lifecycle of the work item
Visibility patterns	visibility is about who can view what items and parts of the workflow in what state
Multiple resource patterns	specification sets the constraints, decided at runtime what resources are actually involved

These resource patterns are elaborated in more detail in Appendix B.

2.2.1.2 Link to APG

In the case management layer of GPS2, the possible task-states are depicted. [APG, 2009] noted: *"a task is in a specific state, and when the task is distributed or executed, the state is changed."* In addition, a stock of work is a collection of tasks in a specific state. Three different stocks of tasks are present, according to [APG, 2009]:

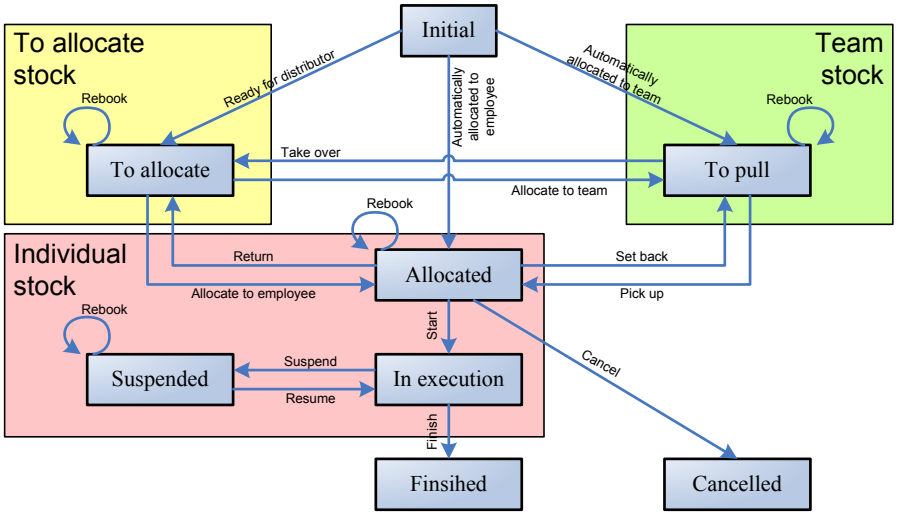


Figure 9: Lifecycle of a task in GPS2 – [APG, 2009]

- *"to allocate stock: tasks that have to be allocated among the employees by a distributor"*
- *"individual stock: tasks for a specific employee (automatically allocated or by distributor)"*
- *"team stock: tasks which could be picked up by employees to their individual stock"*

In Figure 9, the lifecycle of a task including different stocks is depicted in a state transition diagram. The difference with Figure 8 of [Russell et al., 2004] is that at APG there is no separate state of offering a work item to a single resource, and an additional state at APG is present called the 'to allocate' in the 'to allocate stock' (i.e. the stock of the distributor at APG). [Russell et al., 2004] let the system determine which work item is allocated to a single resource, (see Figure 8) at APG a distributor does.

2.3 Case studies

2.3.1.1 Literature

Workflow systems have shortcomings such as *"dealing with unavailability of workers as a result of vacation or illness, overloading, context dependent suitability, deadlines and delegation"* [Kumar et al., 2001]. As a result, the work item is offered to too few, too many, or even the wrong set of employees, which influences the performance of the WFM system. Hence, work distribution is a tradeoff between performance and quality as is concluded by the authors. [Kumar et al., 2001] propose a dynamical model with four parameters and threshold values, to allocate work in a workflow system to prevent shortcomings:

- *"suitability: the degree in which an employee fits to perform a specific task (has a value between 0 and 1)"*
- *"urgency: the degree to which the task has to be executed in a timeframe"*
- *"conformance: a measure of the level of agreement with the constraints"*
- *"availability: measures the overall availability of the workers, taking into account the time planning, the workload and absences"*

The authors simulate their dynamic approach and implement several threshold values to change levels of priority or suitability. They simulate five kinds of strategies:

- Push: work item is visible only to those resources that have maximal suitability for it
- Pull: a work item is visible to all resources
- Typical: a work item is visible to resources if the product of the four parameters exceeds a threshold value of 0.5
- Receptive: a work item is visible to resources if the product of the four parameters exceeds a threshold value lower than the typical (e.g. 0.4)
- Selective: a work item is visible to resources if the product of the four parameters exceeds a threshold value higher than the typical (e.g. 0.6)

All the strategies are simulated for both aspects: quality and performance. Concluded from the paper is that two of the five strategies perform as extremes and each other opposites, which are push and pull. Both do not perform as the best under the conditions the authors used. The other three perform in-between (i.e. between the two extremes on both aspects), because they combine features of the push and pull strategies, and give both reasonable throughput times and fair quality, according to [Kumar et al., 2001].

In the paper of [Liu et al., 2008] a semi-automatic approach for workflow staff assignment during run time using workflow history information is proposed. Based on the historical information in event logs, the machine-learning algorithm is applied to investigate which work items are undertaken by specific actors and generates a classifier that could perform the next task. The authors investigated this approach on three enterprises in the automotive

industries and examined three different machine-learning algorithms to generate the correct classifier. The results show almost no difference in the selected machine algorithms and it is concluded that this approach generated the right factor for 75% of the cases (checked by a distributor who determines by himself/herself which employee receives which work item).

2.3.1.2 Link to APG

The four parameters of [Kumar et al., 2001] can be linked to the decision factors taken into account when work items are distributed at APG.

- The urgency of a work item is not strictly used at APG. In practice, some work items have two deadlines (an internal of 5 working days and external for the client before "lussluiting"). Employees determine by themselves in which sequence work items are processed to reduce the number of tardy jobs.
- Availability is used as decision factor, although this is executed by hand by the manager of the team and is not registered via a system of APG.
- Suitability and conformance could be linked to authorization, which is used when the work items are distributed.

The two basic mechanisms are notified: push and pull. At APG nearly all the teams use a push strategy to distribute the work items, see chapter 3. When a push strategy is used, work items are pushed to a single resource, whereas when pull strategy is used, resources pull work items form a team stock.
The proposal of [Liu et al., 2008] only works at APG, when employees are generalists, since the algorithm determines a resource that could perform the tasks based on event logs. Unfortunately, the teams of APG do not consist of just generalists. At APG, the distribution of work items is performed once a day, (most of the times in the morning). Work items that arrive after the distribution, wait until the next day. When the algorithm is executed at run-time, as is proposed by the authors, an improvement could be reached.

2.4 Decision factors and performance

2.4.1.1 Literature

Distributors or distribution algorithms allocate or offer work items to resources. Before allocating, several decisions have to be made to whom the work item is allocated and why to this resource. All the factors that are taken into consideration are called decision factors. These factors influence the performance of the executed work item, the resource, the organizational unit, or even the organization as a whole. Both aspects (the factors and performance) are described in this section in more detail.

Allocating work items to humans is more complex than allocating to computer resources [Stefansen et al., 2007]. They noted further *"humans have roles, locations, skills, availability, time constraints, etc. Humans have personal preferences, they possess runtime knowledge, and they may choose to override the allocation rules at runtime*." Each individual is unique, due to education, training, skills, and experiences. They are also distinctive in their seniority, preferences and health, which means different additional education or training preferences and consequently work experience [Cruz-Cruz, 1997]. [Stefansen et al., 2007] noted further *"allocation rules can depend on the organization model, activity properties, runtime info, process state, activity state, observables, history, and legacy systems or other external calls."* All these points can be used to determine the decision. However neglected here are the availability of actors and the workloads of actors [Liu et al., 2008], authorization to execute a task [Russell et al., 2004] and preference and health [Cruz-Cruz, 1997]. Employees, who override the allocation rules at runtime to pursue their personal preference, cause under performance [Stefansen et al, 2007] (e.g. tedious tasks will be not 'pulled' by employees,

however could be allocated on a job rotation policy). *"Job rotation can be effective when there is significant variation in task demands or significant variation in worker capabilities"* [Lodree & Norman, 2006]. Another point in distribution is the variation of demand during the day. "*It is possible to cope with this variability through the judicious use of part-time staff and overtime"* [Ernst et al., 2004].
A decision depends first on, to which resource the work item is allocated: a human or a system, [Stefansen et al., 2007]. Further, it could depend on several variables grouped in factors see Table 2:

Table 2: Decision factors

Factor	Variable	Author(s)
Organizational model	authorization	[Russell et al., 2004]; [Stefansen et al., 2007]
	role: (function + location)	[Stefansen et al., 2007]
Inflow properties	activity property	[Stefansen et al., 2007]
	process state	[Stefansen et al., 2007]
	activity state	[Stefansen et al., 2007]
	variation in demand	[Ernst et al., 2004]
	runtime information	[Stefansen et al., 2007]
Presence	availability	[Stefansen et al., 2007]; [Liu et al., 2008]
	time constraints	[Stefansen et al., 2007]
Knowledge & skills	education / skills / experience / training	[Stefansen et al., 2007]; [Cruz-Cruz, 1997]
	preferences / overrule	[Stefansen et al., 2007]; [Cruz-Cruz, 1997]
	health	[Cruz-Cruz, 1997]
	knowledge on runtime	[Stefansen et al., 2007]
	workload	[Liu et al., 2008]
History	last employee	[Stefansen et al., 2007]

The performance (i.e. consequences) of work distribution is measured with a framework of [Brand & Van der Kolk 1995], called the devil's quadrangle. This framework is intended to depict the effects of Business Process Redesign (BPR), and so it is used in this report to evaluate the performance of work distribution.
The devil's quadrangle distinguishes four dimensions of performance:

- Time
- Cost
- Quality
- Flexibility

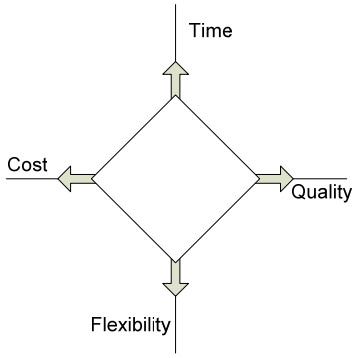


Figure 10: Devil's quadrangle - [Brand & Van der Kolk, 1995]

"Ideally, a redesign of a workflow decreases the time required to handle the case, it decreases the required costs of executing the workflow, it improves the quality of the service delivered and it improves the ability of the workflow to react to variation" [Reijers & Mansar, 2005]. Unfortunately, the improvement is mostly not in all directions, since a property of the devil's quadrangle is that improving on one dimension may have a weakening effect on the other.
[Jansen-Vullers et al., 2007] proposed several performance measures of the dimensions. For the time dimension, the lead time could be used as performance measure. It is the time to handle an entire case. The cost dimension is closely related to other dimensions time (long lead time is a more costly process) or quality (low quality can lead to rework). Direct cost e.g., labor cost is one measure and deals with executing cost of the workflow. Before that, the system has to be implemented, so development costs could be measured (the lower the costs, the better it is). The quality dimension can be measured on two aspects: internal and external

quality. The internal quality is satisfaction of the employees (e.g. work variety, autonomy) whereas external quality is the consistency of work that is produced (e.g. verification of work for the client). A measure of both quality aspects in a metric is not possible, [Jansen-Vullers et al., 2007]. Flexibility can be defined as the ability to react on changes. One of the measures could be routing flexibility, which is the ability to process a case using multiple routes.

2.4.1.2 Link to APG

At APG, several decision factors obtained from literature are used although the teams do not have a common set of factors that are taken into account when distributing work.
The variable last employee is added in GPS1 so that distributors could use this information to allocate the next work item of the case to the same employee, since this employee 'knows' the case and so time and quality is taken into consideration.

The performance criteria of the devil's quadrangle are not all used at APG. The time dimension is important for nearly all the teams, and the external quality is more important than the internal quality when work is distributed. In addition, internal quality as performance criterion is not important for the management. The flexibility and cost dimensions are not taken into account by the distributors at APG. When evaluating the performance of the scenarios, the 4 four dimensions of the devil's quadrangle are used. Important are the measures improvement on lead time, implementation costs of the scenarios, work variety and consistency for the quality dimension and routing flexibility as last dimension.

The performance of the organization also depends on the adaptability of the organization. [Mintzberg, 1983] has described five different structural configurations for organizations. One of these configurations is the Machine Bureaucracy, which could be linked to the characteristics of the organization APG. In Chapter 5, the configuration Machine Bureaucracy and the characteristics of APG are described in more detail.

2.5 Model for a workflow management system

2.5.1.1 Literature

The Workflow Management Coalition, (WfMC) have developed a reference model (see Figure 11). Because of the variety of workflow products in the market, WfMC have constructed a "*general implementation model of a workflow system which can be matched to most products in the marketplace thereby providing a common basis for developing interoperability scenarios.*" [WfMC, 1995]
The reference model consists of a service and interfaces with 5 components. The center of the workflow product is the workflow enactment service. This service and the 5 components are described on in Table 3, although are explained in more detail in Appendix C.

Table 3: Description of workflow Reference model

Workflow enactment service	According to [WfMC, 1995], the workflow enactment service is *"a software service that may consist of one or more workflow engines in order to create, manage and execute workflow instances"*. The enactment service is linked with the 5 components (the interfaces) via WAPI which is *"a set of API calls and interchange functions supported by a workflow enactment"*, according to [WfMC, 1995].
Interface 1: Process definition tools	The business processes are described or designed in different tools (e.g. designed with pen and paper or via a standardized definition tool). The interface import or export the process definition in the form of models.
Interface 2: Workflow client applications	In the process model, (defined in process definition tool) an activity could interact with a human resource. For the interaction with the resource a work list (i.e. software entity for human involvement) The work list forms the queue of work items assigned to a particular user by the workflow engine and communicates with the enactment service and the client applications.

Interface 3: Invoked applications	Although the workflow product consists of standardized applications that can be used as input for the workflow engine, still the need for particular applications is needed (e.g. when the standardized application are not applicable for the function they have to execute.
Interface 4: Other workflow enactment services	The interoperability between two workflow enactment services is important for the invocation of processes or sub-processes, especially when both systems are able to perform the primary business operations. Hence, an interface is needed that communicate between the two workflow enactment services. This is important for the process definitions across multiple workflow enactment services and the runtime control interactions of both enactment services.
Interface 5: Administration & monitoring tools	[WfMC, 1995] noted that *"the proposed interface is intended to allow a complete view of the status of work flowing through the organisation, regardless of which system it is in".* This complete view is most used by management.

2.5.1.2 Link to APG

At this moment, APG uses GPS1 (a workflow management system that administers, manages and executes the pension schemes for the clients). GPS2 is a WFM system that replaces GPS1, at first for just one product (AKP), but in future for other products as well. GPS2 is based on SOA and is built with use of the products of IBM Websphere Suite.
The four most interesting products of IBM Websphere are:

1. Business Modeler *3. Process Server*
2. Integration developer *4. Business Monitor*

These products of the IBM Websphere Suite are more elaborated in Appendix D.

Since the intention of the reference model is to link products of the market to this model, the products of IBM Websphere are mapped to the WfMC reference model, see Figure 11.

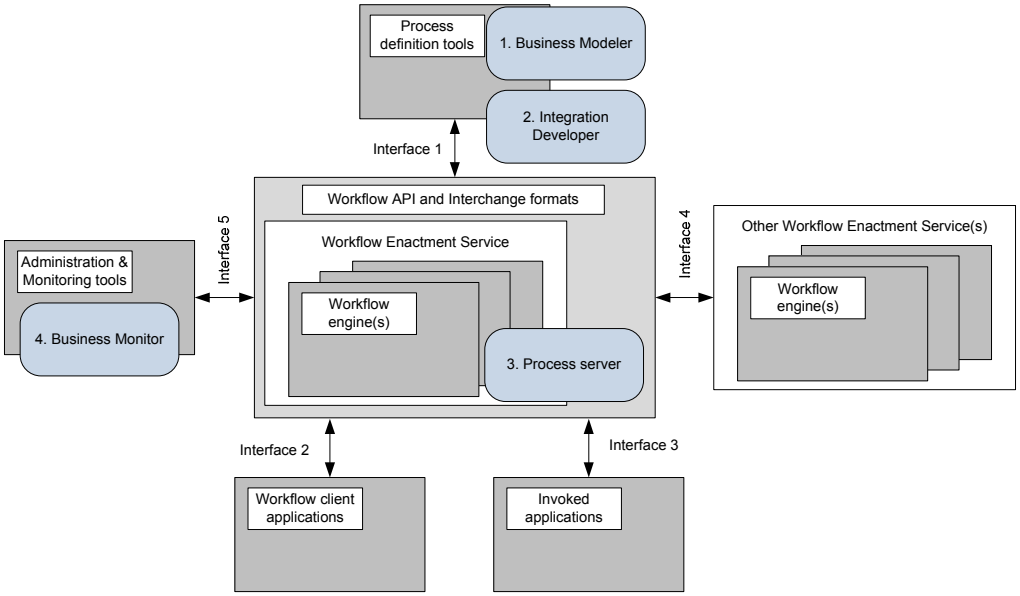


Figure 11: Workflow Reference Model – [WfMC, 1995] and Websphere products

- Business Modeler is mapped to the 'Process definition tools' of the reference model, see Figure 27. What activities have to be done and in which order are created in Business Modeler to define the process structure.
- Integration Developer is linked to the 'Process definition tools' (Interface 1) too. This product imports the models created in Business Modeler and the attributes are assigned to the activities. The navigation and the trigger conditions of the 'Process

definition tools' are assembled in this product. The Integration Developer is a product, between the Business Modeler and the Process Server.

- The Process Server is linked to the Workflow Enactment Service of the reference model see Figure 27. The Process Server creates, manages, and executes workflow instances. Applications may interface with the service such as invoked applications.
- The last product of the Websphere family is the Business Monitor, which is linked to the 'Administration and Monitoring tools'. The status of the processes or instances is managed by the users. In the Business Monitor, different alerts could be established to notify the managers if the status of an instance is crossing the limit.

2.6 Summary

In this chapter, the literature with respect to the project was described and was linked to the definitions used at APG. A review of the literature was conducted and grouped in 5 subjects: workflow management, distribution of work items, case studies, decision variables and their consequences and as fifth a model for a WFM system. This was done to answer the first research question:

Q1: *Which information is available in the literature to support work distribution mechanisms in workflow management systems?*
On all the five subjects literature has been found, although for case studies, the literature was limited. On the first topic: workflow management, literature was found about the definitions on the dimensions of process, case and resource; the classification of resources to roles or units and distribution on run-time. On the second topic, the distribution was depended on the work item lifecycle and was push or pull based. Resource patterns were found to show various ways of how resources were used. In the third subject the case studies were described, of which two were found. The first took into account several shortcomings of WFM systems, whereas the other distributed the items automatically by an algorithm. In the fourth topic, the decision factors in the distribution of work of human resources were obtained. Finally, a reference model for a workflow management system was found.
When the obtained results are compared with APG, the definitions used in the WFM differ, but the classification of resources is the same. The lifecycle of the work item is used in the architecture however the distribution is at this time performed manually. The products used at APG for the workflow management could be linked to the reference model.

The from literature decision factors and performance criteria are left. In the next chapter, the analysis is described, in which those aspects of the distributors are obtained. In addition, the teams are classified in the diagnosis section.

3 Analysis

In this chapter, the current mechanisms of work distribution at APG are described. The aim is to provide an overview of the distribution mechanisms in the different teams within the business units at APG. In the first section, the method is clarified to identify the current mechanisms of distribution. This method forms the outline of this chapter too. In this chapter, the second research question is answered:

Q2: what are the current mechanisms to offer or allocate work by the distributors and what are the decision factors?

3.1 Method

The method used to reach the goal is based on the following steps see Figure 12:

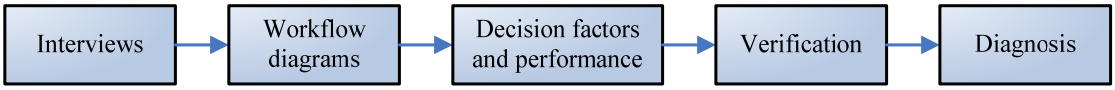


Figure 12: Analysis method

The analysis is started with interviews. In Appendix E an overview of the interviewees and the teams are presented. During the interview, the workflow diagram per team is obtained. This is a diagram of the workflow starting from the demand of a client to the final delivery to a client. If we zoom in on the distributor in the workflow diagram, the decisions for distributing work items to employees and these consequences (or performance of a team) are obtained. After the interviews, verification is performed on different levels and finally, a diagnosis is made.

3.2 Interviews

To obtain the current mechanisms of work-distribution to the employees, interviews are held with the distributors. A structured interview is used to identify several aspects of the distributor, the team, work item properties, and the opinion. Moreover, during the interview the workflow diagram is obtained by a blank sheet approach (e.g. the distributor took a blank sheet and sketched the workflow). In addition, the decision factors taken into account by a distributor are asked. Since those decision factors have consequences on the performance of a team, it is asked during the interview what the performance (e.g. lead time) of a team is. The decision factors and performance criteria are obtained via the same method (i.e. blank sheet approach) and ranked by the interviewee.
The interviews are based on the method of [Emans, 2002] see Appendix F. With this method, the interview is created and conducted with 12 distributors, (see Appendix G). In total 14 different teams are studied to identify the workflow diagrams and the decision variables of a distributor and consequently the performance of a team. All the interviews are recorded and used to check the answers given by the distributors, and additional information is added where needed. Finally, the information obtained is verified by the interviewee.

3.3 Workflow diagram

For each team the workflow diagram is depicted and additional information (e.g. decision factors and consequences) is summarized in Appendix H. In the next figure the general workflow diagram is depicted:

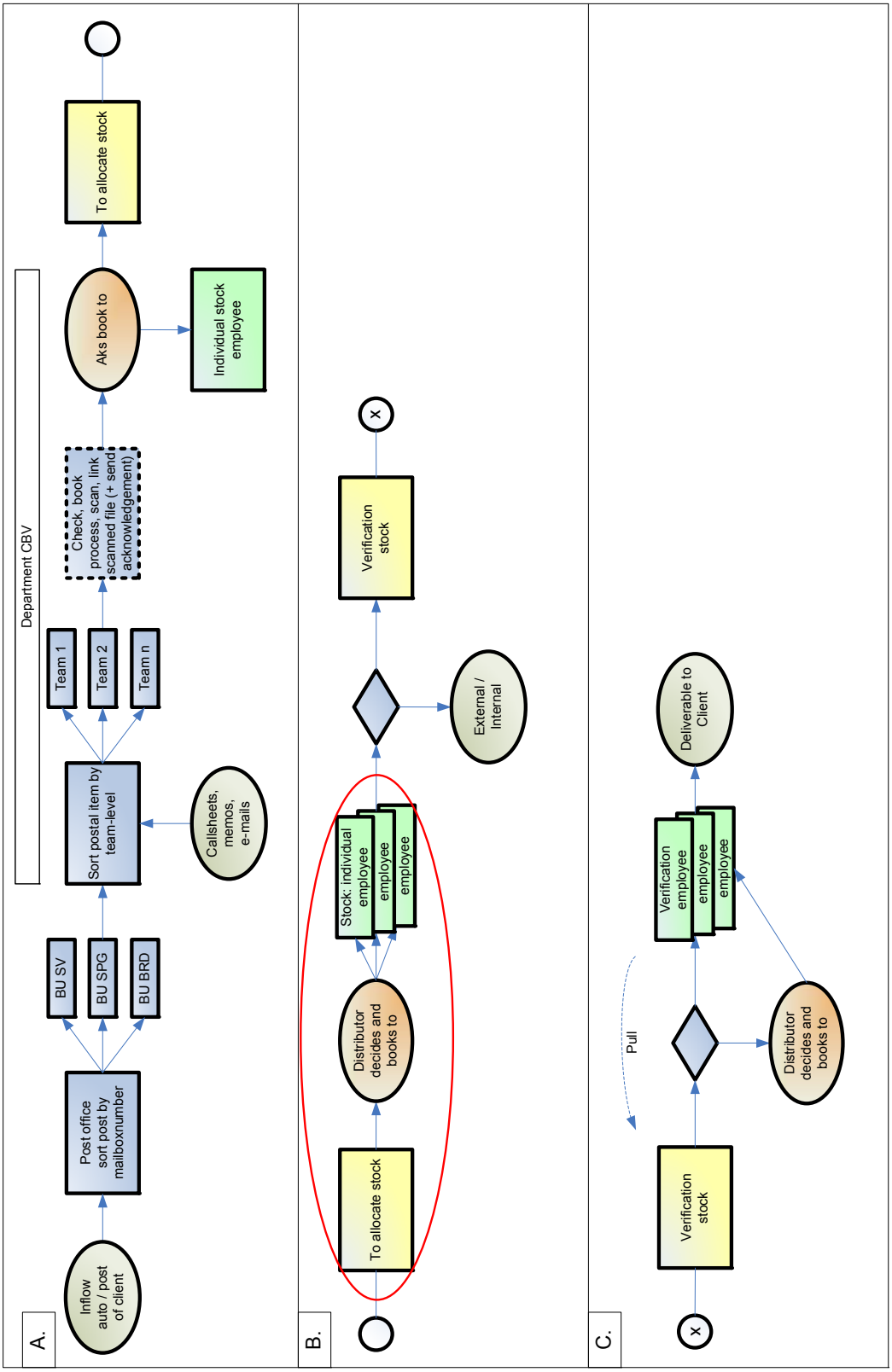


Figure 13: General workflow diagram used by 9 teams at APG

From all the workflow diagrams one general workflow is created. This general workflow diagram is used in 9 out of the 14 teams. Deviations of teams are described in section 3.3.2.

3.3.1 General workflow diagram

The general workflow diagram is a diagram that starts with a demand of a client and ends with the deliverable to a client. In the mean time, several roles such as "Administratieve kracht" (AK), distributor, and (verification) employee are used to provide the client with the right deliverable.
In Figure 13, the general workflow diagram is depicted that is used by 9 out of the 14 teams. Within the (9) teams, the distributor distributes the work items to the employees and distributes the work items which need verification too. Work items, which are verification items could also be pulled by employees from the stock verification.

In the upper left (Figure 13A) we start with the 'inflow auto/post of client' which is the demand of a client. The client sends the post item to a specific mailbox number and the Post Office orders the incoming post based on the first selection method: mailbox number. Secondly, the post is ordered to the right business unit and additionally to the team it belongs, because a clients' demand belongs to a product of APG that is processed at one of the teams. The clients' demand is classified to the right team and the flow continues its way to the box with the dotted line (i.e. the tasks that are executed by the AK). The tasks of the AK are: to check the work item, book the item to a specific process, scan and link the scanned file to the process that is just started. In some cases, an AK sends an acknowledgement to the client, that the post is received. After this, the AK delivers the work item either to the right team (to allocate stock) or to the right person in a team (an individual employee).
In Figure 13B, (continued from Figure 13A) the work items in the 'to allocate stock' are checked by the distributor who distributes the work according to the decision rules, taking into consideration the performance of the team. The verification of the work items depends on the kind of process and the experience of the employee (e.g., managers decide which processes and who of the employees need verification). If no verification is needed (i.e. auto-verification) the work item is finished and the 'Quality Measurement' department checks the quality based on samples.
When verification is needed, the work items are collected in the verification stock and are distributed by either the distributor or the employees themselves according to a pull-mechanism, see Figure 13C. If the verification is completed, the client receives the deliverable.
Despite that the workflow diagram is important, in the report we will only zoom in to the work distribution represented with the red-circle of Figure 13, see section 3.3.3.

3.3.2 Deviation from the general workflow diagram

Since the general workflow diagram holds nine teams, the other teams 'deviate' from the general workflow diagram. In Appendix H the workflow diagrams of the five remaining teams are depicted as well as summaries of the interviews are described. In this section, there is explained why these five teams deviate.

- Team MPG: is a specific team and operates only for clients between the age 64.6 (64 and 6 months) and 65 year. Within this period, the client contacts multiple times with the same employee and is informed about the retirement pension. With use of the "logistieke klok" and the "kapstokcase" (for definition, see List of APG-terms) the client is treated by the same employee during the whole period.
- Team KVI: is the team that processes the work items that consists of general information requests of clients. There is a variety in the requests and to process all the

questions a special group of employees is selected that reads every work item one by one and complete the easy ones. The rest is distributed among the right sub-distributor and employees.

- Team IPHPT: is the team that processes the clients who become incapacitate or clients who receive HPT. Employees receive the work items of multiple distributors who take into account the last 2 numbers of the client number as decision variable (i.e. an arrived work item with client number xxx-xxx-x01 is always executed by a specific employee. Clients are in this way served by the same employee.
- Team VPS: has a similarity with KVI; it is separated in two groups. The first group receives all the work items and processes as many as possible. The second group takes the work items that are difficult and need more time to complete. The distinction between the two groups is made because the stock level was too high which could lead to an increase in the lead times of the work items.
- Team SBG (WO-uit): is a sub-team of SBG, and an AK performs t\the distribution. Before the distribution takes place, a list is set up by the distributor and is given to the AK who distributes the work items to the right employee based on this list.

Team IPHPT is adopted from UWV. At UWV, the distribution of the work items among the employees has been executed based on the client number. Since the team is adopted by APG, the distribution is not changed and the employees have learned the system of APG. Currently the distribution of work items is performed by the (old) decision variable.

3.3.3 *Current situation ('as-is')*

If we simplify the general workflow diagram with the relevant parts for the distribution of work, we receive the stocks and the resources who are directly involved. In Figure 14, the directly involved components are depicted.

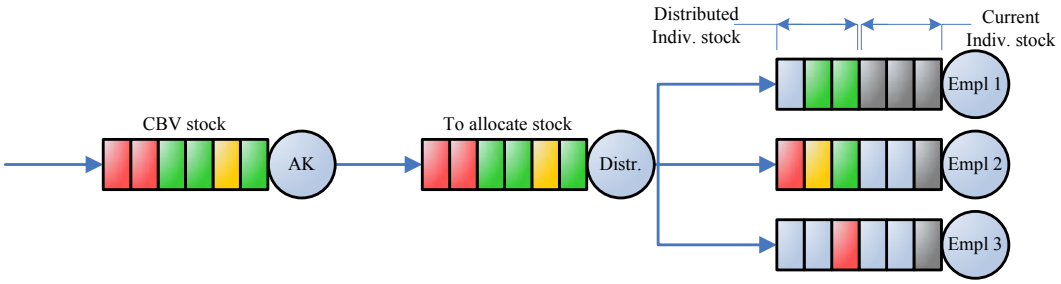


Figure 14: Current situation ('as-is')

Work items (defined here as rectangles in different colors) arrive on the left side of Figure 14 into the stock of CBV. An AK (represented as a circle) processes the work items according a FCFS policy and starts the right process in the system. Then the work item is moved to the 'to allocate stock'. A distributor allocates the work items to the right employee (based on decision factors) and books the item to the specific individual stock of the right employee. At this moment, employees have autonomy to select the work item they prefer form the individual stock, which is called selection autonomy [Russel et al., 2004]. The individual stock is divided in two parts, to make a clear (graphically) distinction between the current individual stock (grey and empty rectangles) and the distributed individual stock (colored and empty rectangles). E.g., employee 1 has three work items in the current individual stock, whereas employees 2 and 3 have both one.

All work items, no matter in which stock they are) need a representative that controls the work items (e.g. if a work item is too long in a stock). In the case of a 'to allocate stock', the distributor is the representative and controls the total number as well as the lead time of work items.

3.4 Decision factors and performance

The decision factors and performance are taken into account by the distributor of work items. This is represented with the red circle in Figure 13. We zoomed in on this part and obtained during the interview, which decision factors and performance criteria are important. From the literature, the decision factors and performance aspects are obtained and used to define the factors taken into account by distributors.
Although nine teams have the same general workflow diagram, the distributors take into consideration a different set of decision factors and performance criteria, as is described in the summary of the interview (see Appendix H). In Figure 15, the factors that play a role (among the different teams) are depicted:

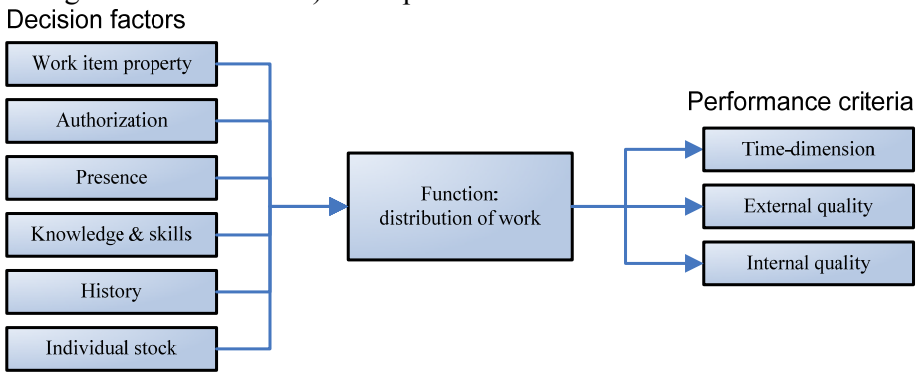


Figure 15: Factors obtained during interviews

The decision factors presented in Figure 15 are explained one by one:

- Work item property consists of variables such as: the number of arrived work items, the delivery basis, kind of processes and kind of inflow (electronic or physical)
- Authorization is a factor that consists of variables such as kind of role, the difficulty of a work item and the kind of employee. An employee can be a specialist or a generalist: the latter is an employee who is allowed to perform all work items within a team. Furthermore, the number of employees within a team could be seen as a variable.
- Presence (i.e. availability) is a factor that consists of variables such as part time / full time presence, vacation, on leave or illness. Scheduling is also a decision variable due to projects that employees also execute, during which they are unavailable to distribute work items.
- Knowledge & skills is the factor that influences some of the other factors too (e.g., authorization depends on this factor). Despite this, the distributor refers with the factor knowledge & skills to: education, skills, knowledge of subjects (depth), but also the width of knowledge (i.e. generalists).
- History is used as a decision variable and is depended on the last employee (i.e. the employee who handled the last work item completed for the client).
- Finally, the individual stock is used as a decision factor, while in the literature it is called workload. The distributors use the concept ‘individual stock’ and although it is personal based, it is a standalone factor similar to authorization.

In Figure 15, the performance criteria of the function work distribution are obtained during the interviews. Asked was which targets the distributor takes into account, during distribution. Two performance criteria of the devil’s quadrangle are answered by the interviewees:

- Time-dimension is the target that is taken into account when distributing work items. Especially, lead time is used: it is the total the time between the start (registered at

APG) and the finish (verified) of a work item.

- External quality is also taken into account. Distributors assess the work item and give the item to the most suitable employee, so that the probability on errors is limited.
- Internal quality is as last obtained during the interview and is the variety in work items that employees get.

During the interviews, the performance criteria cost and flexibility are not obtained. Apparently, these dimensions are not important for the teams.

In addition, obtained is whether the distributor likes his/her job, without the introduction of possibilities for automatically distribution of the work items. Negative answers on this question could lead to positive side effects: the replacement to a non-human distribution is one-step closer (i.e. distribution could be performed via an automatic way). Eight distributors answered the question negatively.

3.5 Verification of as-is situation

With the verification on different levels, it is checked if the obtained results are correct. The interviews are recorded and additional notes are made as [Saunders et al., 2000] proposed. In addition, the workflow diagram and the summary of the interview (see Appendix H) are verified by the interviewees personally. In addition, the results are presented to the managers of CBV of both BUs, and both concluded that this was the expected result.
Moreover, since the performance criteria differs among interviewed the teams, management of the Pension department is interviewed which performance criteria are important at this moment and in the near future and if standardization among all teams is desired.
According to management, it is unfeasible to standardize all the teams and so to perform the distribution under one standard. Since the teams take into account different performance criteria and because the ranking differs, the advice of management is to split the teams in homogeneous groups based on the performance criteria time (i.e. quantity) and (external) quality. For management, it is unfamiliar that teams have internal quality as high performance criterion. In the future, work items are processed as much as possible by Straight Through Processing (STP), according management, see Appendix I. It means that the work items are automatically processed via the WFM system without any interaction of employees. For work items that could not be completed by system (i.e. difficult or special cases), specialists are needed.

3.6 Diagnosis

In a technical point of view, it is desired to support different teams in one way (i.e., a standard). According to management, this standardization is unfeasible for all teams. In this section, the target is to classify the teams into groups, which have the same characteristics, despite of the differences found so far. The performance of teams is used as common shared characteristic to determine the right groups.
During the interviews, identified in teams are the time dimension and both (internal and external) quality aspects as performance criteria, while cost and flexibility are not important for teams. According to [Kumar et al., 2001] work distribution is a tradeoff between performance (i.e., quantity) and quality, see section 2.3. Although most distributors consider both aspects, one of these aspects receives more attention, and hence teams are classified on different variables to obtain which aspect receives more attention. Since both aspects are considered by the distributors, the variables are assessed on both aspects (quantity and quality) to gather a quantity score and quality score per team. The higher the score on an aspect, the more important the aspect is for the team.

Table 4: Variables obtained during interviews

Variable	Teams	KTD	Register partner	CBV - GBA	SBG - DO	SBG - WO-uit	SBG - Vupo	MPG	IPHPT	SVP	VPS	SBO/SAN	GVP	KVI	SAG
General workflow diagram		X	X	X	X		X			X		X	X		X
Distri-bution	Semi-auto							X	X						
	Batch	X	X	X			X			X		X			X
	Case				X	X				X	X	X	X	X	X
Emplo-yees	# empl. in team	14	10	7	8	11	12	28	70	12	14	40	32	40	27
	Generalists	X	X	X	X	X	X	X							
	some Specialists								X	X	X				
	only Specialists											X	X	X	X
Decision factors	Presence	2	1	2	2	1	1			3	2	1	2	3	3
	Individual stock	1		1	3	2	2			2		4	4	4	1
	Work item property							1	1						
	Authorization					4			2				1		2
	Knowledge & Skills				1					4	1	3	3	1	4
	History				4	3				1		2		2	
Perfor-mance criteria	Time dimension	1	1	1	1	2	1	1	1	1	2	1	1	3	3
	External quality		2		2	1			2	2	1		2	1	1
	Internal quality				3	3						2		2	2
Opinion	Negative (-)			X	X	X	X		X	X	X				X
	Neutral (+/-)	X													
	Positive (+)											X	X	X	

Different variables are converted to an interval scale with score (1-5) to determine the right score from the 'score table', see Appendix J. A low score (1) means that teams have low linkage with the specific aspect, whereas a high score (5) represents a high connection.
The variables that are taken into account and are converted to a score are:

- Distribution; divide the teams whether work items are distributed either one by one (i.e. case-based), n work items are selected and allocated to an employee (i.e. batch distribution), or items are already distributed according a system (i.e. semi-automatic).
- Employees; are assessed whether they are allowed to perform all work items (generalists), or just some of them (specialists).
- Decision factors; taken into account by the distributor and are linked to one or both of the aspects. Assumed is that factors 'presence' and 'individual stock' are quantity based and teams in which 'authorization' and 'knowledge & skills' is important are quality oriented. The two decision factors left (history and work item property) are linked to both aspects, see Appendix J.
- Performance criteria; are obtained during the interviews and divide the teams in their performance. The target lead time is linked to quantity, whereas external quality is linked to quality. Internal quality is linked to both aspects, see Appendix J.
- Opinion; is asked about the job of the distributor. The function work-distribution is not challenged by some distributors and assumed is that the distribution is easy. The distribution could be executed automatically, and so those teams are more quantity oriented. If the opinion is positive, it is the other way around.

In Appendix K, a detailed description is explained how the different variables are converted to the right scores.

From Appendix K, Table 5 is copied which provides an overview of the assessment of the variables per team. The quantity and quality scores are averaged per team, and based on those average scores the classification is made. All teams have an average quantity and quality score. When the average score of an aspect is higher than 3.0 (the mean of the interval scale (1-5), the aspect is important for this team. In addition, teams that have a small difference between both scores do not clear focus on one aspect.

Classification: quantity

The first group (the quantity group), nine teams are classified. This group scores high on variable: distribution (i.e. distribution via semi-automatic or batch); employees (i.e. are generalists); decision variables (i.e. presence and individual stock are important); performance criterion (i.e. the time dimension is important) and finally the opinion, since the distributor does not like the job and also assumed is that the distribution is rather easy to perform.

Classification quality

In the second group, it is the other way around. This group is more focused on a case-distribution, specialists in a team, decision factor knowledge & skills and authorization, performance criterion external quality and the distributor likes the job. This group consists of five teams.

Table 5: Results of analysis

	Team	KTD	Register partner	CBV - GBA	SBG - DO	SBG - WO-uit	SBG - Vupo	MPG	IPHPT	SVP	VPS	SBO/SAN	GVP	KVI	SAG
General workflow		x	x	x	x		x			x		x	x		x
Distribution	QNTY	3	3	3	0	0	3	5	5	2	0	2	0	0	2
	QLTY	3	3	3	5	5	3	0	0	3,5	5	3,5	5	5	3,5
Employees	QNTY	5	5	5	5	5	5	5	3	3	3	0	0	0	0
	QLTY	0	0	0	0	0	0	0	3	3	3	5	5	5	5
Decision variables	QNTY	4,5	5	4,5	3,5	3,33	4,5	3	3	3,33	4	3	3	2,33	4
	QLTY	0	0	0	5	1,5	0	0	3,5	2,5	5	2,5	4	3,5	3
Performance criteria	QNTY	5	5	5	3	2,5	5	5	5	5	4	3,5	5	2,5	2,5
	QLTY	0	4	0	2,5	3	0	0	4	4	5	2	4	3,5	3,5
Opinion	QNTY	3	0	5	5	5	5	0	5	5	5	0	0	0	5
	QLTY	3	0	0	0	0	0	0	0	0	0	5	5	5	0
Average	QNTY	4,10	3,60	4,50	3,30	3,17	4,50	3,60	4,20	3,67	3,20	1,70	1,60	0,97	2,70
	QLTY	1,20	1,40	0,60	2,50	1,90	0,60	0,00	2,10	2,60	3,60	3,60	4,60	4,40	3,00
Classification	QNTY	x	x	x	x	x	x	x	x	x	x				
	QLTY										x	x	x	x	x

Explained in more detail are team VPS, which scores on both aspects, and team SAG, which have a small difference between both aspects.

- Team VPS scores on both aspects and the difference between the scores is low (0,40). From the interview summary (see Appendix H), it is concluded that the team consists of two sub-teams. The distribution of this team is in the first team, push based, whereas in the second team it is pull based. Hence, this team scores on both aspects. Since the score of the quality is slightly higher, this team is classified as quality, although the difference is small.
- The difference in team SAG is also small (0,30). The scores on the variable 'opinion' have an impact in this team. Of team SAG, the sub-distributor (substitute of daily distributor) was interviewed, who does not like the distribution, whereas the daily distributor does.

3.6.1 Support for the distributors per group:

For the teams in the quantity group, additional support for the distributor is created by designing scenarios for an automatic distribution mechanism. One of the current (semi-automatic) mechanisms is not preferred to provide the support, since these are typically created for specific groups of clients in the organization (i.e. team MPG) or are copied from history (IPHPT). Hence, they could not be used for the distribution of items for the other teams, however could be input for scenarios. In chapter 4 the different scenarios for the quantity teams are described in more detail.

In addition, for the quality teams, no specific scenarios are created to support the distribution for the distributors. Since the time was too limited during this project, ideas for quality teams are proposed and are further discussed in the recommendation (see section 6.3).

3.7 Conclusion and limitations

In this section, the conclusion and the limitations of the analysis are discussed.
Concluded from the analysis section is that the teams are classified in two groups in the diagnosis part. The diagnosis is based on the data given by the interviewees such as decision factors and performance criteria, and is verified by them. In addition, in a meeting with management, the performances of the teams are discussed. Management could not understand why teams use internal quality as performance criterion. Moreover, the performance criteria costs and flexibility are not used when work items are distributed. Two dimensions are left: the time (e.g. performance is lead time) or quality (e.g. provide consistency in work).
In the literature is obtained there is a tradeoff between quantity and quality aspects [Kumar et al., 2001]. From an information technology point of view, standardization is required, since it is not desired to create different tailor made applications, which are specific for each team. When the views are combined, the distinction of teams in groups is desired for APG, despite of the differences obtained during the interviews.
With use of score tables, the answers of the interviewees are converted to the two aspects: a quantity and a quality score, because those are important according to the distributors. With this approach, the information obtained during the interviews is used and assessed on both aspects to identify which team belongs to which group. In the next table, the teams are classified to the right group:

Table 6: Classification of teams in quantity and quality

Quantity teams	Quality teams
KTD	VPS
SPS-register partner	SBO/SAN
CBV-GBA	GVP
SBG-DO	KVI
SBG-WO-uit	SAG
SBG-VUPO	
MPG	
IPHPT	
SVP	

During the execution of the project, several limitations could be identified.
In the diagnosis, five different variables are used, of which the variable opinion is more related to the internal quality dimension and is not directly linked with differences in the distribution of work items.
Moreover, of the performance criteria, just two are used: quantity and quality, on which all the teams are classified. The flexibility and costs dimensions are not obtained during the interviews, however, there is not asked to. Therefore, just drop of the two aspects is quite rigorous and in future research, the distributors could rank the dimensions of the devil's quadrangle to obtain the importance of the dimensions.
In the current diagnosis, on the variable 'decision factors' some teams score high on quantity, whereas on the next variable 'performance criteria', they score high on quality. Although the answers are verified, some answers are not in one line. This is strange, since both are linked directly to the function of work distribution. When the answers of teams are contradicted, future investigation of the teams is needed in a form of observations.

The classification used in determining which team belongs to which group is in this project based on the average scores. No literature is found how to classify such variables into groups. One option is to classify just the teams, which have a difference in both scores of 2.0. As second option, teams could be classified as quality under specific conditions, (e.g., only when decision factors and performance criteria score more than 3.5). As last, maybe the best option is that a distributor determines the right score on the variables and those results are compared with the answers during the interviews. In such a way, the answers are checked and the data is more reliable. Moreover, the interviewees could give a final score on the quantity and quality aspect to determine the right classification.

3.8 Summary

In this chapter the 'as-is' situation is described. Interviews were conducted with distributors to identify what the distribution mechanism of the team is and which factors they take into account. In addition, the teams were classified in two groups: the quantity teams (i.e. performance is based on lead time) and the quality teams (i.e. performance is based on the quality of work). The research question at the start of this chapter was:

Q2: *What are the current mechanisms to offer or allocate work by the distributors and what are their decision factors?*
The distribution mechanisms used at APG are nearly all push based. Despite the teams used nearly all one of the two basic mechanisms, the workflow diagrams were different among the teams. Moreover, when we look at the decision variables considered by the distributor (e.g. work item properties, authorization, presence, knowledge & skills, history and individual stock) all the teams are unique. These decision factors influence the performance of a team, but only two dimensions (time and quality) play a role according to the interviewees. From literature is obtained that the work distribution is a tradeoff between quantity and quality. For targeted support to the distributors, the teams were classified on these two dimensions. The result is that 9 teams are classified as quantity teams (i.e. performance is the lead time), whereas 5 teams are classified as quality teams (i.e. performance is the quality of work).

At this moment the as-is situation is clear since the different teams are classified in two groups. In the next chapter, scenarios are created on teams, which are in the quantity group. The goal of the project is to provide support to the distributor maybe with an automatic algorithm, and together with the supervisors, the choice has been made to create such an algorithm for the teams, which are classified as quantity.

4 Design

In chapter 3, the analysis of the current situation is described and in section 3.6, the teams were classified in two groups. In this chapter, a design is created for the teams that are classified to the quantity group see Table 5. For those teams, the third research question is answered:

Q3: What are possible mechanisms that can be used to distribute work in the workflow management system and how does the design work?

To answer this research question, five steps are executed. First, the method is described to define how the scenarios are developed. Then the scenarios are presented and assessed on several aspects. After stakeholders have selected one of the scenarios as the most suitable one, it is programmed in a tool and a pilot-run is executed at APG to check if the distribution mechanism could be automated and if an improvement is gathered. Finally, the results of the pilot-run are presented in the last section.

Figure 16: Outline in this chapter

Before the possible mechanisms could be designed, first a goal has to be determined. The goal of the design is to improve on the lead time when the work items are distributed. The lead time of a work item at APG depends on several tasks as is depicted in Figure 17:

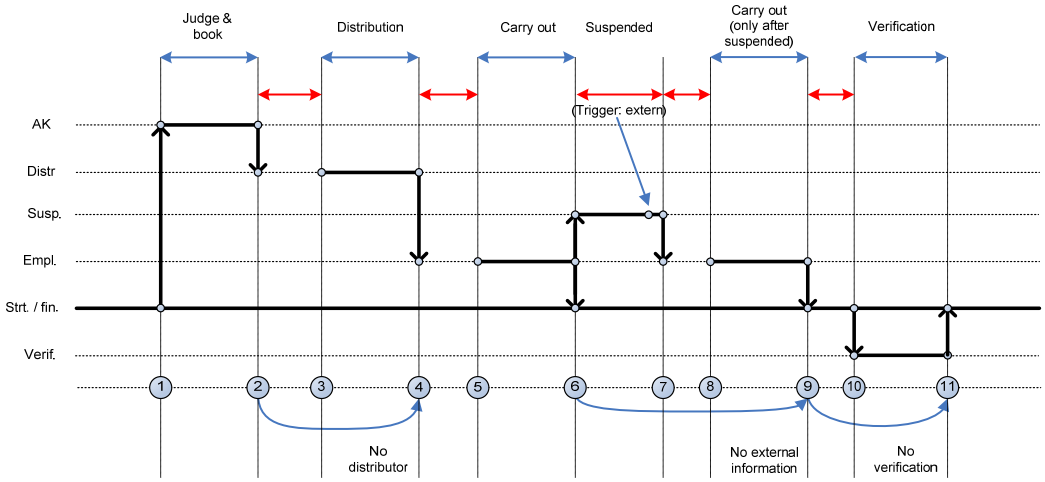


Figure 17: Time frame of a work item

On top of Figure 17, the red arrows indicate a wait time, while the blue arrows are the service times per task. If we sum up the different times, between time-points (1) and (11), we receive the lead time of the work item. A work item is registered at (1): the moment the AK starts to judge the work item and finishes his/her job at (2). The work item is moved to the 'to allocate stock' and waits until the distributor starts the distribution of the work item at (3) and ends it at (4). Then the work item is moved to the individual stock of the employee and waits until the employee starts at (5) and is completed at (6, arrow down) or has to wait for additional information, so the work item is suspended at (6, arrow up). If the latter is the case, the work item waits for an external trigger (i.e. the additional information) and at (7) the work item is removed from suspended and placed in the individual stock. At (8) the employee carries out the next part of the work item and it is completed at (9). Verification starts at (10) and is completed at (11). The different time points are elaborated in more detail in Appendix M.

4.1 Method

In this section, the method is described that is used to come to the design of scenarios. As input the literature, the WFM system (GPS2), and the analysis are used.

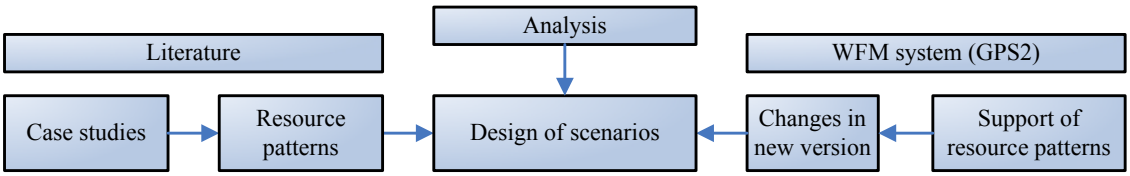


Figure 18: Method for design of scenarios

From the literature side, the case studies and the resource patterns are studied. Two basic mechanisms for work distribution in a WFM system are described: push and pull based. In section 2.3, the case studies found in literature are described. In addition, the some parameters of [Kumar et al., 2001] and the proposal to distribute on run-time [Liu et al., 2008] are taken into account for the design. [Russell et al., 2004] investigated resource patterns, which are various ways in which resources are represented and utilized in workflows, see Appendix B. Although 43 different patterns are found, these patterns could not be used as distribution mechanisms because the former is the representation of resources in WFM systems and are all quite basic, whereas the latter is the actual distribution of work to the resources, which takes into account several factors. Moreover, those resource patterns could be used as input for the design of the scenarios.
On the other side, the support for the resource patterns in the WFM system IBM MQ series (forerunner of IBM Websphere) is investigated, see Appendix L. Changes in both WFM systems (MQ and Websphere is examined), however no additional support is provided. For the distribution of work items, a tailor made application has to be created, which take some time (and thus costs) hence, standardization in distribution of work items is desired from an APG view.
Finally, the analysis (the as-is situation) is used. Decision factors used by distributors as well as the constraints of APG e.g. a responsible person (i.e. the work item owner) who takes care of the work items are used to design the scenarios. Moreover, the goal is to improve the lead time of the work items. Currently, there is no sequential policy (i.e. dispatching rule) used in the individual stocks, because the employees have autonomy to select the work items they prefer. These stocks could be sequenced on the specific policy Earliest Due Date (EDD), [Silver et al., 1998]. In this policy, the work items with the first deadline are processed first. Using this policy an improvement in the lead time could be gained, although this will be relatively small, and so in addition scenarios are designed.

From the literature, two strategies for work distribution are obtained: push and pull [Kumar et al., 2001]. In addition, GPS2 system is analyzed and the implementation of the distribution could be simple or difficult. Implementation is difficult when there is no support for the factors of the designed scenario. Hence, in fact there are two factors each with two variables: strategy and implementation see Figure 19.

For each quadrant, a scenario is created. This leads to four scenarios that are explained in more detail in the next section. In section 4.3, the selection of the scenario is described.

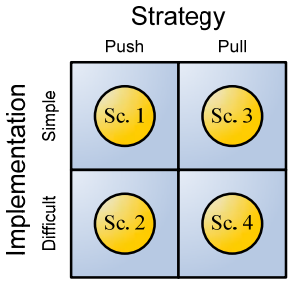


Figure 19: Strategy - implementation quadrants

4.2 Scenarios

In this section, the four scenarios are presented and explained in detail: how those exactly work and where the scenarios originally came from. The 'decision factors' linked to the quantity teams are taken from Figure 15 and in addition, the 'performance criteria' of the scenario are assessed based on the devil's quadrangle (see section 2.4) The changes with the as-is situation are explained per dimension per scenario.

4.2.1 Scenario 1: Push: Round Robin

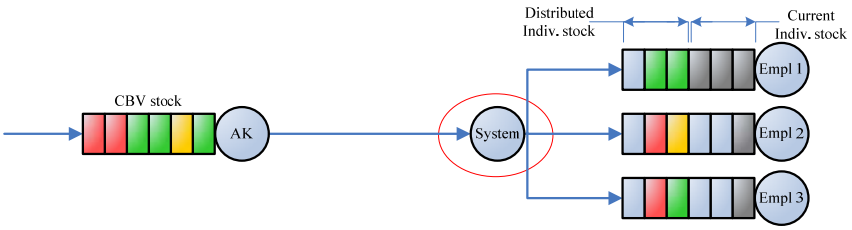
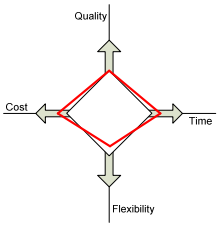
<table>
<tr><td>Origin:</td><td colspan="3">The scenario is based on the literature of [Russell et al., 2004]. It is a simple and equally distributed push mechanism, and requires that only generalists are present in a team.</td></tr>
<tr><td>Literature:</td><td colspan="3">[Russell et al., 2004]: it has "the ability to allocate a work item to available resources on a cyclic basis." The motivation to use this scenario is that "a round robin allocation strategy provides a means of ensuring that all resources are allocated the same number of work items."</td></tr>
<tr><td>Aim:</td><td colspan="3">To distribute the work items equally among the employees on a cyclic basis, to reduce the wait times and consequently the lead times are improved.</td></tr>
<tr><td>Figure:</td><td colspan="3"> 

Figure 20: Scenario 1: Push: Round Robin</td></tr>
<tr><td>Difference with as-is:</td><td colspan="3">It is clear that the distributor is replaced by a system. The system receives the work items directly from the AK (the 'to allocate stock' is unnecessary) and pushes the work items to one of the employees based on the round robin strategy. The system allocates the work items on the FCFS policy and provides an equal work balance situation.</td></tr>
<tr><td>Decision factors taken into account:</td><td colspan="3">Work item properties
Presence</td></tr>
<tr><td>How does it work?</td><td colspan="3">The presence of the employees is registered and the system uses this information when a work item arrives. At that moment, the item is distributed to the first employee. The next work item that enters is distributed to the second etc.</td></tr>
<tr><td>Performance:
 
</td><td>Dimension</td><td>Change</td><td>Arguments</td></tr>
<tr><td></td><td>Cost
(development)</td><td>+</td><td>Although the round robin is not supported by IBM Websphere, it is a rather simple allocation mechanism. Therefore, the costs for development are assessed as positive, which means less time and resources are needed to create the mechanism in practice.</td></tr>
<tr><td></td><td>External quality
(consistency)</td><td>+/-</td><td>When no difference in the work item properties: the generalists are authorized to perform all the work items, so the output in quality is the same. If difference is present, this scenario performs less on the quality aspect, since all employees could receive the item.</td></tr>
<tr><td></td><td>Internal quality
(work variety)</td><td>+/-</td><td>No difference with as-is situation. The employees still receive variety in work items, but now by system.</td></tr>
<tr><td></td><td>Time
(lead time)</td><td>+</td><td>To allocate stock is removed, so wait time could be reduced. The distributor is replaced by a system that could perform the allocation on run-time.</td></tr>
<tr><td></td><td>Flexibility
(routing)</td><td>-</td><td>The system determines the distribution via an algorithm, and so one employee receives the work item.</td></tr>
<tr><td>Implementation:</td><td colspan="3">This scenario is not supported in the WFM system of APG see Appendix L.</td></tr>
<tr><td>Comments:</td><td colspan="3">To run this scenario, the employees have to be generalists, because the decision factor authorization is overruled. In 2/9 teams, the employees are not generalists, hence, this scenario is unfeasible, see Table 5. In addition, the individual stock as decision factor is not used in this scenario, since the employees receive a balanced number of work items that are processed within a time. The expectation is equal individual stocks.</td></tr>
</table>

4.2.2 Scenario 2: Push: based on individual stock

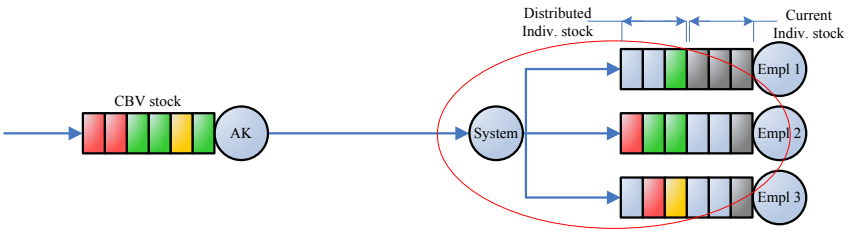
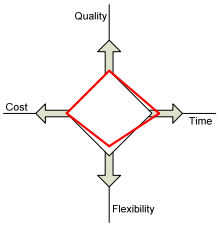
<table>
<tr><td>Origin:</td><td>The scenario is based on scenario 1, but extended with all the decision factors. In addition, the urgency of a work item is used [Kumar et al., 2001]. It is an advanced push mechanism and authorization is included so some specialists could be present in the team.</td></tr>
<tr><td>Literature:</td><td>The two stages scheduling approach of [Subramaniam et al., 2000] is used:
“Stage 1: apply a machine selection rule to identify a free machine to be scheduled
Stage 2: apply a dispatching rule to the machine identified in stage 1”.
In this scenario, the ‘machine’ is an employee and the identification of a ‘free machine’ is in the scenario an employee with the highest available time. To that employee the work item is distributed. The dispatching rule is EDD (see section 4.1).</td></tr>
<tr><td>Aim:</td><td>To distribute the work items to the employee who has the highest available time, so that the distribution is equal with respect to the time available. This will reduce the wait times and consequently the lead times are improved.</td></tr>
<tr><td>Figure:</td><td> 

Figure 21: Scenario 2, Push: based on individual stock</td></tr>
<tr><td>Difference with as-is:</td><td>The ‘to allocate stock’ is removed and the distributor is replaced by a system. The system distributes the work items taking into account several decision factors. Further, this scenario is an imitation of the as-is scenario.</td></tr>
<tr><td>Decision factors taken into account:</td><td>Work item properties, Presence
Authorization, Individual stock</td></tr>
<tr><td>How does it work?</td><td>Required is the presence of the employees registered per day in hours. When a work item arrived, the authorization, presence and the individual stock of the employees is checked, to calculate the available time an employee has (‘available time’ = ‘presence time’ – ‘time in stock’). The employee with the highest available time receives the work item.
In addition, an improvement is made in the priority, as [van der Aalst, 2005] suggested, to improve lead time once more. The priority of a work item is classified in three groups: ‘High’, ‘Medium’ and ‘Low’. This additional property of a work item is used to determine who of the employees will receive the work item.</td></tr>
<tr><td>Performance:
 
</td><td>
<table>
<tr><th>Dimension</th><th>Change</th><th>Arguments</th></tr>
<tr><td>Cost
(development)</td><td>+/-</td><td>Since, this scenario is more difficult to develop than scenario 1 the costs could be higher, which is not desired.</td></tr>
<tr><td>External quality
(consistency)</td><td>+/-</td><td>The same as in the as-is situation: the authorization is used to determine which item is allowed to execute by whom.</td></tr>
<tr><td>Internal quality
(work variety)</td><td>+/-</td><td>No difference with as-is situation. The employees still receive variety in work items, but now by system.</td></tr>
<tr><td>Time
(lead time)</td><td>+ +</td><td>The ‘to allocate stock’ is removed.
The distributor is replaced by a system that could perform the allocation on run-time.
Additional classification of work item is proposed (i.e. High, Medium, Low)</td></tr>
<tr><td>Flexibility
(routing)</td><td>-</td><td>The system determines the distribution via an algorithm, and so one employee receives the work item.</td></tr>
</table>
</td></tr>
<tr><td>Implementation:</td><td>This scenario is not supported in the WFM system of APG see Appendix L.</td></tr>
<tr><td>Comments:</td><td>In the as-is situation the distributor is the responsible who checks the started process of a work item, whereas in this scenario, the AK receives more responsibility. In a more advanced way the scenario is able to plan when which item is executed by the employee, since the average service times are taken into account in determining the individual stock in hours.</td></tr>
</table>

4.2.3 Scenario 3: Pull: selection autonomy

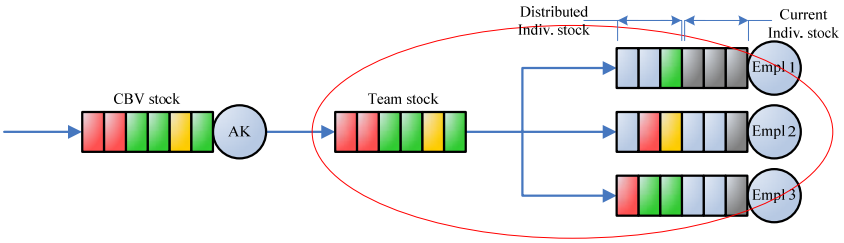
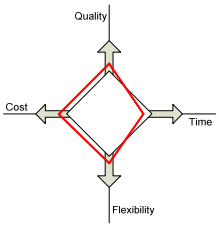
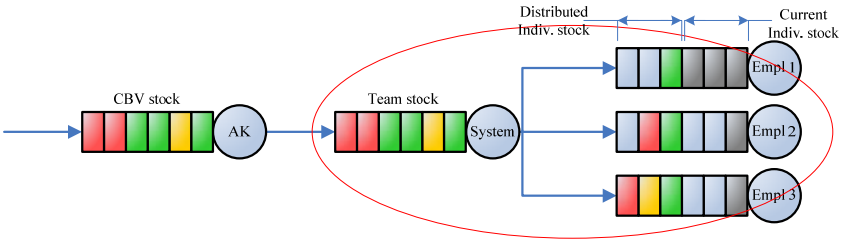
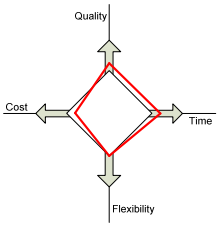
<table>
<tr><td>Origin:</td><td colspan="3">The scenario is based on the support of the WFM system of APG. Therefore, it is a simple pull mechanism, so the work items are offered to multiple resources. The mechanism is suitable for the specialists in the team, since all the employees have autonomy to pull.</td></tr>
<tr><td>Literature:</td><td colspan="3">[Russell et al., 2004}: “The ability for resources to select a work item for execution based on its characteristics and their own preferences” is called selection autonomy. The motivation to choose for this scenario is “it aims to empower resources and let them have the flexibility to prioritise and organise their own individual work sequence”</td></tr>
<tr><td>Aim:</td><td colspan="3">An easy to implement scenario that is able to control the work items in the lead time.</td></tr>
<tr><td>Figure:</td><td colspan="3"> 

Figure 22: Scenario 3, Pull: selection autonomy</td></tr>
<tr><td>Difference with as-is:</td><td colspan="3">The distributor is removed and the employees distribute themselves the work items. The control of the work items is in hands of the employees.</td></tr>
<tr><td>Decision factors taken into account:</td><td colspan="3">Work item properties
Authorization</td></tr>
<tr><td>.ow does it work?</td><td colspan="3">The ‘to allocate stock’ is replaced by a team stock. The employees of a team are authorized to pull work items from the team stock to the individual stock. When the work items are the same (i.e., one kind), the employees pull all an equal part (based on agreements). When work items differ, specialists are needed, hence, the employee pulls only the work items he/she is authorized for (based on agreements with their colleague).</td></tr>
<tr><td>Performance:
 
</td><td>Dimension</td><td>Change</td><td>Arguments</td></tr>
<tr><td></td><td>Cost
(development)</td><td>+ +</td><td>Since the scenario is based on the support of the WFM system of APG, the costs of development are low.</td></tr>
<tr><td></td><td>External quality
(consistency)</td><td>+/-</td><td>The quality will not change, since the work items are executed by generalists. If difficulties do play a role in the work item properties, specialists are needed and the quality of the employees is used.</td></tr>
<tr><td></td><td>Internal quality
(work variety)</td><td>+ +</td><td>Employees are authorized to pull the items they are authorized to and which they prefer.</td></tr>
<tr><td></td><td>Time
(lead time)</td><td>-</td><td>A team stock is needed, so work items are waiting before they pulled. This means, performing the mechanisms on run-time is impossible. Based on agreements, employees have to pull items on a regular basis to reduce the time that work items are in the team stock.</td></tr>
<tr><td></td><td>Flexibility
(routing)</td><td>+</td><td>Employees determine which item they execute, so all the work items could be performed by all the employees in the team, if they are authorized.</td></tr>
<tr><td>Implementation:</td><td colspan="3">This scenario is supported in the WFM system of APG see Appendix L.</td></tr>
<tr><td>Comments:</td><td colspan="3">Preferences of employees play a role in this scenario (i.e. the employee decides which work item is pulled to the individual stock). [Stefansen et al., 2007]: this could lead to under performance, since employees only perform the work items they prefer.
In the as-is situation, the distributor is representative for the work items in the ‘to allocate stock’. At APG all the work items have a (personal) owner (i.e. responsible). Since the employees are the distributors, the work items, which are in the team stock left, have no responsible resource.
Moreover, the target to improve the lead time is assessed as negative. The aim of the scenario is partly reached: it is easy to implement, although the lead time could be not improved, since the team stock is still present. Only with agreements among the employees the lead time could be controlled.</td></tr>
</table>

4.2.4 Scenario 4: Pull: based on individual stock

Origin:	The scenario is based on scenario 3, although is combined with a push strategy as [Kumar et al., 2001] also do. The employee has autonomy to pull, but the system determines which items are allocated to this human resource.
Literature:	The agreements of scenario 3, which has to be made, to perform scenario 3 well, are soft constraints. The preferences as [Stefansen et al., 2007] noted could lead to under performance. With some limitations, the lead time of scenario 3 could be improved.
Aim:	A scenario, that improves the time-dimension of scenario 3 by using of the individual stock to distribute the items more equally. In addition, this scenario has to reduce the number of agreements among the employees.
Figure:	 **Figure 23: Scenario 4, Pull: based on individual stock**
Difference with as-is:	Only the distributor is replaced by a system. The employees determine that they will receive work items, however the system determines which items of the team stock is 'pulled' to the employee.
Decision factors taken into account:	Work item properties, Presence Authorization, Individual stock
How does it work?	The employee determines if he/she want to have work items from the team stock. If this is the case, the system takes into account the decision factors. The system checks the individual stocks of the employees (which are present) and calculate the means of the stocks to determine how and which items have to be executed by the employee. The number of work items that is 'pulled' to the employee depends on his/her individual stock and of its colleagues. Further, an improvement could be made to classify the work items in three groups: 'High', 'Medium' and 'Low'.

Performance:



Dimension	Change	Arguments
Cost (development)	-	It is a difficult mechanism to distribute work items, so the costs are assesses as negative.
External quality (consistency)	+/-	Generalists perform the work items on the same quality as in the as-is situation.
Internal quality (work variety)	+	Although the employee decides at which time he/she wants to have work items, the system determines which item he/she will receive.
Time (lead time)	+	Since the employee 'pulls' work items, which is a mix of work items depending on the classification and the individual stocks, the lead time is improved (e.g., via an equal distribution).
Flexibility (routing)	+/-	An employee activates the system to 'pull' work items to the employee. It depends on which time the employee activates the system. When the employee is later than his/her colleague, he/she will receive other work items.

Implementation:	This scenario is not supported in the WFM system of APG see Appendix L.
Comments:	The assumption in this scenario is that all the employees, which are present, 'pull' work items to his/her individual stock. Only then, the system is able to divide the team stock in the right number of parts. Hence, the number of employees, which are present, has to be registered and an agreement has to be made that all employees 'pulls' the work items from the team stock, once in a day. With this 'pull', the representative for the work items has become the employee. The aim for an improvement in the time dimension of scenario 3 is reached, however, the advantage (low cost) of scenario 3 is limited.

4.3 Selection

4.3.1 Overview scenarios

In the previous section, the different scenarios are explained. In Table 7 an overview of these scenarios compared to the as-is situation is presented and assessed on different points, such as improvements, principles, decision factors, performance, and implementation support. The values presented in the next table are extracted from the previous section:

Table 7: Overview scenarios

	As-is:	**1. push:**	**2. push:**	**3. pull:**	**4. pull:**
Improvements:	**Current situation**	**Round Robin**	**Based on indiv. stock**	**Selection Autonomy**	**Based on indiv. stock**
To allocate stock	Yes	No	No	No	No
Team stock	No	No	No	Yes	Yes
Resource that distributes	Distributor	System	System	Employees	System + employees
Number of work items allocated at once	One by one / batch	One by one	One by one	One by one / batch	Batch
Difference with as-is situation	-	Medium	Low	High	High
Principles:					
Goal (improvement on lead time)	-	Yes, run-time distribution	Yes, run-time distribution	No	Yes, but small
Distribution mechanisms	-	Push based	Push based	Pull based	Pull based
Classification (nr of teams)	-	7 teams	9 teams	9 teams	9 teams
Responsible (owner) for all work items	-	Yes	Yes	No	No
Decision factors: (determined by)					
Presence	Yes (distrib.)	Yes (system)	Yes (system)	No	Yes (system)
Individual stock	Yes (distrib.)	No	Yes (system)	No	Yes (system)
Authorization	Yes (distrib.)	No	Yes (system)	Yes (empl.)	Yes (system)
Work item properties	Yes (distrib.)	Yes (system)	Yes (system)	Yes (empl.)	Yes (system)
Performance criteria:					
Time (lead time)	+/-	+	+ +	-	+
Flexibility (routing possibilities)	+/-	-	-	+	+/-
External quality (consistency of work)	+/-	+/-	+/-	+/-	+/-
Internal quality (satisfaction of empl)	+/-	+/-	+/-	+ +	+
Costs (implementation simplicity)	+/-	+	+/-	+ +	-
Implementation:					
Supported by WFM system of APG	-	No	No	Yes	No

Based on Table 7, different stakeholders select the most suitable scenario that distributes the work items. The managers who select a scenario are:

- Manager of team SVP
- Manager of CBV (BU SPG)
- Manager of CBV (BU SV)

To check whether the lead time of the work items is improved, a pilot has been set up in which the feasibility is checked of the selected scenario in practice. A pilot is executed with one of the teams however; which team was not a matter of course. Team SVP (from the quantity group) was willing to cooperate with the pilot and this manager is asked which scenario is preferred in this team.
Furthermore, both managers of CBV (logistic) are asked to select one of the scenarios. Due to the proposed change of the distribution of work in different teams; the AKs (work in department CBV) start the work items for the different teams and because they are manager of logistic, chosen is to identify which scenario the two managers of CBV prefer, and why.

In the next section, the decision of the three managers is explained which scenario they select as most suitable.

4.3.2 Selected scenario

All the three managers select scenario 2 as the most suitable scenario. The arguments of the managers are listed:

- Due to scenario 3 and 4 both have a team stock, employees have to be triggered to pull the items of the team stock. This change, compared with the as-is situation, is quite high and not desired due to the resistance to change of the organization.
- When the individual stock is used in determining the distribution, the results could be a better equally distribution of the items. The individual stock is used in scenarios 2 and 4.
- Since scenarios 1 and 2 do not have a 'to allocate stock' or 'team stock', whereas scenarios 3 and 4 both have a team stock. The distribution of work items could be performed on a run-time basis in the case when no team stock is present. In addition, without a team stock no responsible is needed.
- Sometimes distributors allocate work items to employees who are not authorized. When a system allocates the work items instead of a distributor, the number of errors will reduce. In all the scenarios, the distributor is replaced by either a system (scenario 1, 2 and 4) or the employee self (scenario 3).
- When scenario 2 runs, the employees perform the work items and a system registers for each item the employee, the start and finish time and the individual stock. An option is to create a stock control system, which determines at which time an employee could be finished with the work items.

Moreover, despite the differences in the decision factors, scenario 2 could be used at all the 9 teams, classified as quantity. Based on the managers, scenario 2 is tested in a pilot.

4.4 Pilot

In this section, the set up of the pilot is described. In addition, a tool, used for the execution of the pilot (i.e. pilot-run) is explained. The pilot-run is performed and the results of the pilot are presented in section 4.4.4.

4.4.1 Goal of pilot

The scenarios are created taken into account one goal: to improve the lead time of a work item during different stages as is depicted in Figure 17. A sub-goal of the pilot is to show that the selected scenario is feasible in practice.
Instead of the lead time, the wait time could be gathered from the databases of APG. The wait time is a well substitute, since, the lead time consists of two times: the wait time and the service time. 95% of the lead time is wait time. Most processes are verified automatically and the number of suspended work items is low. This means, the items are already finished at

time point (6). Furthermore, the service time is not affected, since the distribution of items is improved, not the execution of the items itself. Hence, for most work items the total wait time is the time between points (2) – (3) and between (4) – (5), see Figure 17. Therefore, an improvement in wait time will most likely improve the lead time of the work items and therefore the wait time is from now on further examined.

4.4.2 Description of pilot

The pilot is executed with a distributor that uses the WFM system of APG and a tool (in which scenario 2 is programmed) that provides an employees' name based on several decision factors. Usually a work item is distributed to an employee of a team, based on the decision factors the distributor uses. During the pilot, the work items are distributed by the tool (e.g. inputs are the properties of the work items, and the output is an employees' name). This name is copied by the distributor to the WFM system and the work item is distributed to the individual stock of the copied employees' name. The pilot is executed with real work items.
Team SVP was willing to cooperate with a pilot. This team is classified as one of the quantity teams see section 3.6 and consists of 11 employees (some specialists), items arrive daily (postal items), weekly, and once a month, distributes 125 work items a week, and in total 21 different processes. The pilot is executed for just one week (i.e., five continuous days) to detect the effects on improvement. Finally, team SVP deals with "lussluiting" (LS), see List of APG-terms. The interviewees indicate that LS is an important date and so time point in a month. The pilot-run is executed in the 2nd week after the LS of August and the data is compared with the 2nd week after LS of July (i.e., the baseline).

Before the results of the pilot are described, first an explanation of the tool is presented in next section.

4.4.3 Tool description

To run a pilot, a tool is used in which scenario 2 is programmed. This tool provides an employees' name (i.e., the name to whom the work item is allocated) based on the four decision factors, see Figure 24. This tool is a prototype of the distribution mechanism to check if the items are allocated correctly (i.e., according scenario), and so if the scenario is feasible in practice. Microsoft Excel is used as tool, in which the scenario is programmed. Since the Excel sheet is not linked with any WFM of APG, all the data is entered by hand. During development of the tool, some basic information is programmed as input for the distribution e.g., the processes, service times, deadlines, employees, authorization, presence, individual stocks etc. During the execution of the pilot, just 3 variables are entered by hand: the process ID, the start-date and since some specialists are present at team SVP the variable difficulty item is added. A detailed description of the tool is elaborated in Appendix N.

The decision factors, which are taken into account by the tool, are depicted in next figure:

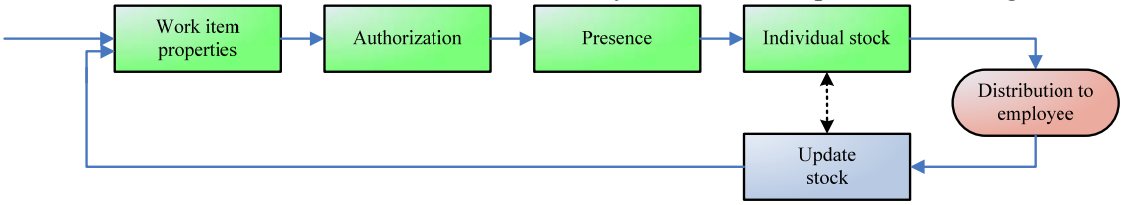


Figure 24: Decision factors of scenario 2

In this figure, the four decision factors are taken into account, before the work item is distributed to the employee (at the right of Figure 24). The rectangle 'update stock' is linked with the 'individual stock' represented with the dotted arrow.

- Decision factor: work item properties

In work items arrived for specific processes. Per work item, just one process could be started and the processes have unique process IDs, see Appendix N. Per process ID, several variables are linked, such as the service time, maximum lead time, the variable “lussluiting”, etc.

- Decision factor: authorization

The authorization is used to determine to whom of the employees the work items could be distributed. Per process ID, the authorization is determined and controlled by the manager. Since team SVP consists of some specialists, an additional variable in the decision factor ‘authorization’ is taken into account that determines the level of difficulty and so deals with the authorization factor, see Appendix O. This difficulty level is judged by the distributor.

- Decision factor: presence

The manager of the team registers the presence (yes/no) and the duration of presence (hours). For the tool, the duration of presence of today and tomorrow is needed per employee to plan which work item will be executed by whom. The presence registration of the employees could be performed once a week.

- Decision factor: individual stock

The individual stock of the employees is used to calculate the time an employee is busy to perform the work items of his/her individual stock. Distinctions (i.e., categories) are made for (i) the work items which have already passed the deadline (i.e., work items are tardy), (ii) have the deadline today and (iii) for items with a deadline tomorrow or later. Per category, the service time is calculated and per employee, these times are summed up. This time is the total service time per category an employee has on stock. The individual stock time (i.e., all the categories summed up) is the total time the employee is busy to process the work items from his/her stock.

- Distribution mechanism

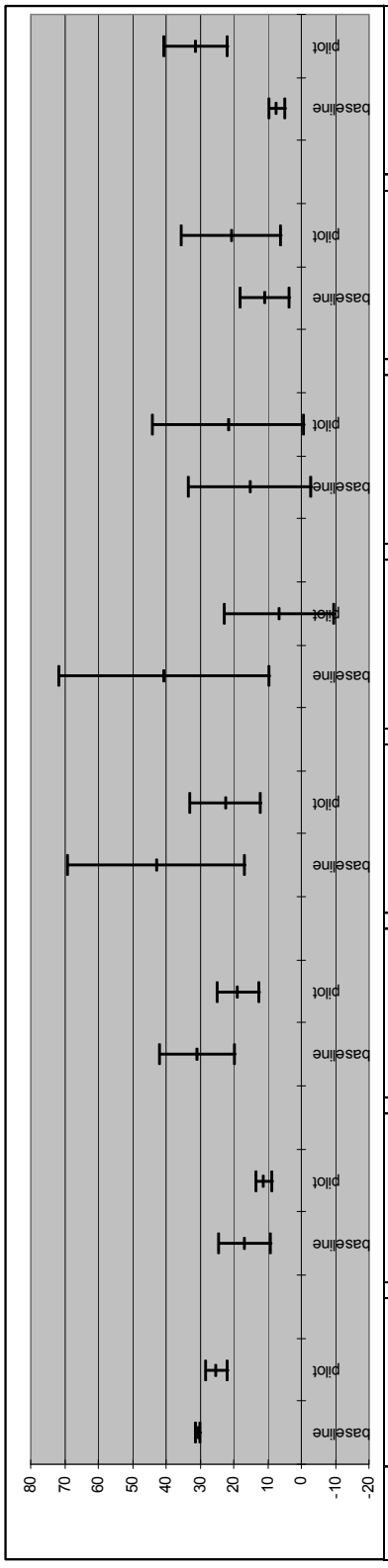
When the four decision factors are taken into account, the available time of the employees could be computed. The available time is time an employee is present minus the time an employee has in individual stock (e.g. today, employee A is 8 hours present, but has on stock 3 hours of work. The available time is then 5 hours). Per arrived work item, the tool determines the authorized employees, uses the available times, and allocates the item to the employee with the highest available time.

Finally, the tool updates the individual stock of the specific employee with just distributed work item and the available time of the specific employee is decreased with the service time that belongs to the work item.

4.4.4 Results and conclusion of the pilot

The data is gathered, prepared (outliers and normality check) and during the analysis, different tests are performed to check if the wait time of the work items is improved. Of the 21 processes, 8 processes are filtered based on the number of arrived work items. Per process ID, the preparation and analysis is performed.
After the outliers are detected and removed, the normality check is executed and concluded is that none of the variables is normally distributed, see Appendix Q. Two tests are performed (the Mann Whitney U-test and the Independent T-test) to check if an improvement in the wait time is reached. Concluded is that 3/8 processes show a significant difference in the mean and so, the pilot shows an improvement of the wait time compared with the baseline, see Appendix S.

An overview of the results of the pilot and the performed tests including their significance level is presented in next table:



Process name	Actieformulier neveninkomsten			Bijsparen OP/NP			Inhouding tbv derden			Neveninkomsten			Overige beheer			Overige herzien			Verzoek Info eigen sit extra			Wijzigen Opbouwgegevens FPU		
Process	PC29WT			PC27WT			PC21WT			PC18WT			PC5WT			PC3WT			PC19WT			PC16WT		
Period	baseline	pilot	sign.	baseline	pilot	sign.	baseline	pilot	sign.	baseline	pilot	sign.	baseline	pilot	sign.	baseline	pilot	sign.	baseline	pilot	sign.	baseline	pilot	sign.
N	756	128		86	73		19	27		19	21		12	5		5	6		10	12		7	8	
Upper	31,1696	28,0812		24,4342	13,3296		41,7387	24,7933		68,9818	32,7078		71,4985	22,3511		33,1175	43,6335		17,9801	35,2038		9,51968	40,6153	
Lower	29,6402	21,8683		9,09102	8,62744		19,3729	12,2526		16,4666	11,8496		9,47906	-9,76298		-3,04275	-1,01547		3,22911	5,89571		4,55746	21,7772	
Mean	30,4049	24,9748		16,7626	10,9785		30,5558	18,5229		42,7242	22,2787		40,4888	6,29406		15,0374	21,309		10,6046	20,5498		7,03857	31,1963	
Std dev	10,7106	17,7606		35,7817	10,0767		23,2018	15,8507		54,4781	22,9113		48,8058	12,9319		14,5612	21,2729		10,3102	23,0638		2,68273	11,2665	
Statistical tests																								
Test	value	sign.		value	sign.		value	sign.		value	sign.		value	sign.		value	sign.		value	sign.		value	sign.	
U	38907	**.000**		2255	**.002**		171	.056		157	.250		14	.092		11	.456		50	.510		0	**.001**	
T	3,357	**.001**		1,434	.155		2,093	**.042**		1,519	.142		2,245	**.042**		-0,557	.591		-1,342	.199		-5,877	**.000**	

Figure 25: Results of pilot

Process ID, PC29WT is most distributed during the pilot (46% of the items) and a description of the process, the hypotheses, and results of the tests can be found in Appendix P.
In the next section, a reflection on the pilot is given.

4.4.5 Reflection on the pilot

In this section, the limitations of the pilot are described:

- Some problems occur during the first two days of the pilot. Issues as the presence of employee was not correct filled in and calculation problems with the individual stock of the employees occurred. These days are not removed, since the time of the pilot-run was limited.
- Not all work items are allocated by the tool, because several work items are distributed internally at team SVP. On average less than 20% of the work items are not distributed by the tool. The distribution is performed manually, so could influence the equal distribution created by the tool.
- The distribution of the work items is executed once a day and is not performed on run-time as was proposed for this scenario (i.e. distributed in the morning). Therefore, in the pilot-run there is still a wait time between time points (2) and (3).
- Although for team SVP in total 21 processes could be started, just 14 different processes are started during the periods. Out of the 14 processes, just 8 processes are started at least 5 times. It is recommended to have at least a sample size of 30 to perform the statistical analysis of a variable, [Hair et al., 2006]. If a sample size of 30 was the minimum level, only 2 processes could be analyzed. Therefore, a longer test period is needed (e.g. 8 weeks) to achieve the desired sample size.

4.5 Conclusion and limitations

In this section, the conclusion and the limitations of the design are discussed.
Concluded from the design section is that scenario 2 is selected and a pilot run is executed at team SVP. For the quantity teams, scenarios are created and the goal was to improve the lead time of the work items. Scenario 2 is selected, which is able to perform the distribution of work items for the 9 teams of the quantity group. A sub-goal is to test the scenario in practice. A prototype of the scenario is programmed in a tool and is used to run a pilot at team SVP. Per process, the improvement in the wait time is measured. Of 21 processes, 8 are selected for the statistical analysis. Concluded is that 3/8 processes show a significant difference in the mean and so, the pilot shows an improvement of the wait time compared with the baseline. For those 3 processes, the wait time is decreased and so the goal is partly reached.
The results show a decrease in the wait time, (and so in the lead time) despite of (i) some start up problems, the first two days, (ii) not all work items of team SVP are allocated by the tool that week, and (iii) the distribution is not executed on run-time but once a day. If those aspects (allocate all work items, without start up issues and on a run-time base) are included (in a new test or pilot in another team) the wait time of the work items could be more improved. In addition, the lead time of work items could be improved when the employees execute the items based on a earliest due date policy.

One of the limitations is the choice to design scenarios only for the quantity teams. For the quality teams, no scenarios are created, just ideas are presented in the recommendations. Second, despite of the 43 resource patterns of [Russell et al., 2004] four scenarios are designed, which are able to allocate the work items to the teams. The 43 resource patterns are a way of representing resources in workflows, which are used for developing the four scenarios. The performance criteria of the different scenarios are assessed on a qualitative point of view. The results are an impression of expectations of how the scenario could perform in practice.
In addition, the selection of the scenario is based on 3 managers. For more completeness, the managers of the other teams could be asked to select one of the scenarios that suits in that team. Scenario 2 is selected by the managers. A ranking of the scenarios is not executed since

all the managers clear indicate that scenario 2 was preferred. This scenario could be used in all the quantity teams, despite of differences between the teams (e.g. the decision factors). For the implementation scenario 1 and 3 have advantages. Although scenario 3 is simple to implement, the change with the current distribution is high, and the degree of adaptability of the organization is low, hence, this change is not preferred at this moment. Scenario 1 is an easy distribution mechanism to allocate the items. Although it is not supported in GPS2, the advantages of standardization and automatic distribution could be used to perform the distribution. Maybe at this moment, the organization is not suited for this algorithm.
Moreover, to run a pilot with team SVP was not a matter of course. It was team SVP, which was willing to cooperate with the pilot. Although this team is classified as quantity team, it scores also on quality, see section 3.6. Team SVP consists of some specialists hence; the decision factor authorization has been updated with an additional variable: difficulty. With use of the additional variable, the scenario is suited for this team.
For the pilot, a baseline, which has the same characteristics as the pilot run has been found. The test is performed without a control group and is based on a pretest and posttest. This is called a 'one group pretest posttest design'. The pretest is not explicit made by the employees, while the posttest is. The test could be improved with use of a control group. For a good test, the groups could be randomly assigned.
Finally, the measurement of the time points could be more accurate. At this moment, some of the time points are available hence, the improvement in wait time could not be calculated accurately. Moreover, due to the unavailable times, it is not sure if distribution of work is the bottleneck in the entire process.

Although the selected scenario is designed for all the quantity teams, the pilot is executed for one team and therefore, concluded is that this scenario is feasible and improves the lead time for just team SVP. From an APG view, generalizations of this result to the other teams could be desired, but no hard conclusions could be drawn.

4.6 Summary

In this chapter scenarios were designed for the - as classified - quantity teams and one of the scenarios is selected as most suitable at APG for these teams. To show that the scenario achieves the goal, a pilot-run was executed in association with team SVP. The results during the pilot-run were promising. The research question at the start of the chapter was:

Q3: *What are possible mechanisms that can be used to distribute work in the workflow management system and how does the design work?*
The scenarios were designed for specific teams and took into account the goal to improve on lead time. In addition, the literature, the GPS2 properties for support and as-is analysis were used to design the scenario. Four scenarios were designed and assessed on several points (e.g. the number of teams for which the scenario could be used and the support within GPS2). One of the scenarios was chosen as a suitable option, and was further processed in a pilot-run. For the pilot-run a tool was programmed that showed how the algorithm works in a more detailed way. Four decision factors were required, which are work item properties, authorization, presence, and individual stock of the employee. Moreover, the work item was distributed to the employee who had the highest available time, which was calculated with the four decision factors. The goal of the pilot-run was to improve the lead time and although the limitations and start-up issues were present, the results are promising: for 3/8 processes the results were significant and supported the goal.

5 Implementation

In chapter 4, a pilot is executed in a tool in which the selected scenario (i.e. the algorithm) is programmed. In this chapter, the goal is to investigate the possibilities of implementation of the designed algorithm in the workflow management system (i.e. an implementation plan for the quantity teams). Since the support of the workflow management system is limited, see chapter 4 and the adaptability of the organization is low, an implementation plan is described considering those aspects and so, the fourth and last research question is answered:

Q4: How will the designed algorithm be implemented in the workflow management system of APG?

5.1 Method

To answer this research question, two aspects are investigated: the technical aspect and the organizational aspect (i.e. the influences of the designed algorithm in the organization). Both aspects are combined to determine the plan of action to provide support for the distributor.

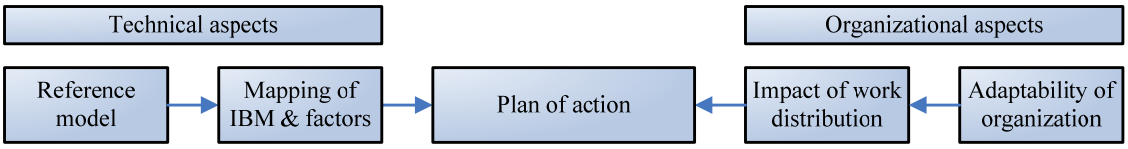


Figure 26: Technical and organizational aspects are used for the implementation plan

In the next section, the technical side is described. In that section, the reference model of a WFM system is linked to (i) the IBM Websphere products and (ii) the decision factors of the tool to investigate the support. In the third section, the organizational side is explained, that consists of the adaptability of the organization as well as the impact of the designed algorithm in the organization. In the fourth and last section, the implementation plan is described and generalizations are suggested.

5.2 Technical aspects

In section 2.5, a reference model for a WFM system is described. IBM Websphere is the WFM system used at APG for GPS2. In section 2.5.1.2, the IBM products are mapped on the reference model of WfMC. To investigate the support of GPS2 on the decision factors of the algorithm, those factors are mapped to this WfMC reference model too and hence, it is mapped to the Websphere products used at APG for investigating the support.
In section, 4.4.3, the four decision factors and the distribution itself are explained. In Figure 27, those factors are mapped on the reference model and the products of IBM Websphere:

- The decision factor ‘work item properties’ is linked to the process server. Properties of the work item (e.g. the start date, max lead time, etc.) are present in the process server and ‘flows’ together with the work item. This factor is thus supported by IBM Websphere.
- Authorization is linked to invoked applications of the reference model. The resource classification of APG consists of different roles, which are determined from functions and organizational units, see section 2.1.2. For each specific process and for the level of difficulty of a work item, authorization is required. Moreover, since APG uses LDAP that requests information from a server, the authorization factor is partly supported by IBM Websphere.
- The decision factor presence is linked to the invoked applications. IBM Websphere does not provide an application to register the availability of employees. At APG, a number of departments use SAP to book the hours worked and to plan their vacation.

This could also be used to register the availability of employees. At this moment, via a portal "Mijn HR" the SAP database is used to show or adjust the hours worked or to plan a vacation. The SAP software is not linked with one of the IBM Websphere products, so it is not supported.

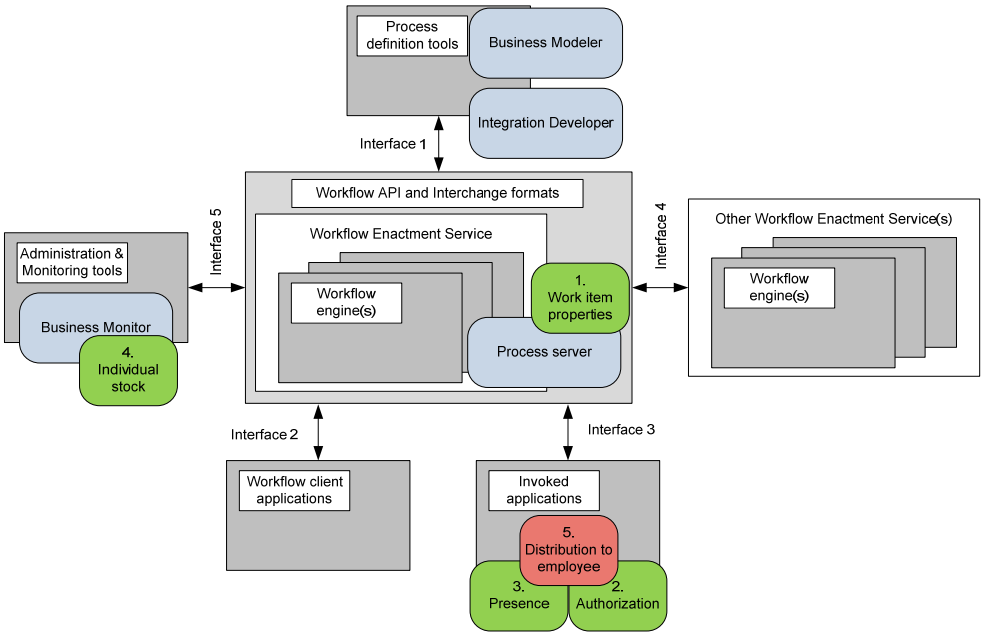


Figure 27: IBM Websphere products and factors of algorithm mapped to WfMC reference model

- The individual stock of the employee is required to determine if the employee has work items in his/her individual stock. Since the scenario could perform on run-time, the individual stock per employee has to be determined on run-time. Monitoring tools could provide the monitoring of the individual stock for each employee. This factor is thus supported.
- The factors (1-4) could be defined in the Process Modeler and assembled in the Integration Developer to distribute the work items. At this moment, the distribution is executed manually, however for the automatic algorithm an application ('distribution to employee') has to be built to replace the programmed Excel sheet. The application is mapped to the invoked application.

Concluded is from this section that the decision factors 'work item properties' and 'individual stock' are fully supported, the decision factor authorization is partly supported, and decision factor 'presence' is not supported by IBM Websphere.

5.3 Organizational aspects

Supporting of the distributor or (if possible), replacing the distributor by an algorithm are both changes in the organization. In this section, the adaptability of the organization is described as well as the impact of the distribution mechanism.

5.3.1 Adaptability of the organization

In section 2.4.1.2 is described that the performance of the organization also depends on the adaptability to suit different conditions. APG is as organization no favorable for changes. [Mintzberg, 1983] has described five different structural configurations for organizations. One of these configurations is the Machine Bureaucracy, which could be linked to the characteristics of APG as organization. APG is a large organization that operates in a stable environment, in which security and reliability is important. From the past, APG is a

bureaucratic organization, in which decision-making is centralized and formalized. [Mintzberg, 1983] classified such an organization as Machine Bureaucracy "*Rules and regulations permeate the entire Machine Bureaucracy structure; formal communication is favored at all levels; decision making tends to follow the formal chain of authority.*"
In addition, the degree of the adaptability of the organization is low. Different stakeholders prefer scenario 2 as most suitable in the organization. This scenario deviates low compared with the as-is situation. "*Machine Bureaucracies are fundamentally nonadaptive structures, ill-suited to changing their strategies,*" [Mintzberg, 1983]. During the interviews is asked, if the distributor had some consult with fellows to obtain how they distribute work. All the interviewees answered with "*no, because it is okay in this team, and I will only gather the information from another distributor if that is needed.*" It is a nonadaptive attitude of the distributors, because they do not feel the necessary to change the distribution.
The adaptability of APG as organization is thus low, which has to be taken into account in the implementation plan for scenario 2.

5.3.2 Impact of work distribution

When the algorithm is implemented, the impact on the distribution of work items is low see section 4.3 (assessment of the scenarios). In this section, the impact of a change in the distribution is explained as well as the impact on the resources who are directly involved.

When the algorithm is used, the distributor is replaced by a system. The distribution could be performed on run-time since the 'to allocate stock' is removed. In this situation, the work items are distributed one by one and directly to the employees, based on the decision factors. This means, the system determines which item is performed by whom. For an equal distribution, the presence of the employees has to be registered in an application by managers or by employees themselves. It could be the case that employees are present according a specific pattern. This pattern could be used as a default present scheme and so only absence of employees has to be registered.
In addition, the work items are no longer distributed to the 'last employee,' because the algorithm is designed for the quantity teams, in which most teams consists of generalists (see section 3.6). Hence, all the employees are allowed to perform different work items. When just 'last employee' is used, the distribution is unequal and so the resource utilization will be.
Finally, at some teams the distributor determines at the same time when the work items are distributed, who of the employees perform the verification. In this project, verification of the work items is out of scope, even though the change of work distribution could have influence on the determination of the verification. It is one of the additional tasks of the distributor, which has to be completed by another resource.

Concluded from this section, is the adaptability of the organization is low and for user acceptance, there is chosen to implement the algorithm according a plan of action, which consists of multiple steps.

5.4 Implementation plan

In this section, both aspects (technical and organizational) are considered to determine how to implement the algorithm in the workflow management system of APG (GPS2). First, the action plan for implementation is described in several steps. After that, a generalization of the action plan is suggested.

5.4.1 Action plan for implementation

Three steps are defined for the implementation plan of the algorithm. These steps are test, part implementation, and full implementation of the algorithm.

- Step 1: test

Since the result of the pilot-run is based on 5 days, the first step is to carry out the pilot for a longer period to conclude if the algorithm performs as expected and desired. E.g., the designed algorithm could be tested for 2 months, so the performance of the algorithm is also tested in weeks of "lussluiting," and to check an improvement in the lead times of the items. For user acceptance, the test could be performed in team SVP, because the employees have participated in the pilot, which is executed without big problems. The distribution is performed by an AK, so no additional distributor (and thus 'to allocate stock) is needed. During the pilot, a prototype of the algorithm is tested and all the required data is gathered by hand and copied into the tool. To avoid errors and for support of the distributor, the prototype is not suited to perform the test.

- Step 2: part implementation

When the results of the test are as expected, the tool could be implemented in the WFM system: GPS2. All the decision factors are automatically 'read' by an application that provides the distribution. Since not all the decision factors are supported in GPS2, some tailor made applications are needed. For the decision factor 'presence' registration is needed that could be performed using the SAP software. In addition, the decision factor authorization is partly supported by GPS2. Authorization per process and for some teams, difficulty per work item is required. Finally, the distribution itself to the employees has to be created in an application, which 'reads' the required input and performs the allocation to the employee. For user acceptance, the current distribution interface is still used, but added is just one column to support the distributor. In this column, the proposed employee's name, based on the algorithm is copied. When the distributor starts with the distribution of work items, an employees' name is proposed and could be used to distribute the items. Moreover, the distributor is still able to use his/her personal decision factors to whom the work item is allocated and so overrule the suggestion of the system. Of course, the aim is the use of the suggested employees' name for the arrived work item.

- Step 3: full implementation

Since the target is to replace the distributor by the automated system, the distributor has to be removed. The work items are then distributed according to the algorithm without interrupting of the distributor by hand. To achieve this goal, the number of times the distributor follows the algorithm or ignores it, could be measured. When the percentage of applying the algorithm is high enough (e.g. 80%), the distributor could be removed, and the algorithm performs the distribution.

5.4.2 Generalization of the action plan for APG

The proposed plan is a setup of how to implement the algorithm in the organization considering the user acceptance and the shortcomings of the technical side. In this section, a generalization of the action plan is described.
During the execution of this project, GPS2 is investigated for the support of the decision factors of the tool. At this moment, for AKP (one product in a sub-team of SVP) GPS2 is under development. Further development of GPS2 for the other teams will take more time than expected. In addition, the current distribution of work items is performed with GPS1. Since the lead time of work items is improved in the pilot and expected is that it will during the test (step 1), the suggestion is to implement the algorithm in GPS1. Because the architecture of GPS1 is much more difficult and the investigated support of the decision factors in GPS2 could not copied to GPS1, the implementation will take a bit longer using GPS1. When a general service is built which could be used by both GPS systems, GPS1 users

could use the service for distribution, and when GPS1 is replaced, the service is ready for GPS2.
In section 5.4, scenario 2 is implemented in a three steps approach. In the first step is determined that the test is executed at team SVP. In section 4.5 is described that only for team SVP a conclusion could be drawn, and for the other teams just expectations could be described. These points are considered in determining the sequence of implementation:

- The suggestion is to start a test with team SVP to check if the results are as expected, based on the Excel sheet. When the results are as desired, the algorithm needs to be programmed in a service called 'distribution' which could be used in GPS1 and GPS2. The algorithm has to be programmed in such a way it could be used in other teams as SVP as well.
- For user acceptance, the service 'distribution' is first implemented at team SVP, because the pilot has been tested in this team. As second, the algorithm could be implemented in 'Register partner' of team SPS. In this team, the distribution is performed by a trainee and the number of different processes is low. This team is classified as quantity, and scores low on the quality aspects. When the distribution is as expected in this team, for teams KTD, CBV-GBA, SBG-VUPO, SBG-Do and SBG-WO-uit the distribution mechanism could be implemented. All those teams are classified in the quantity group.
- The other teams of quantity: team IPHPT, MPG and VPS have their own workflow diagram. For teams MPG, a specific algorithm is designed, which is based on multiple contacts during a period with one client. Since scenario 2 does not consider the history, scenario 2 could not be used in team MPG. In addition, team VPS has split its team in two groups: "dagagenda" and "oud voorraad". In the former group, the algorithm could be used, since a distributor allocates the items, whereas in the latter, the employees pull the 'old' work items, and so the algorithm is unsuitable. Finally, although team IPHPT distributes on the client number, scenario 2 could be used to allocate the work items to the employees. The employees of this team receive a wider range of clients (i.e., not only clients in a specific range). In practice this means, the decision factor last employee is not used.
- The scenario is created for the quantity teams. When standardization is required over all the teams, the scenario has to be used by the - as classified - quality teams. The scenario is unsuited for those teams but, an option could be that the quality teams will more focus on the quantity side. If this shift in performance for the quality teams is a realistic one, is material for future research.

5.5 Conclusion and limitations

In this section, the conclusion and the limitations of the implementation are discussed.
Concluded from the implementation section is that scenario 2 could be implemented in GPS2, even though some tailor made applications are needed.
The section 2.5, the model of WfMC is used as reference model for the products (Websphere Suite) used at APG for GPS2. In addition, the decision factors of the tool are mapped to this reference model and concluded is that the factors presence and authorization are not fully supported. Tailor made applications are needed to perform the distribution of work items as is designed in scenario 2. On the other side, organizational aspects are considered. APG scores low on the degree of adaptability of the organization, due to the structure, and for the impact of changes in the work distribution, an implementation method based on steps is used. The implementation consists of three steps: a test in team SVP to check if the results obtained in the test are as expected. The second step is to implement a service 'distribution' (which could be used in GPS1 and GPS2), that suggests an employees' name, based on the designed

scenario 2. The distributor is at moment supported. The final step is to replace the distributor by the system, when the distributor does not overrule the system.

One of the limitations is that GPS2 is examined for the implementation of the scenario, while at this moment, nearly all teams use GPS1 as WFM system. In this project, GPS1 is not investigated to determine if scenario 2 could be implemented.
In addition, some of the decision factors are not supported by GPS2. This means - as is presented in the quadrant see Figure 19 - the implementation is difficult, and will take some time before the scenario could allocate the work item to the employee.
The decision factor 'last employee' is not taken into account, when work items distributed. The quality and the lead time of the work item could be improved, when the employee knows the case and thus last employee is used as decision factor. During the test, an investigation is needed if this factor is important for the quantity teams.
Finally, the implementation plan is determined based on expected results. When the results of the executed test (i.e., the first step of the implementation plan) are not as desired, an additional plan is not provided. In such a situation, future research is needed to identify the current distribution of work and if support for the distributor is still needed.

5.6 Summary

In this chapter, the reference model of a WFM system is used to map the products of the IBM Websphere Suite (used at APG for GPS2) and the four decision factors from the algorithm programmed in the tool. Further, a plan of action was described how to implement the scenario in the WFM system of APG. The research question at the start of this chapter was:

Q4: *How will the designed algorithm be implemented in the workflow management system of APG?*
In this chapter, the technical as well as the organizational aspect were studied. First, the technical aspects of (i) the IBM Websphere products used at APG and (ii) the factors of the designed algorithm were examined. Two factors of the algorithm were not fully supported by IBM Websphere (used for GPS2): the availability registration of the employees (i.e. the presence factor) and the authorization for each unique process ID. On the organizational side, the degree of adaptability of the organization was discussed and was assessed as low. Changes in the organization do not fit the structure of APG. In addition, the impact of a change in the distribution was described, and was low. The presence of the employees has to be registered, which could be performed by management of the employees. For the implementation, three steps were determined. First, suggested was to execute a test, which verifies the obtained results during the pilot-run. If the desired improvement is achieved, (part) implementation of the scenario in WFM could be started. As final step, the distributor could be replaces by the system, when the system provides the distribution without overrule of the distributor. For user acceptance, the current interface is used, but added is a column with the suggested employees' name, to support the distributor.
Moreover, there was suggested to provide a service 'distribution,' which could be used by GPS1 and GPS2, because GPS2 is under development and the improvement in the lead time could be reached when it is implemented and used directly.

6 Conclusions and recommendations

In this chapter, the conclusions of the project are described in the first section. In the second section, reflection and limitations of the project are summarized. In the third section, recommendations are given and finally, materials for further research are suggested.

6.1 Conclusion

The main goal of this project is to identify how to support the distributor during the execution of work distribution (e.g. the distributor could be replaced by an automatic way of work distribution, called an algorithm).

For support to the distributor, interviews are conducted with 14 distributors. The answers are collected and processed, and results in a classification of the teams in two groups: the quantity teams (i.e. performance is based on lead time) and the quality teams (i.e. performance is based on the quality of work).
For the nine quantity teams, a design for a distribution mechanism is created, which could either replace the distributor or support the distributor during the allocation of the work items. This distribution mechanism is executed (in a pilot) at team SVP, and shows for some processes a significant decrease in the wait times of the work items during the pilot compared with the baseline. However, the wait times could be improved more, when all the work items are distributed by the tool and the tool executes the allocation on run-time.
Unfortunately, the pilot is executed just for one team, so the conclusions for team SVP could not be generalized for all the quantity teams. In addition, an implementation plan is described that consists of steps for user acceptance. Suggested is that at first, team SVP tested the algorithm for a longer period, and when the results are satisfying the algorithm could be created into a service.
The algorithm has to be implemented in a service, which can be used in both WFM systems of APG (GPS1 and GPS2). When the algorithm is implemented in GPS1, the lead time of the work items could be improved, due to an equal distribution mechanism, which takes into account the work item properties, availability of employees, authorization to the processes and the items in the individual stock. Based on these four factors, the teams in the quantity group could perform the allocation of the items to the employees on a run-time basis. Due to a run-time allocation and an equally distributing mechanism, the items could be started earlier by the employees, which decreases the wait time, and probably improves the lead time, of the work item. When GPS1 is replaced by GPS2, the service is already suitable to be migrated to the new workflow management system of APG. Due to user acceptance, team SVP will start with use of the service, and gradually other teams (classified as quantity) could use the algorithm.

6.2 Reflection / Limitations

In chapter 3,4 an 5 different limitations and reflections are given. In this section, the aspects are of a more general way.

- In the analysis part, the answers obtained from the interviews are converted in to a quantity and quality score. The approach is explained, but not supported with literature. When literature was found for the score tables, the classification of the teams in the diagnosis section was much stronger. In addition, just the teams classified as quantity teams are taken into account for a design. For the quality teams, some ideas are generated.
- The pilot was just executed only in team SVP for one week, where a longer period is needed to gather a larger sample size. The conclusions drawn in the section are based

on a ‘one group pretest posttest design’. The obtained significant differences in the wait times are for three processes. In addition, the test executed in the pilot gives insight that the algorithm is feasible in the organization. Moreover, since the algorithm is designed for 9 teams, however is executed at just one team, no generalizations of the results to the other teams could be concluded.

- The project originates from GPS2 and so the GPS2 architecture is studied, while at this moment GPS1 is used at APG. As described in the implementation plan, a service is required which have to call both WFM systems. Since the architecture differs, it could not be copied from one to another. In addition, no costs-benefit analysis is executed, so at this moment, it is not clear if an algorithm outperforms the distributor.
- Tested is just one scenario in a pilot in one team. The other scenarios are only on a qualitative point of view assessed. This means, no hard conclusions for the selection of scenario 2 could be given. Since the pilot is executed at team SVP, the implementation depends on a test executed for a longer period within team SVP. Only when these results are satisfying, the implementation plan could be followed.
- Moreover, the terminology used in the concepts of GPS1 vs GPS2 is different and could confuse the employees. Although the concepts are described in this report, see section 2.1, the interviews in this report are based on interviewees who used GPS1, while investigated are the possibilities of GPS2. The architecture of both WFM systems differs, and in GPS1 the distribution are processes, whereas in GPS2 the distribution are tasks. Although different concepts are distributed, the scenario could distribute all concepts as long as the required input is consistent.

6.3 Recommendations

- Scan all the incoming postal items and train the employees to use only these files. At that moment, the physical flow could be removed, and only the electronic flow is present. When the electronic flow is just the flow at APG, the work items (when digitalized) could be distributed at run-time, which could reduce the lead times of the work item.
- The registration of availability of the employees is required. Although at APG an application is present (“MijnHR”), it is not used at the whole organization. Moreover, the registration of availability is used to plan a vacation, and it is not used when work items are distributed. The registration is required for the algorithm and so a simple registration application (in which the planned hours to work could be filled in) is sufficient. In addition, when employees are absent according a pattern, this could be the default in the presence registration. Only ad hoc changes have to be registered in the application.
- Test the prototype of the scenario for a longer period in team SVP. In this team, the pilot is executed and the users accepted the algorithm. When the results of the test are satisfying, implement the algorithm in a service, which could be called by GPS1 and GPS2. On a short term, the mechanism could be used during the use of GPS1 and when the GPS1 is replaced, the algorithm is ready for the future.

In chapter 3, during the diagnosis, the teams are classified in two groups. For the quantity group, four scenarios are created, while the quality group no scenario is developed. Ideas are created during the execution of this project, which are

- Present the distributor the information when it is needed. So, limit the time a distributor is seeking information. When the information of the work item is filtered (or marked) by a system and is provided to a distributor (via a monitor) the

distribution could be performed with just one view and so the time of distribution is reduced

- For the distribution in quality teams, it is important which properties of a work item are important. Imaginable is that the authorization of who is allowed to perform which work item will be rather complex, and so for the quality teams authorization depends on more then the roles defined in the authorization, but also on specific details of the work items. So, a refinement of the decision factors is needed (e.g., which characteristics are important for determining to whom the work item is distributed?
- Finally, a combination of a push and a pull scenario could be created. In the form of compulsory work items (for specific processes) which are pushed to employees and free work items which could be pulled by the employees. In such a situation, further research is needed for which processes this is suitable.

6.4 Future research

Future research is needed to determine if scenario 2 could also be used for the teams that are classified to the group of quality. Team SVP is assessed as quantity team however scores also on the quality side. The distribution of work items in this team is executed according to scenario 2, and it could be that one of the quality teams would like to use scenario 2 as well for the distribution of the work items.

More research is needed to determine if the distributor could be replaced by a system. Post items are now scanned for the employees so that the flow of post is electronic and the physical paper flow is removed. When post items are ‘read’ by a computer and recognize words, determined can be which process has to be started for which work item. When this technique is used in a more advanced way, the difficulty of work items could be ‘read’ too and could be used to replace the distributor of one of the quality teams.

Further research is required for quality teams. However, thoughts are to adjust the variables of one of the factors of the algorithm, in such way that quality teams are suitable too for the designed algorithm. In addition, in the quality teams the distribution of the work items could also be performed with a combination of a push and pull strategy. For this mechanism, a distinction is required which processes could be pushed, and which not. For those processes, which could be pushed, the designed algorithm is suited.

Since the manager of Pensions said that in future the post items are processed via Straight Through Processing and only qualitative work items are dropped by the system, those dropped items have to be performed manually by employees, who have the required knowledge. In which way these work items are distributed well is material for further research.

List of APG-terms

Table 8: Dutch terms used in master thesis

Products in Dutch	**Explanation**
ABP OuderdomPensioen (OP)	ABP Retirement Pension
ABP NabestaandenPensioen (NP)	ABP Surviving Dependants Pension
ABP KeuzePensioen (AKP)	ABP Multi-Option Pension
ABP Flexibel Pensioen en Uittreden (FPU)	ABP Flexible Early Retirement Pension
ABP Arbeidsongeschiktheids Pensioen	ABP Incapacity Pension
ABP InvaliditeitsPensioen (IP)	ABP Disability Pension
Herplaatsingstoelage (HPT)	Redeployment Benefit
Terms in Dutch	**Explanation**
Kapstokcase	Together with the "logistieke klok" a case for a specific process (and so a work item) is started. During a period of 6 months (between 64.6 and 65) the client has multiple times contact with just one employee. Since the client is serviced by the employee the work items that arrived are hung on a coat and hat stand (i.e. "kapstok")
Logistieke klok	Application that triggers once a month the clients (e.g. which become 64.6) and automatically a work item is started, belonging to the "kapstokcase"
Lussluiting (LS) (BU SPG)	At BU SPG, pension payments have to be paid before a specific date. To guarantee the client the payment in such a specific month, a date is selected to which demands of clients are processed and paid within the same month. This date is called "lussluiting" and is used as a deadline for the work items that enters before the "lussluiting." Work items that arrived after the date receive the next "lussluiting" date as deadline. Distributors take into account the work items that are "lussluiting" based and in the week of the "lussluiting" employees have to execute these items.

List of Abbreviations

In this paper, the following abbreviations are used. APG is a Dutch company and use several abbreviations, which are based on Dutch words. In the following list, the abbreviations are listed with a short description.

Table 9: Abbreviations used in project

Department Pensions:		
Abbrev.	**In Dutch**	**Explanation**
BU BRD	Bijzondere Regelingen Defensie	BUSINESS UNIT that concerns with the special regulations for employers and employees worked for the military protection.
BU SPG	Service Pensioen Gerechtigden	BUSINESS UNIT that concerns with the service for persons who are entitled for pensions
BU SV	Service Verzekerden	BUSINESS UNIT that concerns with the service for insured persons
GVP	(Gerechtigden vervroegd pensioen) Met FPU gaan	TEAM that grants Flexible Early Retirement Pension or Multi-Option Pension
IP/HPT	Invaliditeit Pensioen / Herplaatsingstoelage	TEAM that grants and services clients Disability Pension and / or Redeployment Benefit
KID	Klant treedt In Dienst	TEAM that services clients when they enter
KVI	Klant Verzoekt om Informatie	TEAM that services clients, when they have a request and needs some information
MPG	Met Pensioen Gaan	TEAM that grants Retirement Pension.
SAG	Service Aan Gepensioneerden	TEAM that services retiree during their Retirement Pension
SAN	Service Aan Nabestaanden	TEAM that services retiree during their Surviving Dependants Pension
SBAP	Service Bij Arbeidongeschiktheid Pensioen	TEAM that service retiree during their Incapacity Pension
SBG	Service Bij Gaan	TEAM that services client when they leave
SBG DO	Diensttijd Onderzoek	Sub-team of SBG that services clients in registering their time of deployment
SBG VUPO	(Vervroegd) Uniform Pensioen Overzicht	Sub-team of SBG that service clients a (early) uniform Pension Overview
SBG WO-uit	Waarde Overdracht uit	Sub-team of SBG that services clients in asset management when leave
SBO	Service Bij Overlijden	TEAM that grants Dependants Pension
SPS	Service Persoonsgegevens	TEAM that services clients when client register new partner / divorced
SVP	(Service Vervroegd Pensioen) Met FPU zijn + AKP	TEAM that services retiree during their Flexible Early Retirement Pension or Multi-Option Pension
VIK	Verstrekken Informatie aan Klantgroepen	TEAM, that services the organization in communication, does not distribute work items
VPS	Verevening Bij Scheiding	Sub-team of SPS that service clients during their divorcement
APG abbreviations:		
Abbrev.	**In Dutch**	**Explanation**
AK	Administratieve Kracht	An employee who executes the lower level of work (working at department CBV or logistics)
APG	Algemene Pensioen Groep	All Pensions Group
CBV	Centraal Bericht Verwerking	Department that concerns with processing of the postal items from post office to the right team
CIS/CIM	Afdeling ICT	Department: Concern Information Systems / Concern Information Management
EVW	Eerst Volgende Wijziging	Upcoming change

GBA	Gemeentelijk Basis Administratie	Municipal Administration
GPS	Generiek Pensioen Systeem	General system that is used to administer, communicate and manage the pension schemes
PMSs	Proces Materie Specialist	An employee in a team which is a specialist in what have to be executed and how at a specific domain
SVB	Sociale Verzekerings Bank	Organization that implements national insurance schemes in the Netherlands
UWV	Uitvoeringsinstituut Werknemers Verzekeringen	Executes the employee insurance by the Ministry of Social Affairs and Employment
VUT	Vervroegde Uit Treding	Regulation of the Dutch government to stop with working before the age of 65.

Other abbreviations:

Abbrev.	**In Dutch**	**Explanation**
BPEL	-	Business Process Execution Language
BPR	-	Business Process Redesign
EDD	-	Earliest Due Date
FCFS	-	First Come First Serviced policy
ICT	-	Information and Communication technology
KPI	-	Key Performance Indicators
LDAP	-	Lightweight Directory Access Protocol
SAP	-	In German: Systeme, Anwendungen, Produkte in der Datenverarbeitung
SOA	-	Service Oriented Architecture
STP	-	Straight Throuh Processing
WADP	-	Workflow Application Development Process
WAPI	-	Workflow Application Programming Interface
WFM	-	WorkFlow Management

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Appendices

A. Organization chart

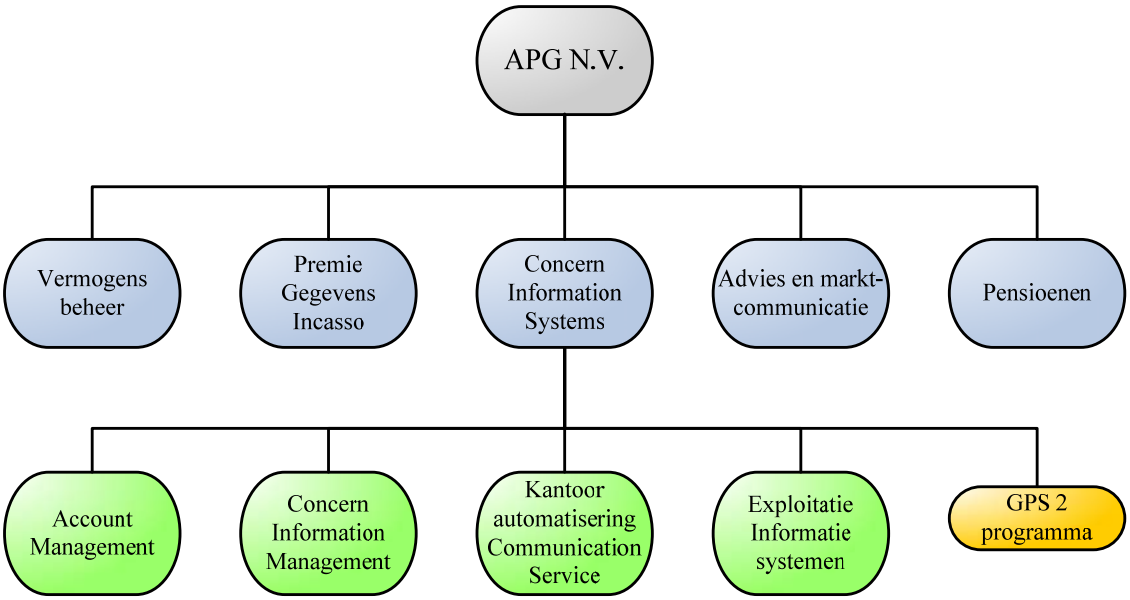


Figure 28: Organizational chart of APG

B. Literature review: resource patterns

In this section a series of workflow resource patterns are described "*that aim to capture the various ways in which resources are represented and utilized in wofrkflows*", according to [Russell et al., 2004]. The authors identified 43 different patterns and aggregated them into 7 groups. Per group a short description will be given, and Figure 8 will be used to show the relation of the pattern to the work item lifecycle.

Group 1: Creation patterns

Creation patterns provide a *"degree of clarity about how a work item should be handled after creation during the offering and allocating stages prior to it being executed"*. In Figure 8 the arc description S:create represent the creation patterns. The operation of workflow processes are in this way confirmed with the intended purpose and will so operating efficiently. These patterns are specified in the design time and by doing so they form part of the process model that defines workflow processes.

Table 10: Creation patterns – [Russell et al., 2004]

Creation patterns					
1	Direct allocation	the identity of the resource that will execute a task	7	Retain familiar	allocate a work item within a given workflow case to the same resource that undertook a preceding work item
2	Role based allocation	a task can only be executed by resources which correspond to a given role	8	Capability based allocation	offer or allocate instances of a task to resources based on specific capabilities that they possess
3	Deferred allocation	the identity of the resource that will execute a task until runtime	9	History based allocation	offer or allocate work items to resources on the basis of their previous execution history
4	Authorization	the range of resources that are authorised to execute a task	10	Organizational allocation	offer or allocate instances of a task to resources based their position within the organization and their relationship with other resources
5	Separation of duties	two tasks must be allocated to different resources in a given workflow case	11	Automative execution	ability for an instance of a task to execute without needing to utilize the services of a resource
6	Case handling	allocate the work items within a given workflow case to the same resource			

The different creation patterns have a supporting role in the designing phase of a workflow system. This means that the designer can choose to select different creation patterns and implement them into one workflow management system (e.g. for the authorization pattern it is possible to define a security framework over a workflow implementation that is independent of the way work items are routed).

Group 2: Push patterns

Push patterns are situations in which a workflow system actively offer or allocate work items to resources. This may occur indirectly by presenting work items to shared work lists or directly by allocating work items to the proper resource. In both situations, the workflow system takes the initiative to distribute the work items among the resources. When we map this on the possible state transitions of Figure 8, the arc descriptions S:offer_s, S:offer_m and S:allocate are associated with push patterns.

The nine push patterns identified by [Russell et al., 2004] are further separated in three sub-groups. The first three patterns identify the actual manner of work distribution, whether the system offers the work items to a single resource, to multiple resources or direct allocate a work item to a single resource. The second sub-group relates to the distribution of work items to a single resource when there are multiple resources identified which can perform the work

item. Push patterns that relate to this sub group are random allocation, round robin allocation, and shortest queue. The last sub group identifies the "*timing of the distribution process and in particular the relationship between the availability of a work item for offering / allocation to resources and the time at which is commences execution*". The last three patterns that form this group are early distribution, late distribution and both simultaneously: distribution on enablement.

Table 11: Push patterns – [Russell et al., 2004]

Push patterns					
12	Distribution by offer single resource	offer a work item to a selected individual resource	17	Shortest queue	allocate a work item to the resource that has the least number of work items allocated to it
13	Distribution by offer multiple resources	offer a work item to a group of selected resources	18	Early distribution	advertise and potentially allocate work items to resources ahead of the moment at which the work item is actually enabled for execution
14	Distribution by allocating single resource	directly allocate a work item to a specific resource for execution	19	Distribution on enablement	advertise and allocate work items to resources at the moment they are enabled for execution
15	Random allocation	offer or allocate work items to suitable resources on a random basis	20	Late distribution	advertise and allocate work items to resources after the work item has been enabled
16	Round robin allocation	allocate a work item to available resources on a cyclic basis			

Group 3: Pull patterns

Contrary to the previous group, the pull patterns relate to the situation where individual resources are notified of specific work items that need to be executed. The workflow system offers work items to resources in two ways: either by offer a work item directly to a resource, or indirectly by offer a work item to a shared work list (which is accessible for multiple resources). The resource determines by itself rather than the system to undertake the work item and on which time the work item will start. When linking again this pattern to Figure 8, the arc descriptions that are dealing with pull patterns are: R:allocate_s, R:allocate_m, R:start_s, R:start_m and R:start.

Six pull patterns are identified and are divided into two sub-groups. The first three (number 21, 22 and 23) are the actual pull action initiated by the resource. In the second subgroup, the sequence of how work items are presented to a resource states central (i.e. determine the system or the resource in which sequence the work items are listed in a queue and can the resource influence this sequence). The last pull pattern corresponds to the degree of freedom of the resource to select the next work item to execute.

Table 12: Pull patterns – [Russell et al., 2004]

Pull patterns					
21	Resource initiated allocation	ability for a resource to commit to undertake a work item without needing to commence working on it immediately	24	System determined work queue content	ability of the workflow engine to order the content and sequence in which work items are presented to a resource for execution
22	Resource initiated execution allocation work item	ability for a resource to commence work on a work item that is allocated to it	25	Resource determined work queue content	ability for resources to specify the format and content of work items listed in the work queue for execution
23	Resource initiated execution offered work Item	ability for a resource to select a work item offered to it and commence work on it immediately	26	Selection autonomy	ability for resources to select a work item for execution based on its characteristics and their own preferences

The distinction between the push and pull patterns is in which way either the system or the resource determines which work item will be allocated and executed by the resource. In Figure 8 it is clear represented with the prefix 'S' or 'R'.

Group 4: Detour patterns

According to [Russell et al., 2004] "*detour patterns refer to situations where work allocations that have been made for resources are interrupted either by the workflow system or at the instigation of the resource*." Consequently, the sequence of the workflow of a work item is different than in a normal workflow. Work item can have different impacts due to detour patterns, depending on the state and whether the work item was initiated by the system or a resource. In Figure 29 the different transitions are linked to each other with the detour patterns, indicating that a started work item can either e.g. suspended, completed and failed or e.g. work items can re-allocate, escalate, de-allocate, or have to be executed again (redo).

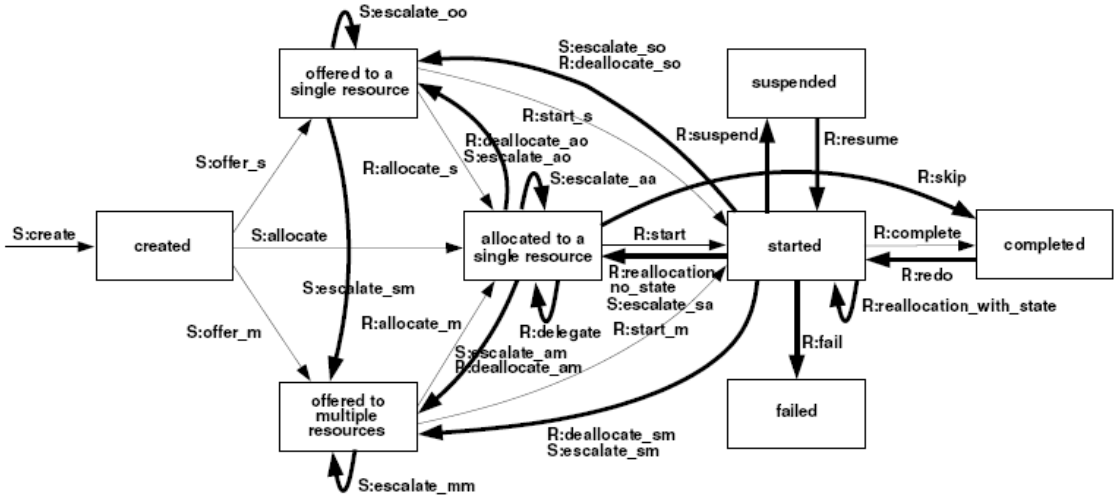


Figure 29: Detour patterns - [Russell et al., 2004]

In Table 13, the detour patterns are summarized e.g. resources are able to reject to execute a work item and will allocate it to another resource. The system is also able to offer or to allocate a work item to a resource or group, other than previously offered or allocated. The re-allocation resource pattern is possible in two ways: (1) stateful re-allocation which is the ability of a resource to allocate a work item to another resource without loss of data, and (2) stateless reallocation which is primary the same as the previous pattern but with loss of data. Finally there are some detour patterns that give the resource ability to skip, suspend and redo work.

Table 13: Detour patterns – [Russell et al., 2004]

Detour patterns					
27	Delegation	ability for a resource to allocate a work item previously allocated to it to another resource	32	Suspension / resumption	ability for a resource to suspend and resume execution of a work item
28	Escalation	ability of the workflow system to offer or allocate a work item to a resource or group of resources other than those it has previously been offered or allocated to in an attempt to expedite the completion of the work item	33	Skip	ability for a resource to skip a work item allocated to it and mark the work item as complete
29	De-allocation	ability of a resource (or group of resources) to relinquish a work item which is allocated to it and make it available for allocation to another resource or group of resources	34	Redo	ability for a resource to redo a work item that has previously been completed in a case
30	Stateful reallocation	ability of a resource to allocate a work item to another resource without loss of state data	35	Pre-do	ability for a resource to execute a work item ahead of the time that it has been offered or allocated to resources working on a given case
31	Stateless reallocation	ability for a resource to reallocate a work item currently being executed to another resource without retention of state			

Group 5: Auto start patterns

Auto-start patterns correspond to situations where execution of work items is triggered by specific events in the lifecycle of the work item. [Russell et al., 2004] stated that "*such events may include the creation or allocation of the work item, completion of another instance of the same work item or a work item that immediately precedes the one in question"*.

Auto start pattern 'commencement on allocation' is represented in Figure 8 with the arc: R:start. Further there can be an arc drawn from state created to started which represent the auto start pattern 'commencement on creation' and a reverse arc between the completed transition and the started. The last two auto start patterns 'piled and chained execution' relate to these transitions when a work item is already started.

The first two auto start patterns deal with the commencement of a work item and the system determines whether the work item can be started or not, Therefore the in Figure 8 arc R:start can be deceptive for the reader and have to be replaced for this auto start pattern by S:start_on_allocate[1]. The prefix is changed to an 'S', meaning that at this moment the system determined the allocation of work-items as desired. The last two auto start patterns are identified as an optimal way of system performance. The system determines a work item whether the same case or a different case that can be executed by the same resource. Doing this kind of allocating work items the system is gaining from the benefit of exposure to the same type of task. These last two auto start patterns create a jump between two work items, i.e. it links the lifecycles of two different work items.

[1] In the paper of [Russell et al., 2004] the authors notify the reader per group of patterns a figure that represent the arcs dealing with the group of patterns they described. For a clear overview, I used one figure as reference which has to be slightly updated when treating a specific group of patterns.

Table 14: Auto start patterns – [Russell et al., 2004]

Auto start patterns					
36	Commencement on creation	ability for a resource to commence execution on a work item as soon as it is created	38	Piled execution	ability of the workflow system to initiate the next instance of a workflow task (perhaps in a different case) once the previous one has completed
37	Commencement on allocation	ability to commence execution on a work item as soon as it is allocated to a resource	39	Chained execution	ability of the workflow engine to automatically start the next work item in a case once the previous one has completed

Group 6: Visibility patterns

Visibility patterns classify different scopes in which work item availability and commitment are able to be viewed by workflow resources. These patterns give indication of how open the operation of the workflow system is. Two patterns are found and both deal with the configuration of the visibility, see Table 15.

Table 15: Visibility patterns – [Russell et al., 2004]

Visibility patterns					
40	Configurable unallocated work item visibility	ability to configure the visibility of unallocated work items by workflow participants	41	Configurable allocated work item visibility	ability to configure the visibility of allocated work items by workflow participants

Group 7: Multiple resource patterns

In the last group, the multiple resource patterns are identified. The authors found two additional patterns when they put away their assumptions to the one-to-one correspondence between the resources and the work items (i.e. resources cannot work on different work items simultaneously and multiple resources cannot work on the same work item). Many-to-many correspondence between resources and work items in a given allocation or execution is possible due to information technology. In the first multiple resource pattern, a resource is able to work on more than one work item simultaneously (a one-to-many correspondence) and in the last multiple resource pattern a resource can request other resources to assist in the execution of a work item which is undertaking from that point by multiple resources.

Table 16: Multiple patterns – [Russell et al., 2004]

Multiple resource patterns					
42	Simultaneous execution	ability for a resource to execute more than one work item simultaneously	43	Additional resources	ability for a given resource to request additional resources to assist in the execution of a work item that they are currently undertaking

More resource patterns

According to [Stefansen et al., 2007] the 43 resource patterns described by [Russell et al., 2004] is incomplete. E.g. [Stefansen et al., 2007] proposed that combinations of more than one resource pattern are neglected by the paper. Also limitations of such combinations are not depicted. Some patterns that are undiscovered according to [Stefansen et al., 2007] are:

Table 17: Undiscovered patterns - [Stefansen et al., 2007]

Custom hook	a Java method invocation that maps the activity state and process state to a single resource
Location based	allocation work based on a location, (e.g. default, any or a list)
Allocate to creator (is owner)	entire process is allocated to the resource who instantiated it,
Multiple roles	an activity is allocated to several roles
Soft constraints	the need to be able to specify that some rules are non-violable, while others can

	be ignored (ignoring is a soft constraint)
Multiple resources	allocated to several resources, who all of them need to collaborate on the work (see pattern 43 of [Russell et al., 2004])
Scalar properties	not binary properties of resources (i.e. resource have or have not), but for skills, there can be several levels (e.g. novice, medium, expert)

The authors further noted other allocation schemes of interest:

Table 18: Other allocation schemes - [Stefansen et al., 2007]

Overflowing	overflow group can be used for allocation, when work list queue of some people is too long
Timeout patterns	when a work item is not started / completed before a specific deadline, branch off to a different part of the control flow or reallocate is an option. Time is needed in the model.
Minimize make span	due to soft constraints, there is no optimization of the resource allocation process, because of preferences and simplicity is prioritized.
Maximize skill refreshment	assigning tasks to resources that have not used a required skill for a long time. [Hamadi & Quimper, 2006]
Maximize skill match	it is undesirable to assign an over-qualified resource to a task. It is a better solution to keep this resource available for more demanding tasks. [Hamadi & Quimper, 2006]

All the different patterns indicated by [Stefansen et al., 2007] are all interesting during the design and run-time allocation of resources. Not all patterns can be used at the same time (e.g. push and pull patterns are each other opposite) and a selection should be made to come with the most suitable option for resource allocation.

C. Reference model of WfMC

The Workflow Management Coalition, (WfMC) have developed a reference model (see Figure 30). Because of the variety of workflow products in the market, WfMC have constructed a "*general implementation model of a workflow system which can be matched to most products in the marketplace thereby providing a common basis for developing interoperability scenarios.*" [WfMC, 1995]

The reference model consists of a service and interfaces with 5 components. The center of the workflow product is the workflow enactment service. This service and the 5 components are described here in more detail:

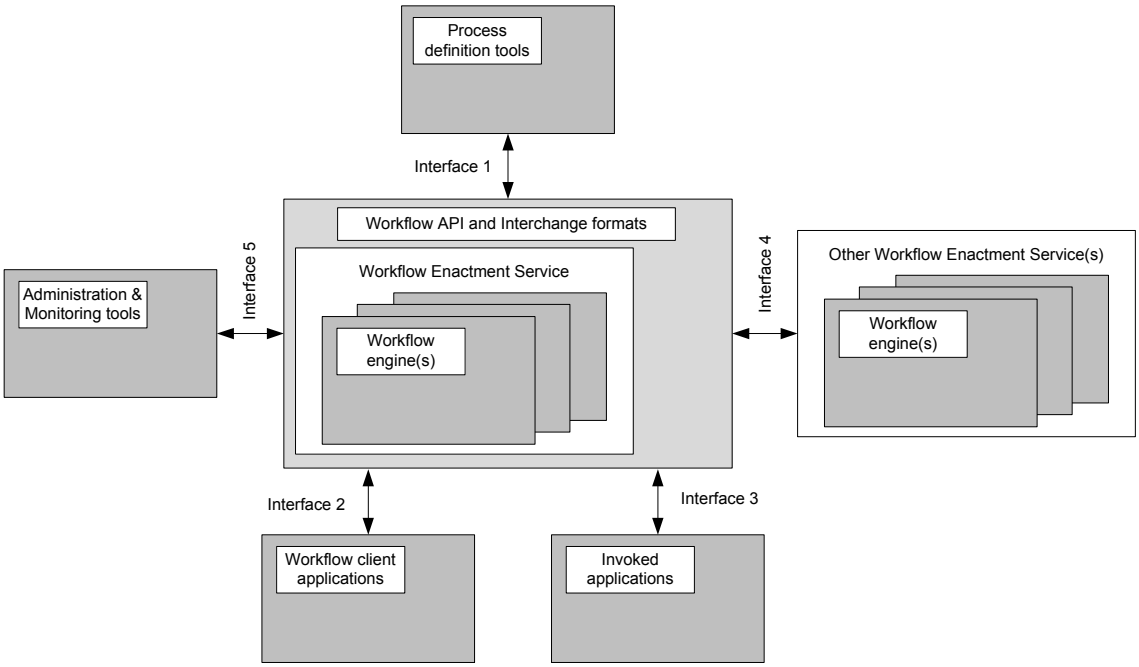


Figure 30: Workflow Reference Model – Components & Interfaces – [WfMC, 1995]

Workflow enactment service

According to [WfMC, 1995], the workflow enactment service is *"a software service that may consist of one or more workflow engines in order to create, manage and execute workflow instances. Applications may interface to this service via the workflow application programming interface (WAPI)".* Inside the enactment service, the workflow engine is running. The workflow engine is a software service that provides the run-time execution environment for a workflow instance. The workflow engine runs and manages complex applications to realize the business primary intent.
The enactment service is linked with the 5 components (the interfaces) via WAPI which is *"a set of API calls and interchange functions supported by a workflow enactment"*, according to [WfMC, 1995]. The five components are described one by one:

Process definition tools (Interface 1)

The business processes are described or designed in different tools (e.g. designed with pen and paper or via a standardized definition tool). If a standardized tool is used, the model is via interface 1 linked to workflow enactment service. The interface import or export the process definition in the form of models that contain:

- the process structure

- the activities and navigation
- roles and participants
- trigger conditions and
- application invocation

The models describing the business process are created on a build time base and are used as input for the workflow enactment service and so the engine that execute the instances on run-time.

Workflow client applications (Interface 2)

In the process model, (defined in process definition tool) an activity could interact with a human resource. For the interaction with the resource, a work list is used. *"The worklist handler is the software entity which interacts with the end-user in those activities which require involve human resources",* [WfMC, 1995]. The work list forms the queue of work items assigned to a particular user by the workflow engine and could be interacting with several workflow engines and several different enactment services. The interface that is used is able to communicate between the workflow client applications and the workflow engine(s). In the client application, several applications can be used such as:

- process and activity control functions (i.e. the creation, start or terminate of process instances or assigning or query of an attribute (e.g. priority) of a process or activity instance)
- the process status functions (i.e. fetching details of process instances by use of queries of filters) and
- the work list manipulation commands (i.e. opening / closing work list, fetching work items and reassignment)

Invoked applications (Interface 3)

Although the workflow product consists of standardized applications that can be used as input for the workflow engine, still the need for particular applications is needed (e.g. when the standardized application are not applicable for the function they have to execute. The invoked applications (or application agents) are "*designed to be "workflow enabled" (ie to interact directly with a workflow engine)"*, according to [WfMC, 1995]. The interface with the workflow enactment service (interface 3) is realized by the standard sets of APIs to communicate - to accept application data, signal, and respond to activity events. *"Such APIs may be used directly by an application tool or by a application agent process acting as a front end for interaction with heritage or other applications written without a specific knowledge of workflow"* [WfMC, 1995].

If the connection between the workflow enactment service and the application is created, the communication can start. This could be asynchronous, or synchronous depending on the function. Some activities that could be used via invoked application are:

- workflow engine to application
    - start activity (workflow engine to application)
    - suspend / resume / abort activity (where an asynchronous application interface is available)
- application to workflow engine
    - activity complete notification
    - signal event (e.g. synchronization)
    - query activities attributes

Other workflow enactment services (Interface 4)

The interoperability between two workflow enactment services is important for the invocation of processes or sub-processes, especially when both systems are able to perform the primary business operations. According to [WfMC, 1995] the *"workflow products are diverse in nature ranging from those used for more ad-hoc routing of tasks or data to those aimed at highly regularised production processes"*. Hence, an interface is needed that communicate between both workflow enactment services to provide:

- activity or sub-process invocation
- process / activity status / control
- application / workflow relevant data transfer
- synch point coordination
- process definition read / write

Interface 4 has to work fluently and provides profit when both workflow enactment services communicate the same. This is important for the process definitions across multiple workflow enactment services and the runtime control interactions of both enactment services. When the process definitions can be used by both enactment services, the view of the process definition object and their attributes is the same. "*This potentially enables individual workflow engines to transfer execution of activities or sub-processes to heterogeneous workflow engines within the context of a common naming and object model"* [WfMC, 1995]. The runtime control interactions are needed to perform on runtime (i.e. without delay). [WfMC, 1995]: *"at runtime, the WAPI calls are used to transfer control between workflow services to enact sub-processes or individual activities on a specific service"*. It is important to provide a direct connection between the workflow enactment services to improve performance.

Administration & monitoring tools (Interface 5)

[WfMC, 1995] noted that *"the proposed interface is intended to allow a complete view of the status of work flowing through the organisation, regardless of which system it is in"*. This complete view is most used by management in the form of applications that could be:

- user management (establish / delete)
- role management (define / delete, set / unset role attributes)
- audit management (query / print / start new / delete audit trail or event log)
- resource control (set / unset / modify process or activity concurrency levels)
- process supervisory functions (changing status process definition, assigning attributes to specific type process or instances)

D. IBM Websphere Suite

IBM Websphere is a solution for the management of business processes. *"Business Process Management (BPM) leads to business innovation and optimization by implementing business strategy through modeling, developing, deploying, and managing business processes throughout their entire life cycle,"* according to [Wahli et al., 2007].

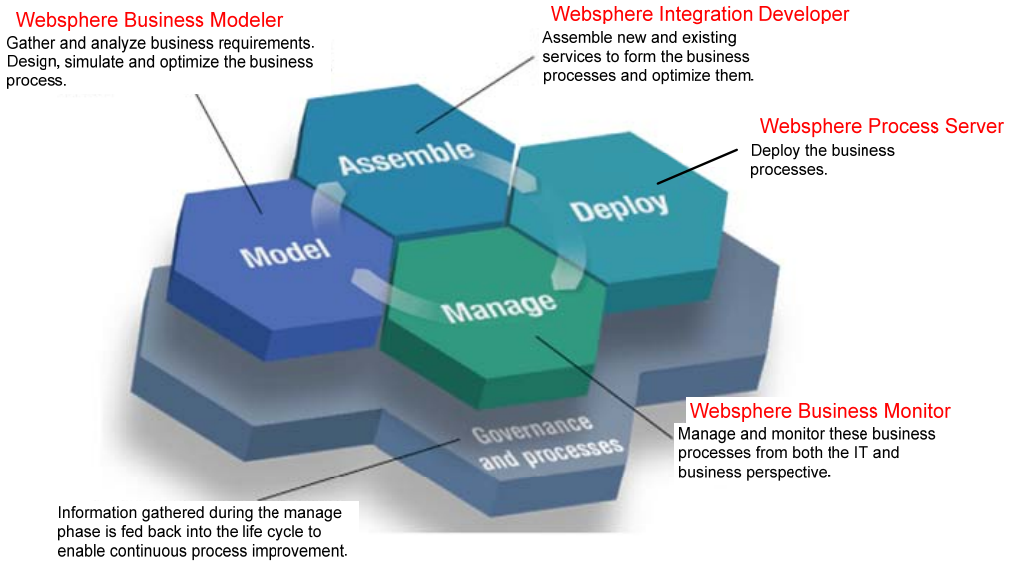


Figure 31: BPM lifecycle according IBM - [Wahli et al., 2007]

In Figure 31, the BPM lifecycle is mapped to the products of Websphere. The lifecycle consists of four phases: 'model', 'assemble', 'deploy', and 'manage'. From the 'governance and processes' layer information is gathered during the manage phase and is used for improvement. In Figure 31, the Websphere products are linked to the four phases. In Table 19, the four phases and these products are explained.

Table 19: Description of IBM Websphere products - [Wahli et al., 2007]

Websphere Business Modeler	In the model phase, the business models are captured, simulated, analyzed, and optimized to reduce risk and increase flexibility. *"Business modeler is used by a business analyst to specify what activities have to be done and in which order. Modeler can export a business process as Business Process Execution Language (BPEL) for implementation"* [Wahli et al., 2007]. Business Modeler enables the analyst to visualize, document and model business processes for understanding and process execution.
Websphere Integration Developer	In the assemble phase, the integrated solution is developed, assembled and tested. *"With Integration developer you implement the business process model as an executable IT flow. This is done by mapping the model activities to reusable service components to construct composite business applications. Integration developer is used by a developer to specify how activities get implemented"* [Wahli et al., 2007]. Integration Developer simplifies the integration and uses the (current) IT assets as service components suitable for the SOA. The business models of Business Modeler are imported in the Integration Developer.
Websphere	In the deploy phase the direct deployment of models and policies to

Process Server	realize business intent is executed. *"The process server provides the production server to run and manage the application you create. A system administrator works its Process Server"* [Wahli et al., 2007]. The Process Server is built upon open standards; it deploys and executes processes that orchestrate services (people, information, systems, and trading partners) within a SOA or non-SOA infrastructure.
Websphere Business Monitor	In the manage phase the deployment models are managed by monitor and correlate metrics and alerts in run time from internal and external resources to gain visibility into the business and IT performance: *"the business monitor provides real time performance monitoring of the application. It is usually set up and administered by a system administrator"* [Wahli et al., 2007]. Key Performance Indicators (KPIs) are used to measure the values from different activities and bottlenecks in the system could be determined and alerted to management.

E. Interviewee per team

The interviews are conducted with the representatives of a team, such as: work-distributors, managers or sub-distributors. In Table 20 an overview of the representatives per team and the product that belongs to that team are given.

Table 20: Overview team and interviewee per team

Business Unit	Product	Team - name	Team - specialization	Interviewee
SPG	IP	IPHPT 1	IPHPT	Manager
		IPHPT 2		
	FPU	GVP	GVP	Manager
		SVP	SVP	Manager
	OP	MPG	-	*
		SAG	SAG	Sub-distributor
	NP	SBO	SBO/SAN	Distributor
		SAN		
SV	Service	KVI	KVI	Distributor
		KTD	KTD	Distributor
		SPS	VPS	Distributor
			Register partner	**
		GBA	GBA	Distributor
		SBG	DO	Distributor
			WO-uit	Distributor
			VUPO + Uitruil	Distributor

* this team is not interviewed. The information is gathered by surrounded managers

** the distributor of team-specialization VPS gives also the information of the team Register partner. In the past, the distributor divided also the work in this team.

The team-name is actually the name used by APG on the workfloor and in organizational charts (i.e. see Figure 1). For the distribution of work two teams are joined, due to the distribution of work is executed by the same work-distributor, or a team is split up in more sub-teams and consequently more work-distributors are interviewed.

Team MPG is added because it has a special form of allocation of work items to specific employees. This team is triggered by the “logistieke klok” and work items are called “kapstokcase”. Although no representative is interviewed, different managers are asked about the workflow diagram and the factors that are taken into account.

F. Set-up interview scheme

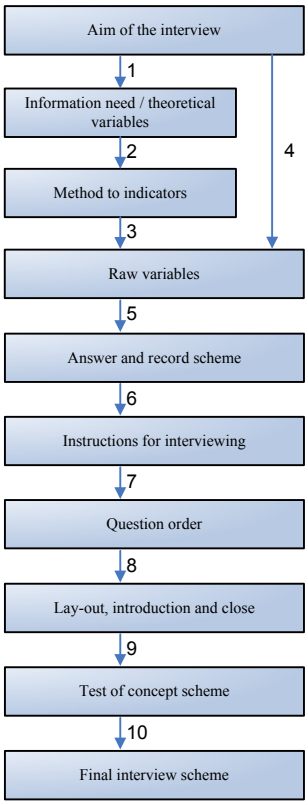


Figure 32: Setup of interview - [Emans, 2002]

According to [Emans, 2002] an interview has to be set up in 10 steps. When the steps are taken, a final interview scheme is produced.

1. It is started by the aim of the interview: how is the distribution within a team executed.
2. The information is gathered via first observations, and via the literature study which is the first research question.
3. The method to indicators is quite difficult, since the literature provides an amount of variables, such as presence and personal factors etc.
4. The steps to the raw variables could also be reached via a bypass. The raw variables are the variables of the literature.
5. An answer and record scheme is made, see next appendix.
6. The distributors are invited for an interview. Later the specific date and time are announced.
7. The question order is changed, based on a meeting with the second supervisor of the TU/e.
8. The introduction and end of the interview are made.
9. One interviewee is used as test. The answers are used since the interview was quite ok, only the other is once changed, and some questions are deleted, since the overlap with others.
10. the final interview scheme is finished, see next appendix

G. Questionnaire (in Dutch)

Table 21: Questionnaire

Doel onderzoeken hoe werkverdelen binnen een team uitgevoerd wordt
welke factoren invloedt hebben op de beslissing, en wat daar de prestatie indicatoren van zijn

St 1	St 2/3	Benaming	sub Benaming	Verzameling	Verzameling alle waarden	Step 5 Antwoord systeem	Vragen	Doorvragen (eventueel)	Controlevraag
1	1,1	Geinterviewde		alle geinterviewden	de namen en een label (nr)	Gesloten	naam: (en nummer):		
	1,2	Datum		alle geinterviewden	de data	Gesloten	datum:		
	1,3	Duur		alle geinterviewden	getal van duur (in minuten)	Gesloten	start en eindtijd:		
2	2,1	Ervaring		alle geinterviewden	Aantal (jaren)	Gesloten	Het interview begint nu, we zullen starten met een paar algemene gegevens van u en het team waarvoor u werkt. Laten beginnen met gegevens over u persoonlijk omtrent werkverdelen: Hoe lang verdeelt u al het werk voor het team?		
	2,2			alle geinterviewden	persoonlijke mening	open	Kunt u iets vertellen over wat u persoonlijk van het werk verdelen vindt.	Wat vindt u bijvoorbeeld wel leuk / niet leuk om te doen omtrent werk verdeling? Misschien weet u een voorbeeld van werkverdelen waarin uw mening naar voren komt?	
3	3,1	vragen omtrent team	welk team	alle geinterviewden	afdeling gespecificeerd in organigram	open met field-coding	Om duidelijk te hebben waar u het werk precies voor verdeelt in het bedrijf komen nu een paar vragen omtrent het team waar u voor werkt. Welk team is dit?		
	3,2		beschrijving van de diverse taken binnen team	alle geinterviewden	informatie verstrekking; voor duidelijkheden.	open	Kunt u kort een beschrijving geven van de diverse werkzaamheden binnen het team?		Zijn er nog meer werkzaamheden binnen het team dat belangrijk zijn om te noteren?
	3,3		team eigenschappen	alle geinterviewden	Opsomming van eigenschappen team	open	Ieder team heeft een aantal specificaties. Wat zijn de team-eigenschappen dat kenmerkend zijn voor team "team".		
	3,4		doelstelling team	alle geinterviewden	motivatie hoofddoel team	open	Wat is het belangrijkste doel dat het team heeft?		
4	4,1	input factoren die invloed hebben op beslissing van werkverdelen	factoren die invloed hebben	alle geinterviewden	alle mogelijke factoren en combinaties van factoren zijn mogelijk	open	We hebben het nu gehad over het team waarvoor u werkt en uw mening. U verdeelt het werk op uw manier en probeert dat zo goed mogelijk te doen. U houdt waarschijnlijk met een aantal factoren rekening. Wat zijn de factoren die u meeneemt in de beslissing om het werk te verdelen?	U heeft het over factor "A" en factor "B". Zijn dit de enige factoren die een rol spelen? Bij "nee": welke factoren spelen nog meer een rol? Bij "ja" >>	Als een andere werkverdeler uw taak overneemt, zijn deze <factoren> dan bepalend om het werk te verdelen?
	4,2		motivatie waarom die factoren	alle geinterviewden	alle motieven zijn welkom om zo een compleet mogelijk beeld te krijgen	open	Waarom spelen deze "factoren" een rol?		
	4,3		volgorde zetten van de factoren	alle geinterviewden	top n van factoren die rol spelen	open met field-coding	U heeft nu een aantal factoren opgenoemd, kunt u deze factoren in ordenen van meest belangrijk naar minst belangrijk voor het team?	<geef de geinterviewde de tijd>	
			uitleg van volgorde	alle geinterviewden	alle motieven zijn welkom om zo een compleet mogelijk beeld te krijgen	open	Waarom kiest u voor deze volgorde van factoren?		
5	5,1	output factoren die invloed hebben op team prestatie	performance factoren die worden beinvloed door de keuze van werkverdelen	alle geinterviewden	alle mogelijke factoren en combinaties van factoren zijn mogelijk	open	Bij het verdelen van het werk houdt u rekening met een aantal factoren waarop u verdeeld, namelijk "noem factoren". Er volgen nu een paar vragen omtrent de doelstelling van het team. Het werkverdelen binnen een team doet u met een bepaalde doelstelling neem ik aan. Welke doelstelling(en) vindt u belangrijk dat het team dient te behalen?	U heeft het over doelstelling "A", zijn er nog meer factoren die belangrijk zijn. Bij "ja": Welke doelstellingen zijn nog meer belangrijk? Bij "nee">>	Opgesomd heeft u het over <doelstellingen>. Als uw collega uw taak overneemt en stuurt op deze doelsteliing(en), zal het team dan goed functioneren?
	5,2		motivatie	alle geinterviewden	alle motieven zijn welkom om zo een compleet mogelijk beeld te krijgen	open	Waarom vindt u deze factoren belangrijk?		
	5,3		volgorde zetten van 5 factoren	alle geinterviewden	lijst met volgorde	open met field-coding	U heeft nu de volgende <doelstellingen> opgesomd. Kunt u deze doelstelling(en) in volgorde zetten van meest belangrijk naar minst belangrijk voor het team?	<geef de geinterviewde de tijd>	
			uitleg van volgorde	alle geinterviewden	alle motieven zijn welkom om zo een compleet mogelijk beeld te krijgen	open	Waarom kiest u voor deze volgorde van factoren?		

6	6,1	Voorwaarden (preconditions)	proces verloop aanvoer	alle geinterviewden	goed / niet goed, waarom	open		De factoren die invloed hebben op het werkverdelen en de doelstellingen van het team zijn nu bekend. We gaan nu dieper in op het werkverdelen in en zullen beginnen waar de post binnen kont. Hoe verloopt het proces van aanvoer van de te verdelen poststukken?	Bij "goed" hoe verloopt het proces op dit moment dan. Bij "niet goed": hoe verloopt het proces nu dat eigenlijk beter moet gaan lopen?	
	6,2		labels aanwezig	alle geinterviewden	ja / nee	gesloten		Binnen APG zijn er twee soorten stromingen (papier en elektronische) die worden gesorteerd per team. Voordat de papieren post bij u terecht komt, wordt deze eerst verwerkt bij de postkamer. Er worden hier labels op gezet. Zijn deze labels altijd aanwezig?		
	6,3		labels goed	alle geinterviewden	ja / nee	gesloten		Aannemend dat de administratieve krachten zo goed als ze weten de juiste labels op het poststuk zetten. Zijn er labels die niet juist zijn geplaatst?		
	6,4		afspraken met Administratieve krachten van postkamer	alle geinterviewden	ja / nee	gesloten		Het is mogelijk om de papieren stroom te laten sorteren naar de behoefte van de werkverdeler. Heeft u afspraken met de administratieve krachten van de postkamer hoe de papieren stroom aangeleverd dient te worden?		
	6,5		soort afspraken	alle geinterviewde	alle mogelijke factoren en combinaties van factoren zijn mogelijk	open		Bij "ja" Wat houdt die afspraak precies in? Bij "nee": Zou een afspraak helpen met de medewerkers van de postkamer hoe ze de papieren stroom zouden aanleveren?	Bij "ja": Wat betekent dit voor de doelstelling die het team heeft? (Bij "nee": waarom helpt een afspraak niet?	
7	7,1	systeem	te kort komingen van het systeem	alle geinterviewden	ja / nee / geen mening	gesloten		Het werkverdelen wordt uitgevoerd met hulp van GPS1. Op dit moment wordt er gewerkt aan een nieuw systeem GPS2. De volgende vragen gaan over het eerste systeem: GPS1. Het systeem wordt gebruikt om u te helpen met het werk te verdelen. Zijn er tekort komingen van het systeem?	Bij "nee": stel u mag het systeem aanpassen naar alles wat u nodig heeft om het werkverdelen zo makkelijk mogelijk te maken. Ontbreken er in het huidige systeem nog opties die het werkverdelen makkelijker kunnen maken?	
	7,2		missende opties	zo ja	alle antwoorden zijn welkom bijv schermen onduidelijk, prestaties te laag	open		Bij "ja": Hoe kan het systeem aangevuld worden om het te verdelen werk te vermakkelijken?	Zijn er nog meer opties die in het systeem gebouwd moeten worden om het werkverdelen makkelijker te maken?	Bij "nee": het systeem voldoet nooit aan de wensen van alle gebruikers. Probeert u eens aan voorbeelden te denken waarvoor u extra gegevens nodig heeft om te verdelen. Wat voor gegevens zijn er nodig?
	7,3		invloed op performance criteria	zo ja	alle mogelijke factoren en combinaties van factoren zijn mogelijk	open		Bij "ja": Stel de opties die u noemt worden geimplementeerd in het systeem. Wat is de invloed van deze implementatie op de doelstellingen van uw team?	Zijn er nog andere voordelen of juist nadelen te benoemen?	
	7,4		overbodige functies	alle geinterviewden	alle mogelijke functies en combinaties van functies zijn mogelijk	open		Zijn er ook overbodige opties in het systeem die niet gebruikt worden?	bij "ja": welke overbodige opties worden niet gebruikt bij het verdelen van werk in het team?	
	7,5		gebruik knop 'alles naar laatste behandelaar'	alle geinterviewden	ja nee soms	gesloten		Wordt de knop "alles naar de laatste behandelaar" gebruikt om het werk te verdelen binnen het team?		
	7,6		waarom wel / niet gebruikt	alle geinterviewden	motivatie	open		Wat zijn de resultaten als deze knop (wel) gebruikt wordt?		Zijn er nog meer scenarios denkbaar als de knop (wel) gebruikt wordt?
8	8,1	de medewerkers	wat als ziekte medewerker van korte duur	alle geinterviewden	alle mogelijke factoren en combinaties van factoren zijn mogelijk	open		Bij de volgende vragen gaat het om de personeeleigenschappen. Er worden een aantal voorbeelden geschetst die voor kunnen komen in het team. Een van deze voorbeelden is dat medewerkers ziek kunnen worden. Hoe wordt op de korte termijn met deze ziekte omgegaan?		
	8,2		wat als ziekte medewerker van lange duur	alle geinterviewden	alle mogelijke factoren en combinaties van factoren zijn mogelijk	open		Als de medewerker langere tijd ziek is (vb 1,5 maand) en er is op dit moment geen vervanger die direct de werkzaamheden op het gewenste niveau kan uitvoeren. De werkzaamheden van de zieke persoon dienen toch uitgevoerd te worden. Hoe lost u dit op?		
	8,3		inwerken medewerker	alle geinterviewden	alle mogelijke factoren en combinaties van factoren zijn mogelijk	open		Een nieuwe medewerker is nodig voor het uitvoeren van de taken. Deze medewerker dient ingewerkt te worden. Waar houdt u rekening mee omtrent werkverdelen voor de nieuwe werknemer?	Wordt er gebruik gemaakt van de verificatie mogelijkheid?	
	8,4		motivatie medewerkers	alle geinterviewden	alle mogelijke motiverende aspecten en combinaties daarvan	open		Een van de aspecten waar u rekening mee kan houden, is de motivatie van de medewerker. Hoe blijven de werknemers gemotiveerd om hun werk uit te voeren als het werk door u verdeeld wordt.		

9	9,1	vervanger	werkverdeling van vervanger	alle geinterviewden	alle mogelijke factoren en combinaties daarvan zijn welkom	open		In tijden dat u als werkverdeler op vakantie gaat, wordt het werk tijdelijk overgenomen door een vervanger. Hoe verdeelt de vervanger zijn werk?	bij "hetzelfde of goed" als antwoord: Er zijn een aantal factoren die anders zijn tussen u en de vervanger. Misschien weet u een voorbeeld van een vervanger dat positieve / negatieve gevolgen had?	
	9,2		tevreden met vervanger	alle geinterviewden	ja / nee / geen mening / geen idee	gesloten		Zijn de medewerkers tevreden met de tijdelijke werkverdeler?		
	9,3		waarom wel / niet	alle geinterviewden	alle mogelijke factoren en combinaties daarvan zijn welkom	open		Waarom waren de medewerkers (niet) tevreden met de vervanger.	Weet u een voorbeeld waar dat uit bleek?	
	9,4		medewerkers tevreden met je terugkomst	alle geinterviewden	ja / nee / geen mening / geen idee	gesloten		Als u terug komt van uw vakantie neemt u het werk weer over van de vervanger. Zijn de medewerkers hierdoor tevreden met uw terugkomst?		
	9,5		waarom wel / niet	alle geinterviewden	alle mogelijke factoren en combinaties daarvan zijn welkom	open		Kunt u dat antwoord bevestigen met een voorbeeld dat heeft plaatsgevonden in het verleden?		Zijn er nog meer voorbeelden die u weet waaraan u kon merken dat de medewerkers tevreden waren?
10	10,1	beschrijving lastige cases	case is te moeilijk voor medewerker	alle geinterviewden	ja / nee / soms	gesloten		Er zijn situaties denkbaar waarin een bepaalde case niet naar de juiste persoon kan, maar aan iemand anders wordt toe bedeeld. In zo'n situatie kan de case te moeilijk zijn voor de specifieke medewerker. Komt dit wel eens voor?		
	10,2		waarom	zo ja	zo ja, welke	open		bij "nee": Hoe voorkomt u dat deze situatie nooit voorkomt bij het team? Bij "ja" Om wat voor soort cases gaat het precies?	bij "nee": Waar houdt u rekening mee? Bij "ja": Hoe wordt dit opgelost?	Zijn er nog meer situaties of cases denkbaar waarin dit speelt?
	10,3		cases die voorrang krijgen	alle geinterviewden	zo ja, welke	open		Er zijn ook situaties denkbaar waarin bepaalde cases voorrang krijgen. Is dit bij dit team het geval?	bij "nee": Hoe voorkomt u dat? Bij "ja: Om welke cases gaat het precies?	
	10,4		meerdere medewerkers betrokken	alle geinterviewde	alle mogelijke taken en combinaties van taken	open		tenslotte zijn er mogelijke situaties waarin meerdere medewerkers zijn betrokken bij het afhandelen van een bepaalde case. Vindt dit weleens plaats in het team waarvoor u verdeelt?	Bij "ja": Kunt u beschrijven hoe dit in zijn werk gaat?	
11	11,1	vragen omtrent automatisering	1e stap van automatisering	alle geinterviewden	alle mogelijke plannen en combinaties van plannen zijn mogelijk	open		Ondersteuning van het werkverdelen kan plaatsvinden via het nieuwe GPS 2 systeem. Ziet u mogelijkheden om bepaalde cases via (semi-) automatische weg te verdelen naar de medewerkers in het team?	bij "nee": denkt u even aan het verdelen van uw werk, bijvoorbeeld welke cases komen vaak voor en welke cases heeft u net verdeeld. Als u de verschillende cases voorbij ziet komen, is er dan een mogelijkheid voor één van die cases (semi-) automatisch verdeeld te kunnen worden?	
	11,2		welke case kan geautomatiseerd worden	alle geinterviewden	bijvoorbeeld: case "A" en "C"	open met field-coding		bij "ja": welke (soort) cases zouden via de (semi-) automatische weg toebedeeld kunnen worden?		Zijn ern og meer cases denkbaar die via een semi-automatische weg toebedeeld kunnen worden?
	11,3		hoe kan de case geautoamatiseerd worden	zo ja, dan	Alle motivaties zijn welkom	open		bij "ja": hoe zou deze case <case> volgens u het beste (semi-) automatisch toebedeeld kunnen worden?	Hoe ziet u dit precies voor zich?	
	11,4		bekend met kapstokcase	alle geinterviewden	ja / nee / twijfel:	gesloten		In toebedelen van cases aan specifieke medewerkers wordt er binnen APG gebruik gemaakt van een zogenaamnde "Kapstokcase". Bent u bekend met het begrip kapstokcase?	Bij "nee": het concept kapstokcase wordt gebruikt bij het team MPG. In een bepaalde leeftijdscategorie krijgt iedere klant een specifieke medewerker toebedeleed die als er nieuwe cases voor de klant komen automatisch naar dezelfde specifieke medewerker gaan. Begrijpt u dit?	
	11,5		kapstokcase te gebruiken in het team	zo ja, waarom wel / niet	ja / nee / twijfel + motivatie	open		Is het concept van de kapstokcase te gebruiken om werk te verdelen binnen uw team?		
12	12,1	invloed van management	performance indicatoren moeten worden behaald	alle geinterviewden	alle mogelijke factoren en combinaties van factoren zijn mogelijk	open		Ik neem aan dat u als werkverdeler gesprekken heeft met uw leidinggevende over de doelen die opgelegd worden. Wat voor doelen worden er opgelegd door het management?		
	12,2		case niet goed uitgevoerd	alle geinterviewden	alle mogelijke factoren en combinaties van factoren zijn mogelijk	open		Wat gebeurt er als een bepaalde case niet goed uitgevoerd is?		
13	13,1	Vergelijking teams / cases	overleg met werkverdelers	alle geinterviewden	ja / nee	gesloten		Het team "team" staat niet op zichzelf, maar heeft -neem ik aan- banden met andere teams en werkverdelers. Is er overleg met andere teams en werkverdelers hoe dat team het werk verdeelt?		

	13,2		waarover overleg	alle geinterviewden	alle mogelijke factoren en combinaties van factoren zijn mogelijk	open		zo "ja": wat wordt er besproken met het andere team?	Wat wordt er gedaan met de besproken onderwerpen?	
	13,3		team is te vergelijken met	alle geinterviewden	andere team(s), waarom	open		Het werkverdelen van dit team is te vergelijken met een ander team nl…	Wat zijn de overeenkomsten/verschillen met dat team?	
14	14,1	Controle vragen	gemiste aspecten	alle geinterviewden	alle mogelijke factoren en combinaties daarvan zijn welkom <niet in verdediging schieten>	open		Om een compleet beeld te krijgen van het aspect werkverdelen binnen het team zou ik een paar controle vragen aan u willen stellen. Welke aspecten van het werk verdelen heb ik niet of niet volledig belicht met dit interview?		Heb ik een compleet beeld van het werkverdelen gekregen van dit team?
	14,2		zo nee, wat mis ik	Zo nee, dan	alle mogelijke factoren en combinaties daarvan zijn welkom	open		bij "nee": wat mis ik nog?		

H. Summary Interviews

Table 22: Summary interview team: IPHPT

Team: IPHPT	Properties	Comments
Inflow post	Post flow: Amount: 8000 / month Inflow: daily - constant Distribution: semi-automatic* Stock: none Extra: has "lussluiting" Automatic flow: (UWV, GBA, "Wijziging opbouw") Amount: 8000 / month Inflow: daily, weekly, monthly Distribution: semi-automatic Stock: conversion with UWV Extra: has "lussluiting" *Semi-automatic: on the front: 10 AKs distribute the work to the team by signal type and client number. Each employee executes a specific range of client numbers. On the back: an IPHPT-empl can change the range of clientsnumber for a specific employee.	
Team properties	70 employees: some specialists 3 processes: "toekenning", "herzien", "beheer" 5 groups: 29 empl: IP group 17 empl: HPT group 3 empl: "samenloop (IP + FPU)" 5 empl: "beslaggroep" 4 empl: "bezwaargroep" (difficult, and has own distribution)	
Decision variables	• Signal type • Last 2 numbers of client number • Priority on deadline actions	Easy to distribute, employee has a fixed group of clients, system APG is unsuited
Targets	• Lead time • Financial error (external quality)	
Opinion	Ok, but not whole day (same acts)	
Paper / scan	Employees use scanned files	
Extra	Absenteeism does not play a role; an IPHPT-empl controls the ranges and eventually update the range. According to the distributor, automatic distribution is an option via Business Rules by taking into account deadline, authorization, presence, individual stock, and last employee.	

Additional notes:
First, the AKs judge the signal type. The signal type could be a factor of external quality. From now on, the items are distributed to employees specific in that group. All clients have an identical client-number. A specific range of clients is allocated to one employee. Ranges are formed of the last two numbers of this client-number. When the AK has booked a process of a specific client, the system allocates this client to the employee conform the range.

Team IPHPT: execution of work-distribution

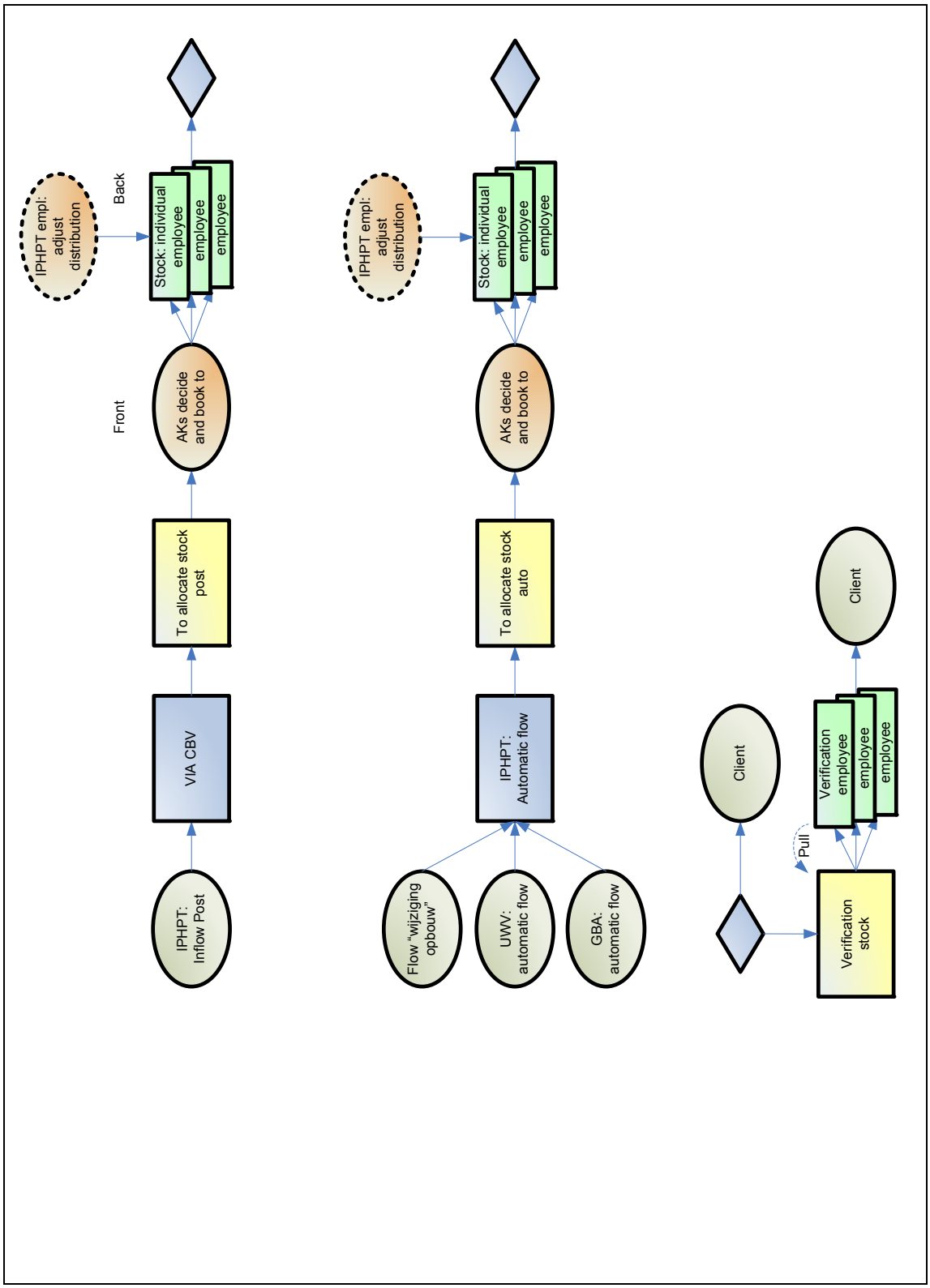


Table 23: Summary interview team: GVP

Team: GVP	Properties	Comments
Inflow post	Post flow: "offerte" Amount: 1000-1500 / month Inflow: daily – fluctuate → Distribution: case – daily Stock: average 150 Extra: lead time <5 days Post flow: "toekenning" Amount: 1000 / month Inflow: daily - fluctuate Distribution: case – daily Stock: average 2000 Extra: has "lussluiting"	Depends on process "toekenning" of educational clients
Team properties	32 employees: only specialists 2 empl: fixed verification 2-3 empl: domain VPS 2 empl: domain: police "samenlopers (FPU+IP)": 75% of team is unsuited.	
Decision variables	• Difficulty item (determines the distributor) • Personal (absenteeism, education, quality, specialist) • Individual stock	Interpret the time needed
Targets	• Lead time (1st pay "toekenning") • Lead time (general) • Absenteeism • Financial error (external quality) ←	(Depends on factor personal). Satisfaction of the client is also a factor.
Opinion	Manager team: fantastic, it is always a challenge to improve the results. The work-distributor is the person who has the most influence.	(he also has the knowledge of the team-employees)
Paper / scan	Employees use paper and scanned files	
Extra information	FPU (early retirement) is unplanned and is dependent on the outcome of "sociale partners". The legislations are retrospective.	

Additional notes:
There are two streams of inflow: "offerte" and "toekenning". The execution of work-distribution is for those two streams different. The causal factor is history. As long as there are no problems, both streams will not be updated.
In addition, AKs supply the items to this team, but the flow is not fluent. Both factors could be interpreted as motivation to change the execution of work-distribution.

What is missing is the performance criteria quality. It is not specific mentioned by the distributor, but is definitely a target that has to be in the list. In combination with (i) the employees in the team, which consists of only specialists, and (ii) the personal factor as decision variable, is quality the logically missing target.

Team GVP: execution of work-distribution

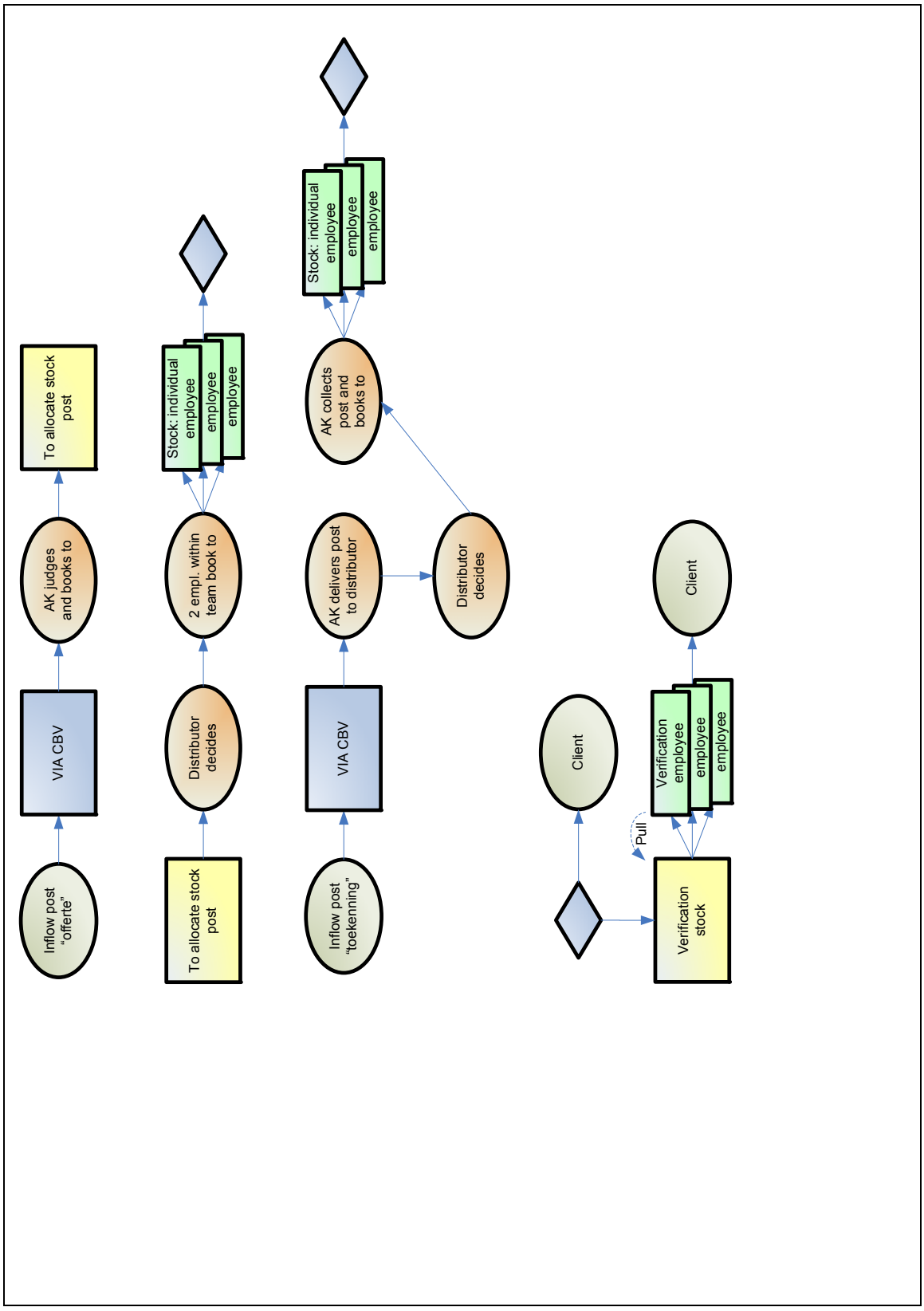


Table 24: Summary interview team: SVP

Team: SVP	Properties	Comments
Inflow post	Post flow: Amount: 500 / month Inflow: daily – fluctuate* Distribution: case – daily Stock: max 150-400 Extra: * additional perquisite (when annual report is finished) Auto flow: of employer Amount: 300 / month Inflow: 2 times a week – fluctuate** Distribution: batch – 2 times a week Stock: none Extra: **determine annual report	 Process: agree and then verify
Team properties	12 employees: some specialists Some processes are difficult → specialists needed Processes: "herzien uitkeringen", "mogelijke loonbelastingen", "codering van de klant", "mutaties die APG triggert", "mutaties die klant aangeeft"	Target: 90% → all-round employees
Decision variables	• Last employee (7/10 times correct) • Individual stock (team-feeling) • Presence • Difficulty item (some processes)	
Targets	• Lead time • Quality product (verification) • Cooperation / actions (management issue) Target is lead time: sometimes a item has to wait on reply or additional data. This is saved in the system however, the work item stays on the individual stock.	 Based on inflow of employer: 200-500 items has to be reviewed, 2 or 3 members of the team will execute this.
Opinion	Manager team: do not like his job, would like to have an AK in his team that distributes the items to the employees. The job is not difficult.	(The AK is in this way up to date of the knowledge of the employees)
Paper / scan	Employees use paper and scanned files	
Extra information	In the past, another mechanism has been used. This was a pull strategy: all the items are booked in team-stock and employees pull the work items when they finished their current. Negative aspects: there is no control for lead time; there is no process owner (person who is responsible for that specific case)	

Additional notes:
Manager will update the execution of work-distribution. Nowadays, it takes too much time before an item is on the right desk. The manager explained that even an AK could do the job, if he/she has enough commitment with the team.
When we update the mechanism to a pull strategy, as it was in the past, it is unclear who is responsible for a specific item, since all items are in the team-stock.
If an action is started, the distributor selects 3 employees in a team which execute all the items that belongs to the action (i.e. 2 of them execute and the 3rd provides the verification of the items).

Team SVP: execution of work-distribution

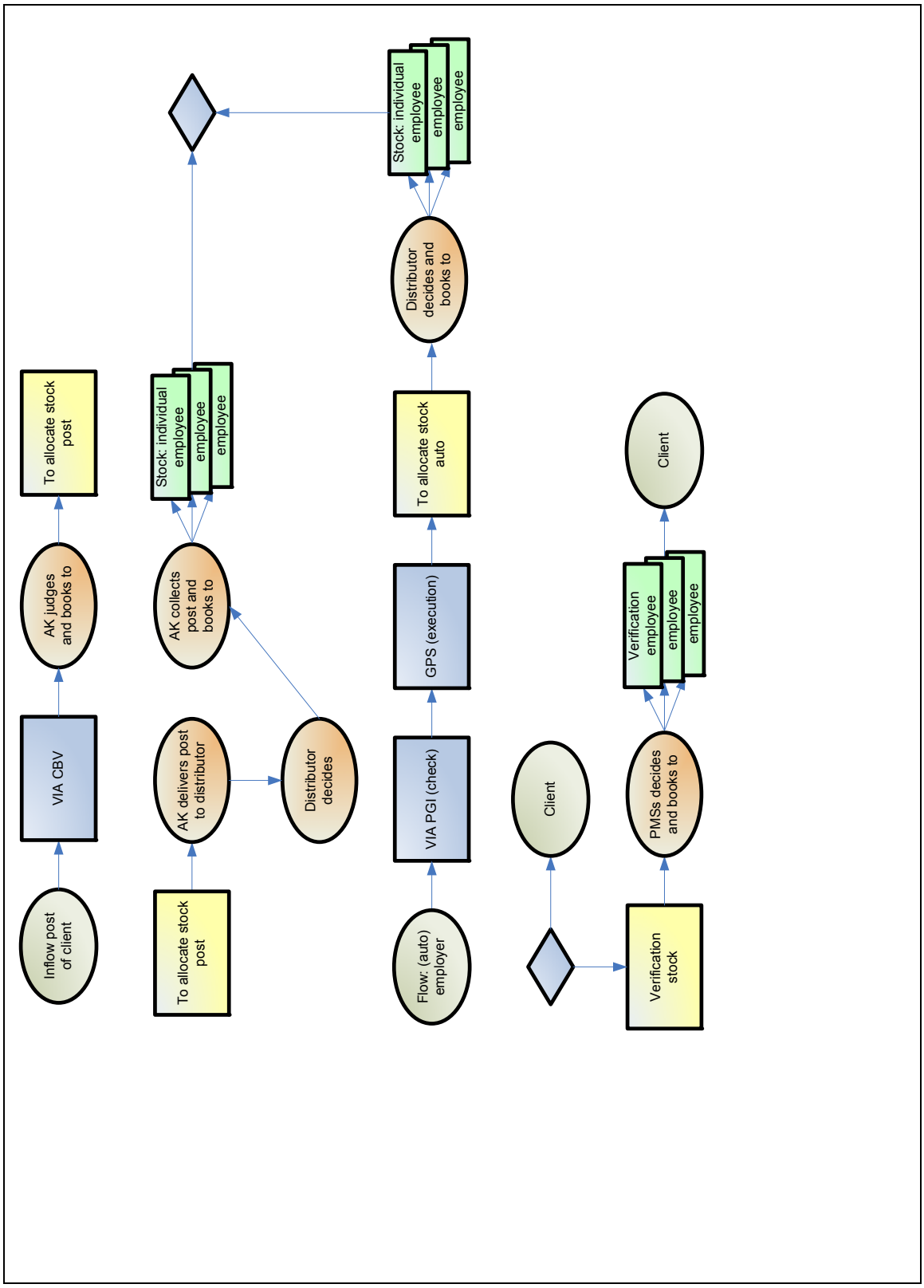


Table 25: Summary interview team: MPG

Team: MPG	Properties	Comments
Inflow post	Post flow: Amount: 5000 / month Inflow: daily – constant Distribution: case – semi-auto "kapstokcase"* Stock: none Extra: *x clients are managed by 1 employee.	
Team properties	28 employees: generalists	
Decision variables	• Post is sent to the right "kapstokcase" by system	
Targets	• Lead time	
Opinion	No interview has been held	
Paper / scan	-	
Extra information	"logistieke klok" triggers the clients who become 64.6 years old. Automatically a package is sent to the client and SVB.	

Additional notes:
In this team, no distributor is interviewed, since the distribution is executed by a system. During a meeting with managers, the right information is explored. Interesting for this project is the allocation of items, since it performs the allocation automatically.
First, a "logistieke klok" triggers at a specific time specific clients. Clients, who become 64.6 years old are triggered and receive a package including the right information to inform those clients about their possibilities to retire.
Because a priori, the number of clients is known, the range of clients is specifically allocated to one employee. When an item enters and belongs to this team, the item is a specific case, called "kapstokcase". With this construction, the client is indirectly connected to one employee of this team during a time-period.

Team MPG: execution of work-distribution

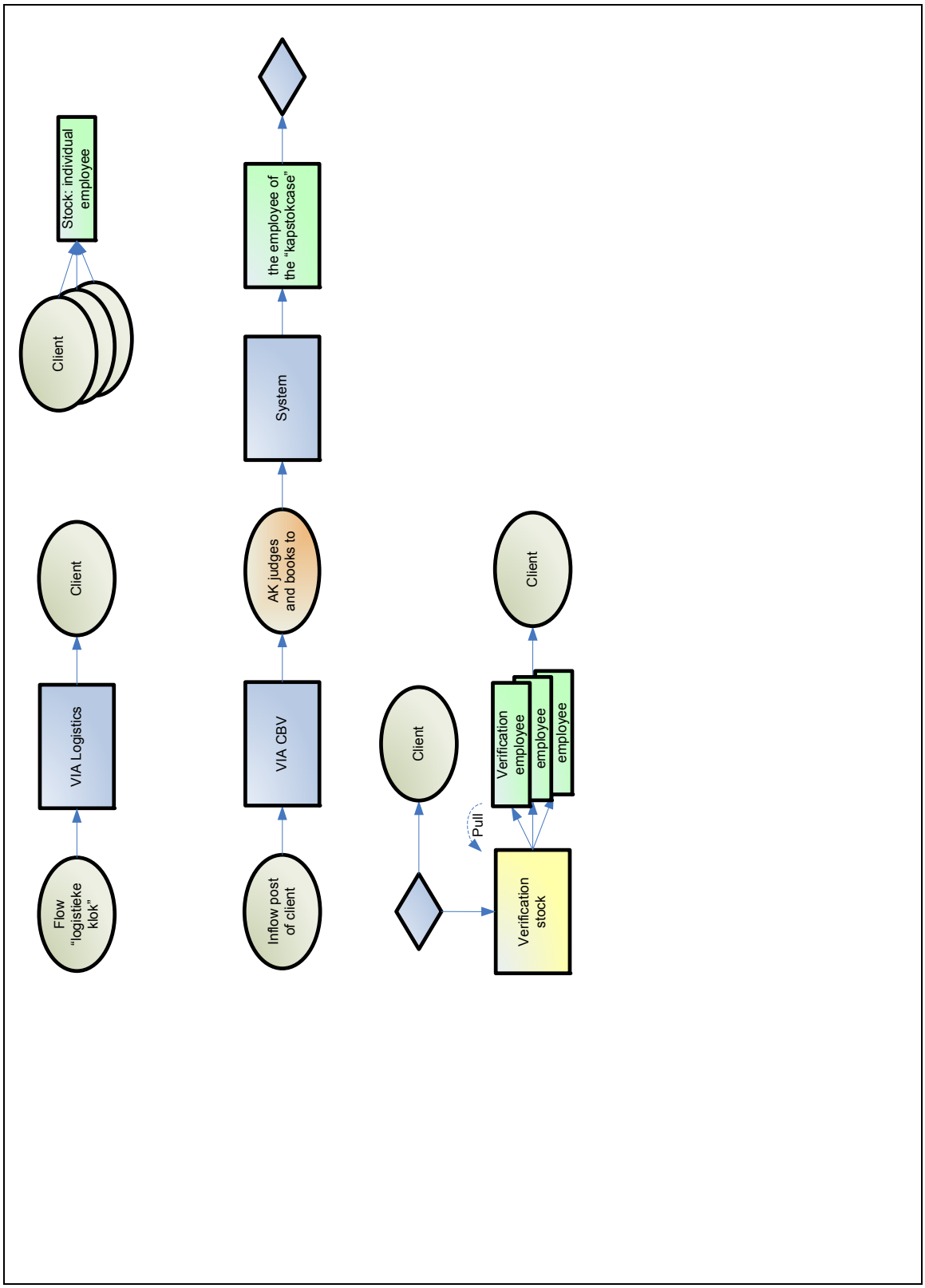


Table 26: Summary interview team: SAG

Team: SAG	Properties	Comments
Inflow post	Post flow: Amount: 3000 / month Inflow: daily – constant Distribution: case – daily Stock: none Extra: has "lussluiting" Auto flow: "wijziging opbouw" Amount: 800 / month Inflow: weekly Distribution: batch – weekly Stock: none Extra: has "lussluiting" Auto flow: SVB Amount: 300 / month Inflow: monthly Distribution: batch – monthly Stock: none Extra: has "lussluiting" Auto flow: EVW Amount: 500 / month Inflow: monthly Distribution: batch – monthly Stock: none Extra: has "lussluiting"	
Team properties	27 employees: only specialists 4 empl: Domain: military 4 empl: Domain: creditors 4 empl: Domain: VPS	
Decision variables	• Individual stock • Difficulty work item • Presence • Knowledge of subjects (width) • Knowledge of subjects (depth)	Interpret the time needed for an item Specific processes Competence
Targets	• Quality • Balance of work • Lead time	Take care for pay correctly and on time Production in one day is another target.
Opinion	Sub-distributor: it has to be done, not his favorite job.	
Paper / scan	Employees use paper and scanned files	
Extra information	Automatic distribution is not possible, based on the knowledge of the employees. Every employee has his own qualities and has to be used in a function.	

Additional notes:
According to the distributor: lead time depends on quality. When an (unqualified) employee gets a item and takes extra time to complete the item, than a qualified employee, the verification time that is needed, could also be higher, since it can contain errors. Therefore, you pay 2 times time, just for one work item. In addition, for automatic distribution: knowledge of subjects (depth) cannot be (easily) read by a computer. The automatic flow can be distributed by a system, although the time that is gained is low and will not outperform the costs, the distributor guess.

Team SAG: execution of work-distribution

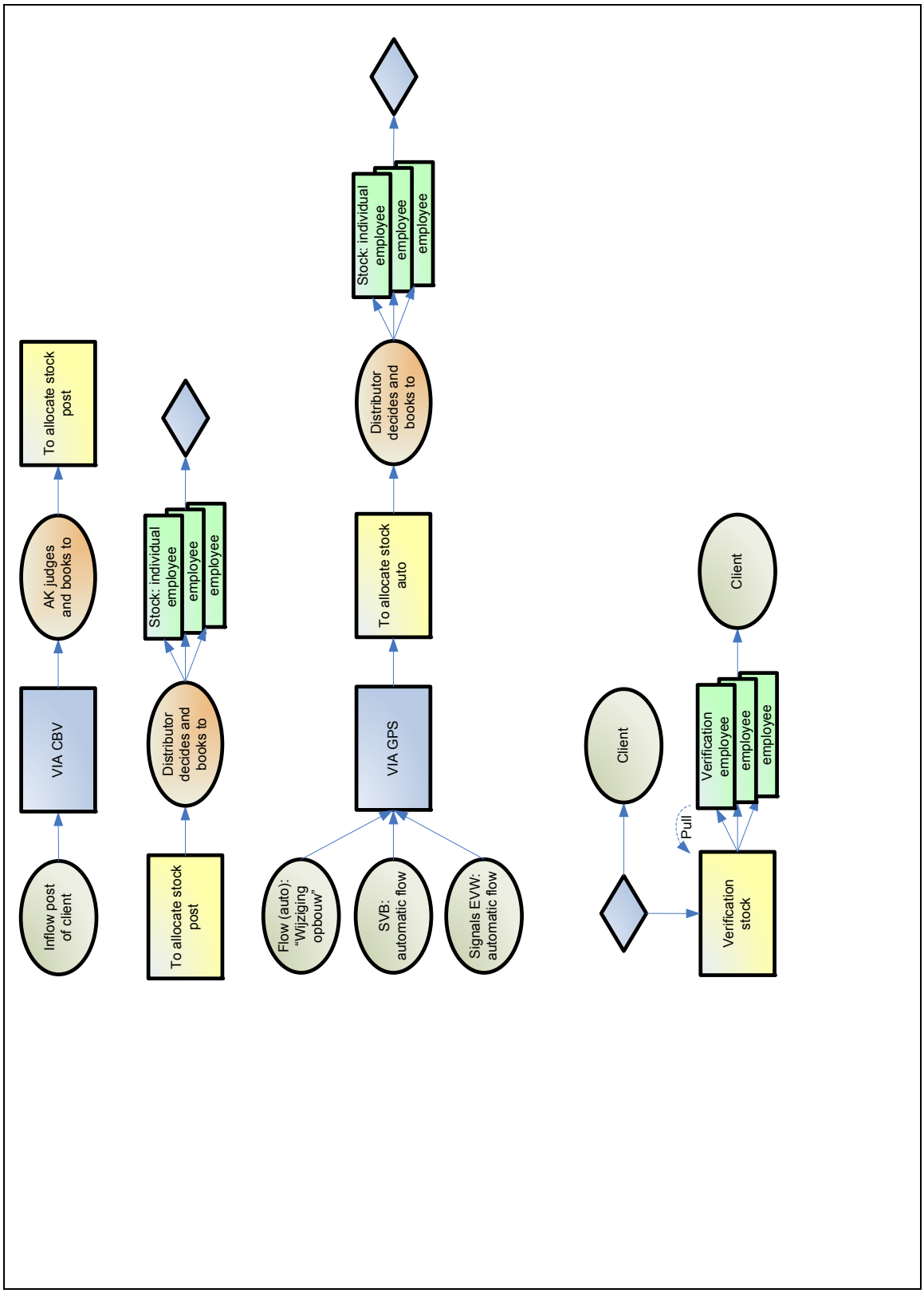


Table 27: Summary interview team: SBO/SAN

Team: SBO/SAN	Properties	Comments
Inflow post	Post flow: Amount: 8000 / month Inflow: daily – constant Distribution: case – daily Stock: none Extra: has "lussluiting" Auto flow: GBA Amount: 1200 / month Inflow: daily Distribution: case – daily Stock: none Extra: has "lussluiting" Auto flow: SVB Amount: 1200 / month Inflow: monthly (3 processes) Distribution: batch – (2/3 before "lussluiting", the last flow is distributed after the "lussluiting") Stock: none	
Team properties	30-40 employees: only specialists Processes: "toekenning", "herzien", "beheer" NP is specialization of OP	
Decision variables	• Presence • Last employee • Competence skills • Individual stock	
Targets	• Lead time • Balance of work (level taken into account)	
Opinion	It is a fulltime job for the distributor in this team. "It is okay." The distributor is only busy with his function: dividing work and does not take motivation or control into account. That is a task of management.	
Paper / scan	Employees use paper and scanned files	
Extra information	Targets of the team are speed of communication, client focus, client friendliness, cooperation within the team. Management has to support the distributor in absenteeism, motivation, quality, and control.	

Additional notes:
At Targets, one point is missing, called quality and at Extra information, the distributor noticed that several aspects are important in the team, such as client focus, friendliness, cooperation among the employees. In addition, at the decision variables, competence/skills is one of the parameters the work-distributor takes into account. Both aspects could be classified as quality aspects, however at Targets, only lead time and a work balance are mentioned. According to the distributor, "*the manager is the responsible for quality and motivation of the employees.*" The (external) quality is missing here as performance criteria, and has to be added.

Team SBO/SAN: execution of work-distribution

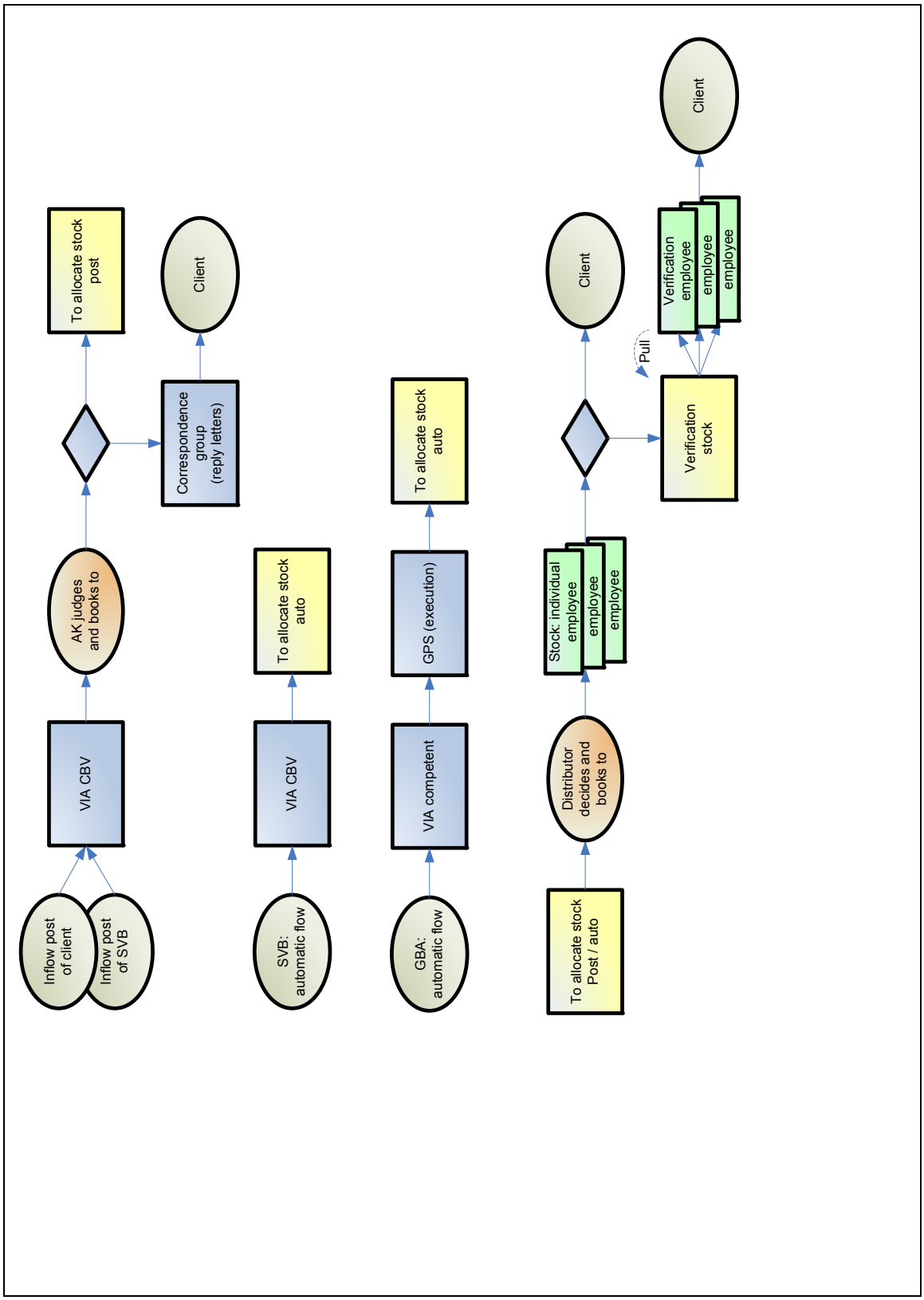


Table 28: Summary interview team: KVI

Team: KVI	Properties	Comments
Inflow post	Post flow: Amount: 2800 / month Inflow: daily – constant Distribution: case – daily Stock: domain: FPU higher stock Extra: special group of readers: 12 employees After the group of 12 empl, again 4 work-distributors	
Team properties	40 employees: only specialists Processes: Questions are grouped in the different domains. 12 empl group of readers 5 empl: FPU 5 empl: ABP Extra 2 empl: NP Rest empl: AKP and others	
Decision variables	• Knowledge of subjects • FPU stock (old stock) • Quality employees (knowledge / skills) • Presence / vacation • Schedules • Individual stock • Variety	
Targets	• Client satisfaction • Team satisfaction • Lead time (automatically signal old item) • Stock	Cannot be seen as individual points (i.e. when there is no satisfaction in a team, processing within the lead time is not reached)
Opinion	Nice to do	
Paper / scan	Employees use paper and scanned files	
Extra information	Special group of readers (generalists employees) read all items and complete easy work items by themselves. The rest of the items are coded and distributed to the other distributors, which represent a specific domain in team KVI. A list is present, who of the employees can perform a specific domain, and is used by the group of readers.	

Additional notes:
To decrease the (old) stock in this team, a group of readers is introduced. The stock-level is well, because the group also complete easy items by itself.
As can be seen in next figure, first a group of readers is finishing and distributing work to distributors again. The question is why the group cannot deliver directly the items to the right person, without use of an intermediate.

Team KVI: execution of work-distribution

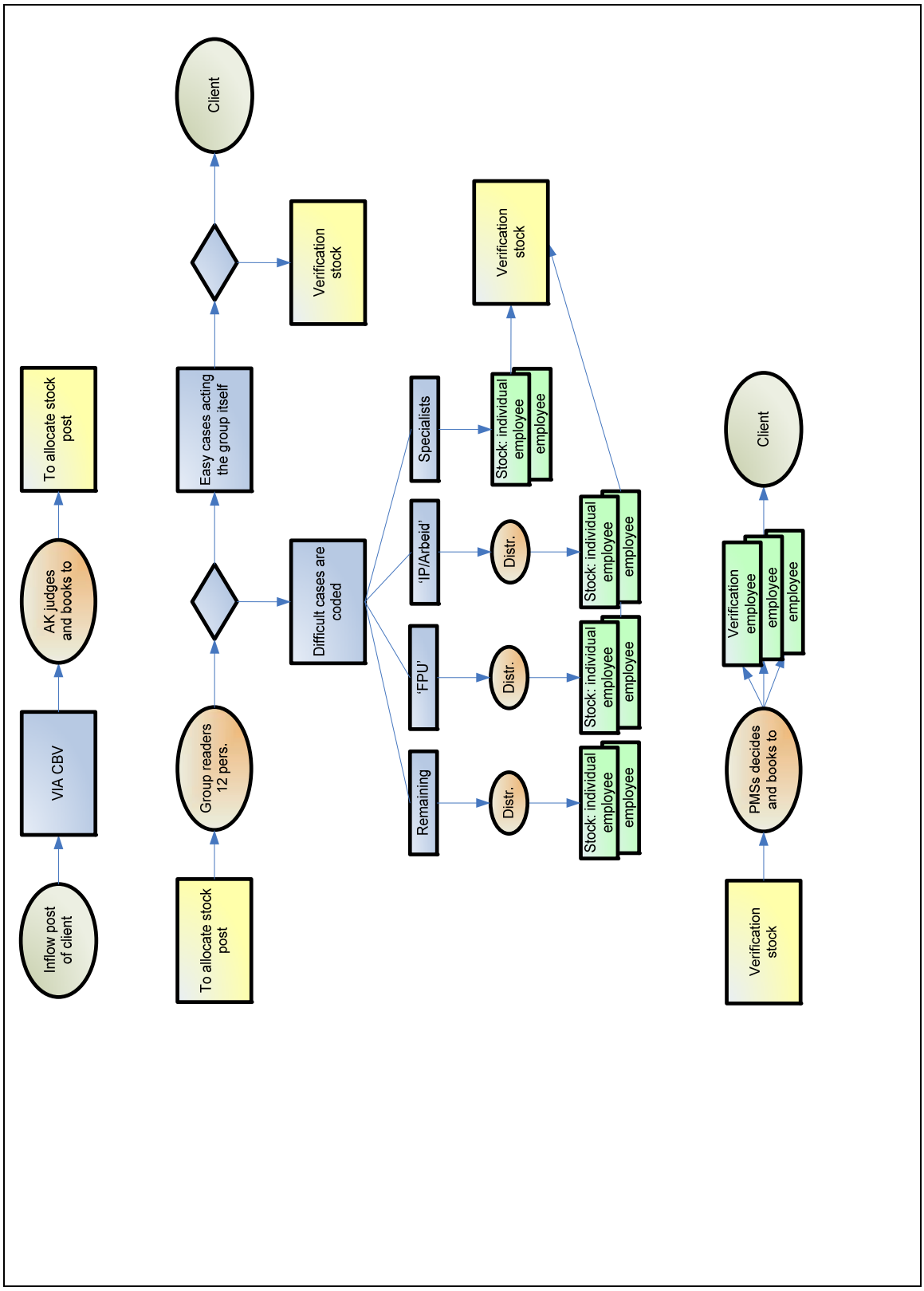


Table 29: Summary interview team: KTD

Team: KTD	Properties	Comments
Inflow post	Post flow: Amount: 2400 / month Inflow: daily – constant Distribution: batch – daily Stock: none Extra: 6 of the 14 are verification employees	
Team properties	14 employees: generalists 1 empl: "hereffectueren" Processes: "completeren", "aanmaken offerte", "effectueren", "poststukken divers", "hereffectueren"	
Decision variables	• Verification (1st action) • Individual stock • Part time / fulltime • Vacation	
Targets	• Lead time (production < 1 day)	
Opinion	Nice to do: different kinds of people It has to be done, and it is not the most rewarding job	(weak vs. strong argument)
Paper / scan	Employees use scanned files	
Extra information	Distributor decides the verification and process: "completeren". The rest is divided by an AK on decision variable: last employee.	

Additional notes:
In this team, the employees are generalists. This means they can perform all the tasks except the verification.

The opinion of the distributor is contradicted. On the one hand the "*nice to do*," as the work-distributor said, is broken by "*not the most rewarding job*" on the other hand. The argument *"different kinds of people"* is weak as we look to the decision variables. None of the variables has internal a specific skill or competence contribution.

This team is performing in a way like MPG. Although the "kapstokcase" is important for team MPG, both teams receive multiple postal items of clients, and per client, one employee is allocated to perform all the processes (except the verification).

Automatic allocation of work items is an option, if the postal items are scanned. At this moment, the items are used by the employees. Folders are on the desks of the employees and items are stored until the next item is received for a specific client (the AK allocates this item to the last employee). At this moment, a specific team is scanning all the incoming postal items and those are linked to the process that has to be started up.

Team KTD: execution of work-distribution

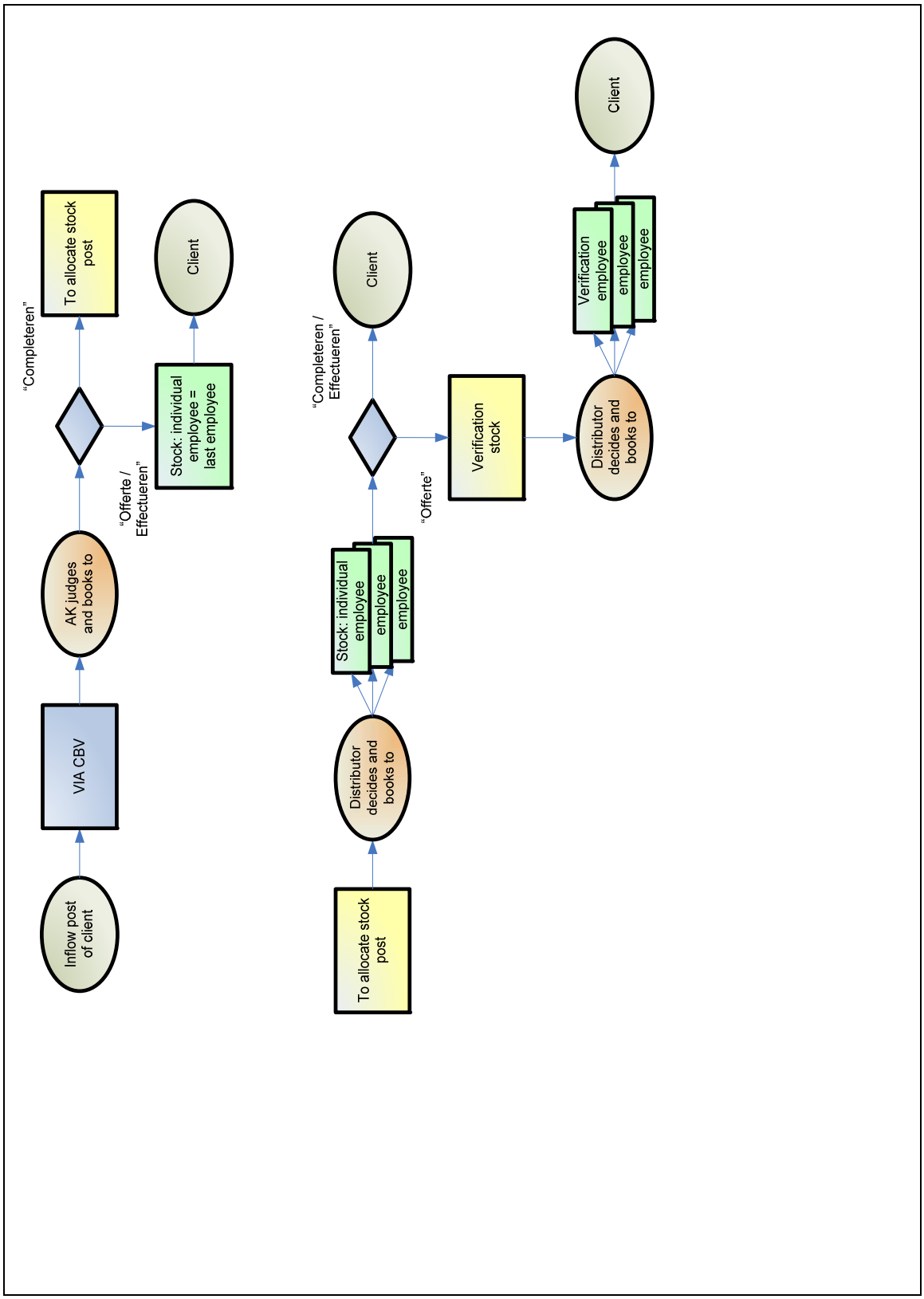


Table 30: Summary interview team: SPS - partner registration

Team: SPS - Part	Properties	Comments
Inflow post	Post flow: Amount: 1600 / month Inflow: daily – constant Distribution: batch – daily Stock: average 300 Extra:	
Team properties	10 employees: generalists Processes: "Registratie partner", "afmelden partner", "beëindiging ABP-partnerschap"	
Decision variables	• Presence (part time / fulltime)	
Targets	• Lead time • Quality work	
Opinion	The trainee is not interviewed.	
Paper / scan	Employees use paper and scanned files	
Extra information	The trainee filters the items by type and the employees receive all kind of items.	

Additional notes:
At this time, a trainee divides the work among the employees of the team. The trainee looks at the presence of the employees and filters the items in such a way that the employees receive the same workload. This allocation of items among the employees could be easily automated in this team.

Team SPS – Partner registration: execution of work-distribution

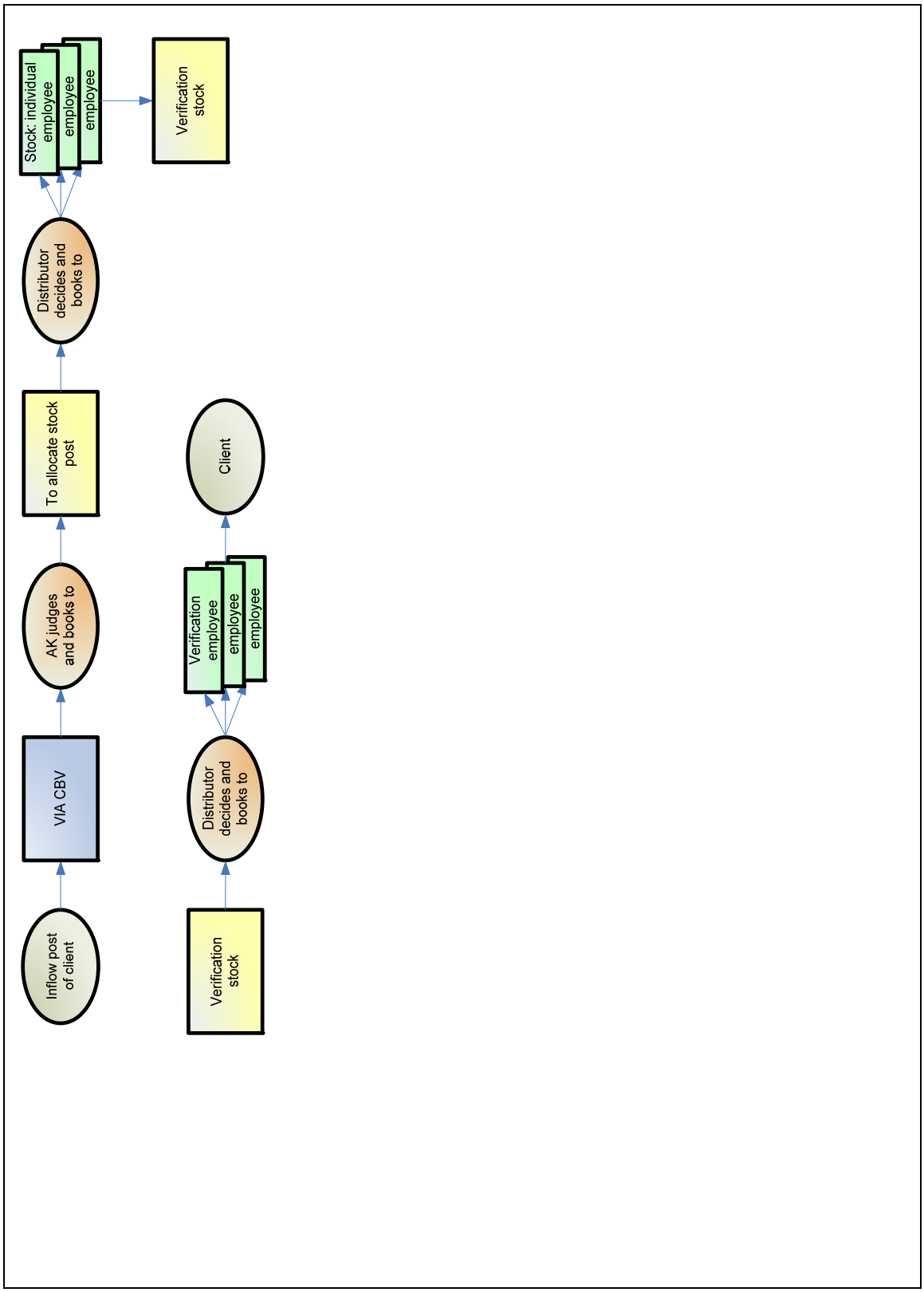


Table 31: Summary interview team: SPS -VPS

Team: SPS -VPS	Properties	Comments
Inflow post	Post flow: Amount: 1000 / month Inflow: daily – constant Distribution: case – daily Stock: average 250 Extra: team in two sub-teams: "dagagenda" and "oud voorraad"	
Team properties	14 employees: generalists + specialists 4 empl: generalists: group: "dagagenda" 7 empl: generalists: group: "oud voorraad" + 3 empl: specialists Processes: "afzien NP + uitsluiten VPS", "Contante Waarde Berekening opgave", "Her-indexatie", "Proforma berekening", "VPS registratie"	
Decision variables	• Knowledge of subjects • Presence (part time / fulltime)	
Targets	• Client focus • Quality work • Lead time	Give sense to the clients
Opinion	Sometimes, the distributor likes the job. This is when no troubles occur.	
Paper / scan	Employees use paper and scanned files	
Extra information	Team is divided in two sub-teams to decrease and control the 'to allocate stock'. The employees support a split in this team to control the stock level. In the first sub-team: "dagagenda" the employees try to complete most of the items before a specific deadline. When the item is too difficult or takes too much time to complete, it will be stored temporarily in a cabinet. The second sub-team "oud voorraad" takes the items out of the cabinet and complete these items. Once a week, one employee takes 50 items and processes those at home. The next week the employee delivers the items and takes another 50. Variables of item taking into account for decision: - what is the question o a registration o a "proforma berekening" o a general question o "afzien NP" - age - date of divorce	

Additional notes:
Due to the split in this team, the competence and skills of the employees are better used. Group "dagagenda" consists of employees who prefer a high workload, like to perform many items and takes the responsibility. In the second group "oud voorraad" the employees have other competence and preferences such as: deliver quality of work within a greater timeframe, complete difficult items and use their capacity for computing "offertes" or other difficult work.

Team SPS - VPS: execution of work-distribution

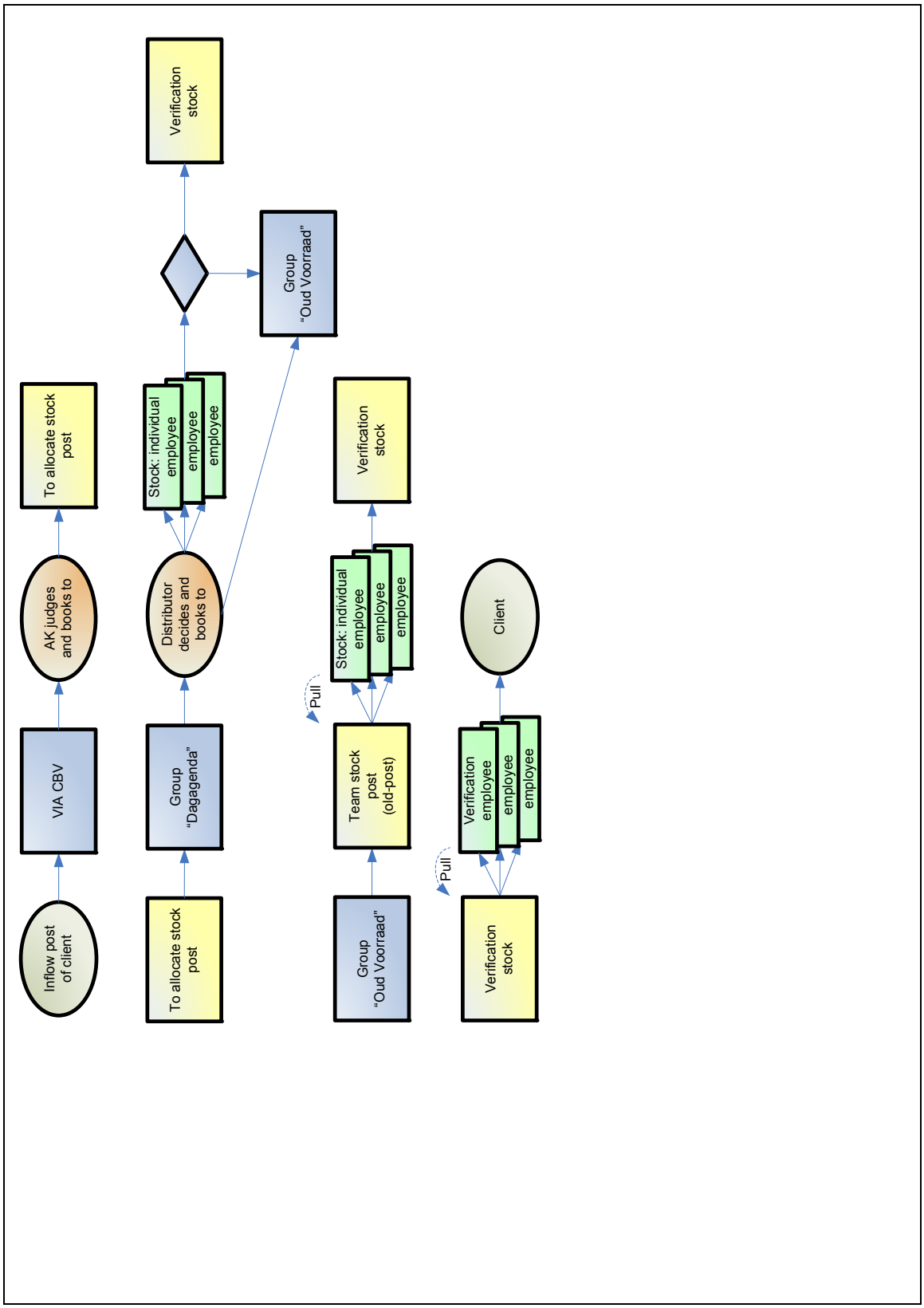


Table 32: Summary interview team: CBV - GBA

Team: CBV - GBA	Properties	Comments
Inflow post	Post flow: Amount: 2500 / month Inflow: daily – constant Distribution: batch – daily Stock: * Auto flow: GBA Amount: 1000 / month Inflow: daily – constant Distribution: batch – daily Stock: * Extra: * team-stock < 500	
Team properties	7 employees: generalists beyond process "GBA signalen" 2 empl: fixed verification Processes: "GBA signalen", "Emigratie", "Mutaties GBA / niet GBA"	
Decision variables	• Individual stock • Presence / planning • Signal type (variable will leave end of 2009)	
Targets	• Lead time (team-target) • Stock < 500	
Opinion	Not difficult, when the inflow is all right	
Paper / scan	Employees use paper and scanned files	
Extra information		

Additional notes:
From history, there could be some persons, who prefer to be a specialist and protect their domain of work. This could be happen when only one employee is suited to perform a specific task, although this has to be prevented.

During the interview, an option came up: a pull strategy for this team in which employees take items from the team stock by themselves. Items for verification should be placed in another stock to separate the stocks from each other. A manager has the task to control the stock in the team and employees have to be instructed. The preferences of employees could be a problem in this allocation mechanism.

Team CBV – GBA: execution of work-distribution

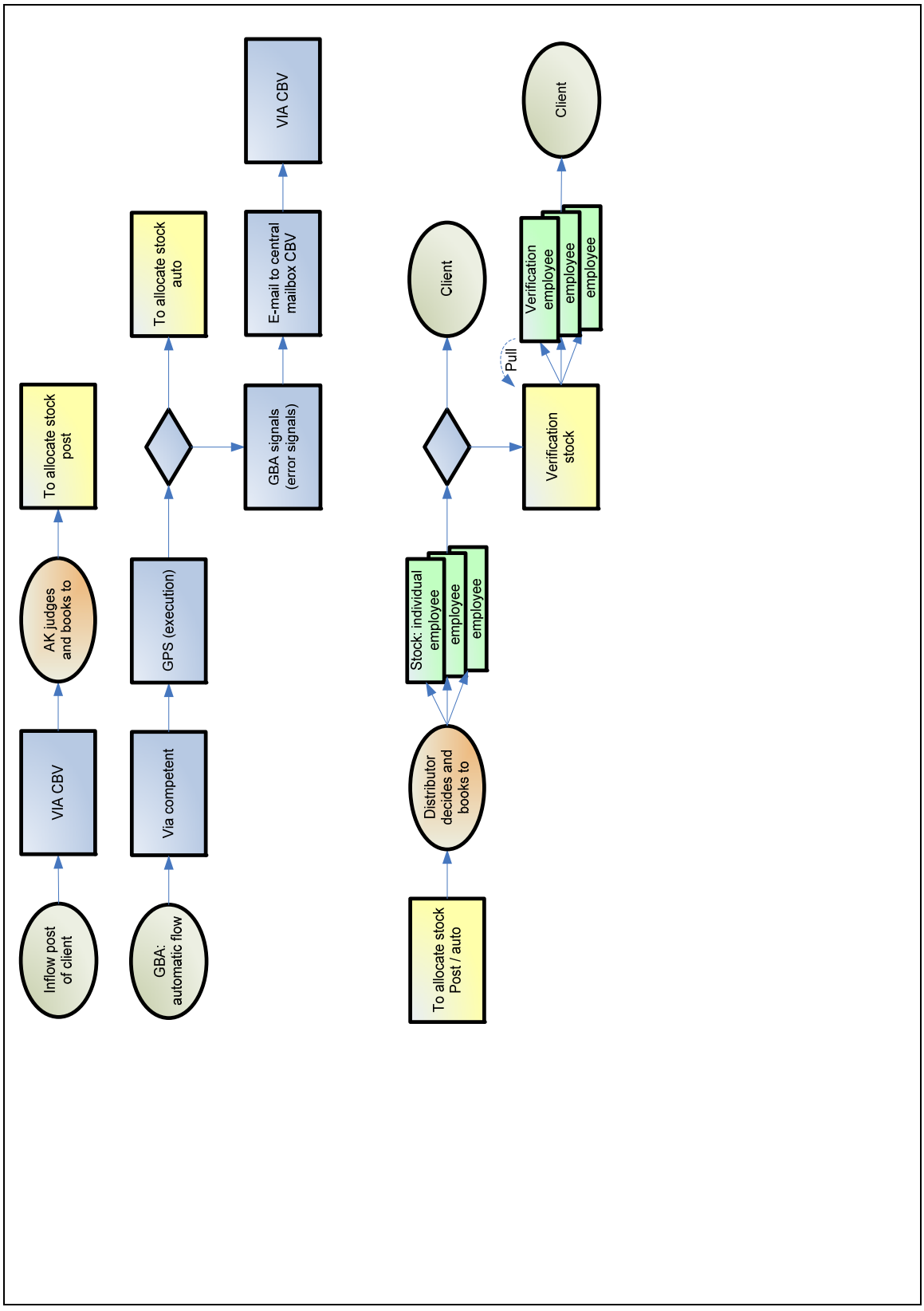


Table 33: Summary interview team: SBG - DO

Team: SBG-DO	Properties	Comments
Inflow post	Post flow: Amount: 180 / month Inflow: daily – constant Distribution: case – daily Stock: none Extra:	
Team properties	8 employees: generalists 6 empl "Diensttijdonderzoek" 1 empl "Pensioenreparatie" 1 empl "Aanvullende FPU tijd" Processes: "DiensttijdOnderzoek", "Pensioenreparatie", "Aanvullende FPU tijd"	
Decision variables	• Signal type • Presence (part time / on leave) • Individual stock • Last employee	Individual stock has to be empty before vacation starts
Targets	• Lead time • Quality work • Work balance	
Opinion	It is no big deal; an AK can do this job. Distinction is not necessarily.	
Paper / scan	Employees use paper and scanned files	
Extra information		

Additional notes:
Team SBG is separated in three sub-teams, one of them is SBG-DO:

Per month, the inflow is low for this team and the number of employees too, which could be based on the level of difficulty of work this team. The verification is on all items.
The distribution is quite easy and can be performed by an AK.

Team SBG - DO: execution of work-distribution

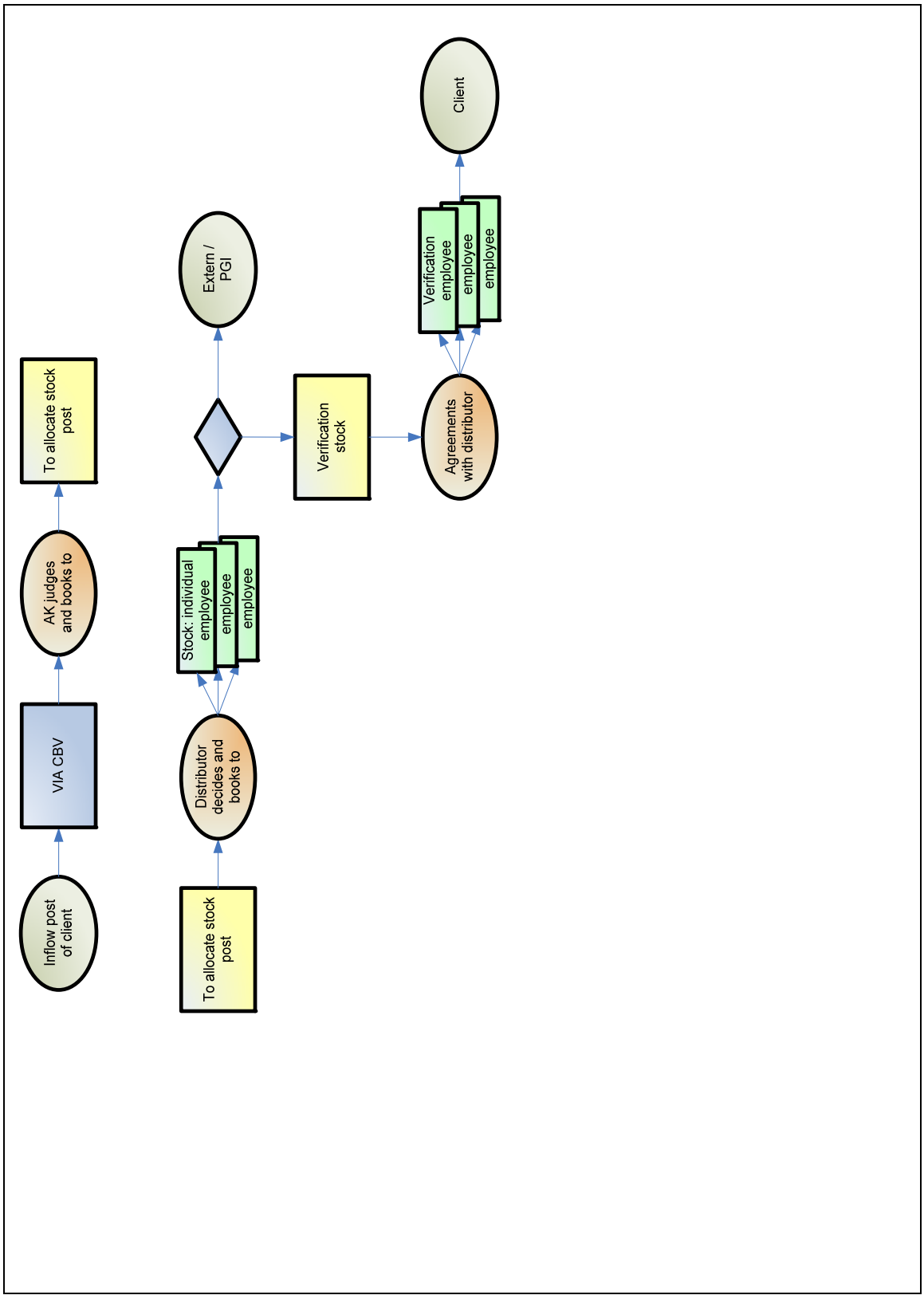


Table 34: Summary interview team: SBG - WO-uit

Team: SBG-WO-uit	Properties	Comments
Inflow post	Post flow: individual Amount: 1000-1100 / month Inflow: daily – constant Distribution: case – daily Stock: none Extra: Post flow: collective Amount: unknown Inflow: if applicable Distribution: batch – if applicable Stock: none Extra: 3 employees are selected to execute the collective process. 2 of them calculate, the last employee does the verification	
Team properties	11 employees: generalists Processes: "Aanmaken offerte", "wo-uit effectueren", "Hereffectueren", "poststuk divers"	
Decision variables	• Presence • Individual stock • Old stock • External pressure (urgent task) • Verification (not allowed for all employees)	
Targets	• Correctness via verification • Lead time • Work balance	
Opinion	Well it is not difficult. The only task is to check the individual stock.	
Paper / scan	Employees use eventually paper docs	
Extra information	This team has less or no contact with the client, only with the pension insurer. The management target is that an AK books the process and a distributor divides the items among the employees. Automatic option is no problem, only the verification has to be executed.	

Additional notes:
Team SBG is separated in three sub-teams, one of them is SBG-WO-uit:

The Post flow: Collective is comparable with an action, because it only occurs when the government decides for a privatization of a public firm. Items have to be created by the work-distributor and as he said, "just two maybe three knows how to act when such application is requested. Off course procedures / handbooks are there to help."
For the execution of such an action, the distributor selects 3 employees of the team. 2 of them perform the execution of the items, and number 3 will verify all the items. With this construction, the lead time of the items is decreased due to the experience the employees received by performing the same tasks.

Team SBG – WO-uit: execution of work-distribution

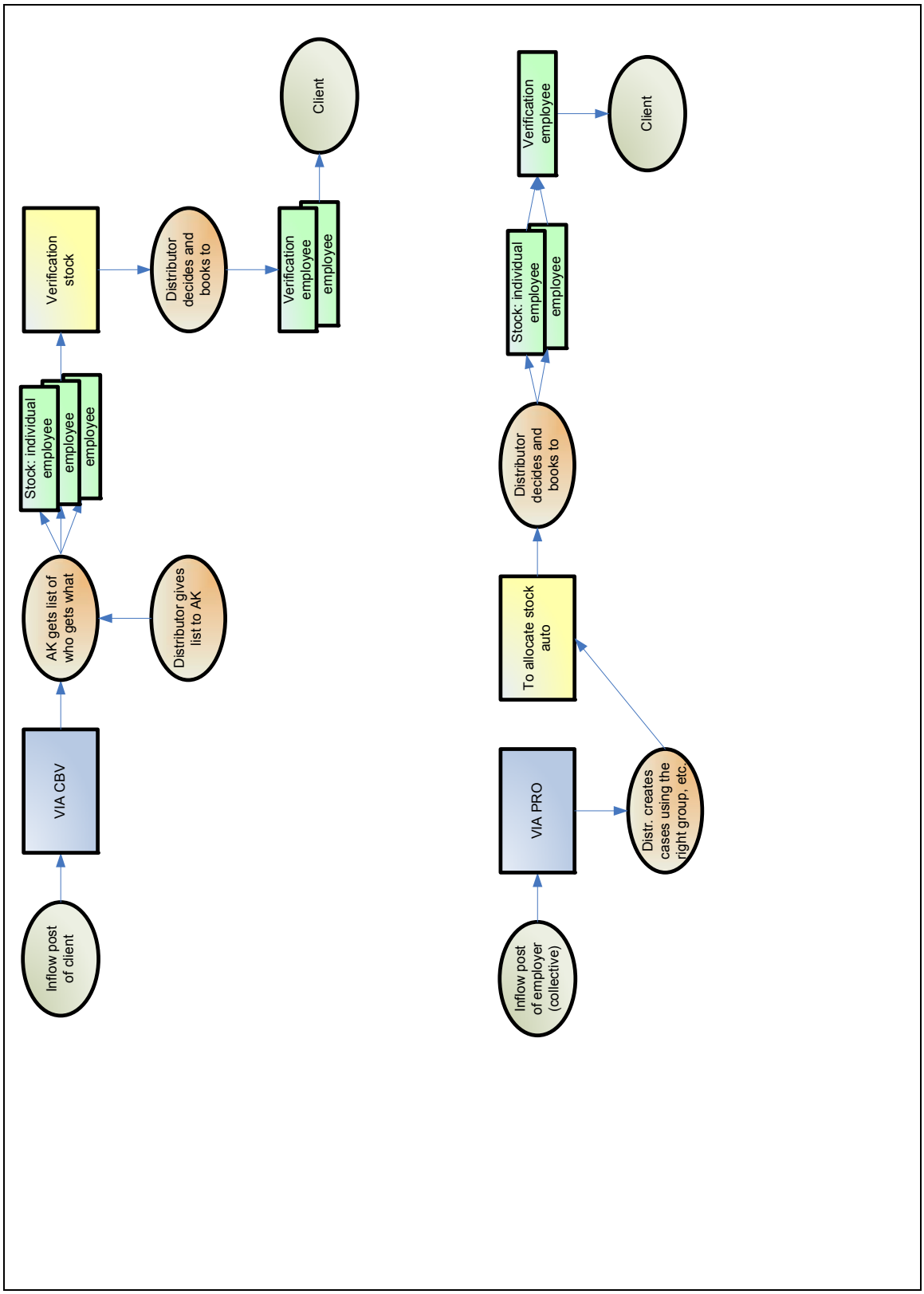


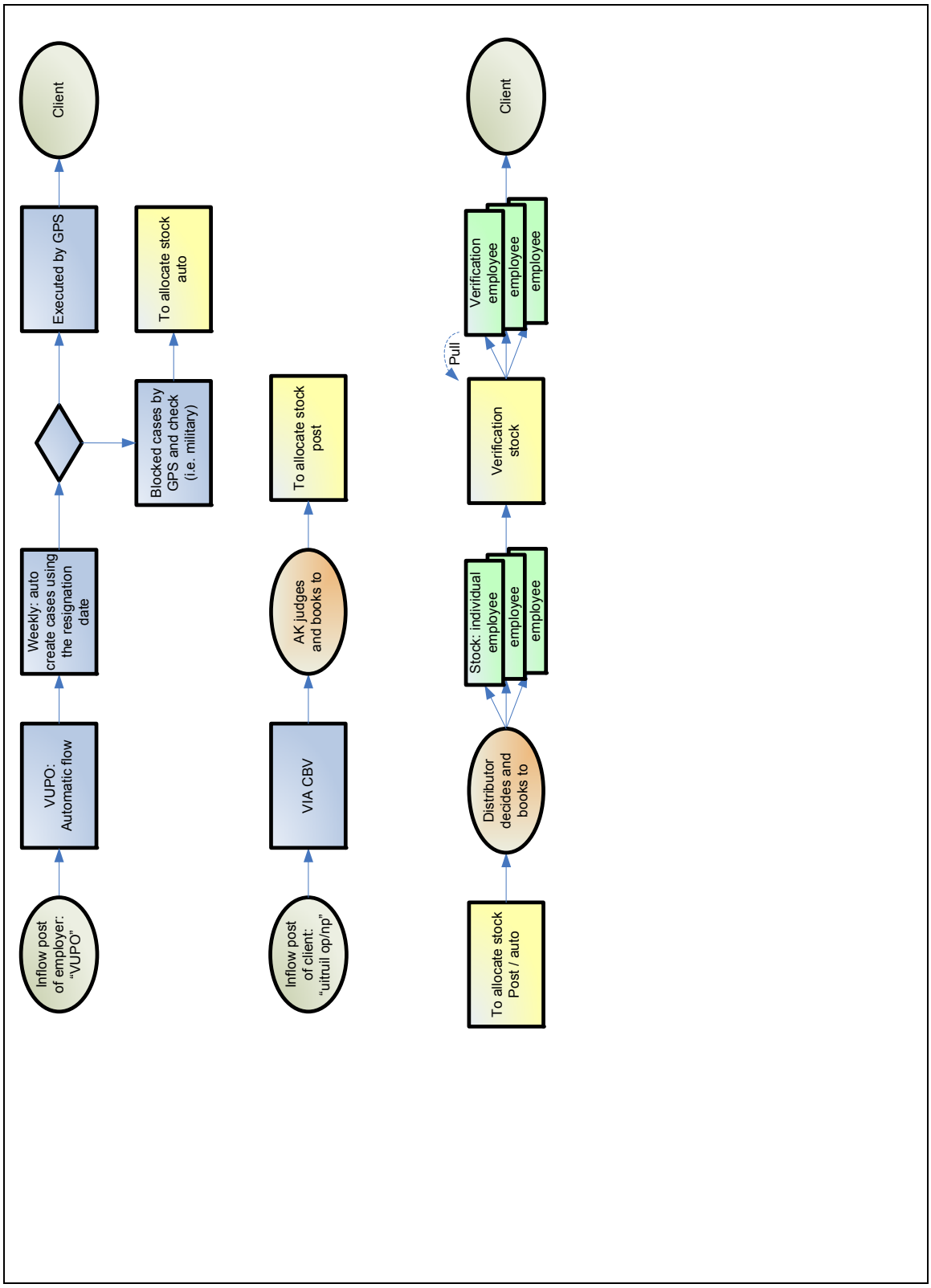
Table 35: Summary interview team: SBG - VUPO

Team: SBG-VUPO + uitruil	Properties	Comments
Inflow post	Auto flow: VUPO Amount: 500 / month Inflow: weekly – fluctuate Distribution: batch – weekly Stock: items 2008 Extra: items of 2009 have priority on items of 2008. Post flow: uitruil OP/NP Amount: 400 / month (raw estimate) Inflow: daily – constant Distribution: batch – daily Stock: none Extra:	
Team properties	12 employees: generalists 9 empl "VUPO" 2 empl verification (fixed) 3 empl "Uitruil OP/NP" Processes: "VUPO", "Uitruil OP/NP"	
Decision variables	• Presence • 1 empl (unsuited) → will leave this team • Individual stock • Part time / full time	
Targets	• Lead time	
Opinion	Not so nice, it is not one of his hobbies.	
Paper / scan	Eventually, employees use paper files	
Extra information	Inflow is determined by the date of resignation. 4 months later, the items are processed by this team. Processes are quite new, started last year. The inflow is therefore quite difficult to determine.	

Additional notes:
Team SBG is separated in three sub-teams, one of them is VUPO + Uitruil:

The processes executed in this sub-team are quite new. Due to this, the number of inflow can be biased. Distribution of work is not his hobby. The distributor: *"an AK could do this, or maybe an automatic system can execute this task."*

Team SBG – VUPO + Uitruil: execution of work-distribution



I. Management view

In the meeting with the director of Pensions, two topics of interest are discussed.
1. The required level of standardization in allocating work and
2. The priority settings in the targets when allocating work set by management (control for quantity, quality etc.

1. Level of standardization
Managements' view of standardization is quite clear. It is impossible to consider the quality performance criterion on simple processes. In addition, it is a waste of time to make a distinction between processes, which could be carrying out by generalists. Of course, some processes need the intention of quality aspects. Requests of clients (team KVI) could be very divers, and could not be performed by the same employee. Specialists are needed in such a case.
Standardization in the allocation of work is unfeasible; due to the differences in work items that arrive in the different teams.

2. Priority settings in performance criteria
The priority of the performance is simple according the director. On the long term all the requests are processes via Straight Through Processing (STP). The work items are automatically processed by a GPS and clients will be informed by the system, within a specific time-frame and according the quality aspects. Difficult items are dropped out of the system and will be carried out by employees with quality as the first performance criteria. On the mid-long term, the system is not finished. Parts of the products are running by the system, but the current teams are still there. The split between the targets as set in Figure 33 is okay. The target: internal quality is quite unclear for the director, since the variety of work is unimportant in management' view.

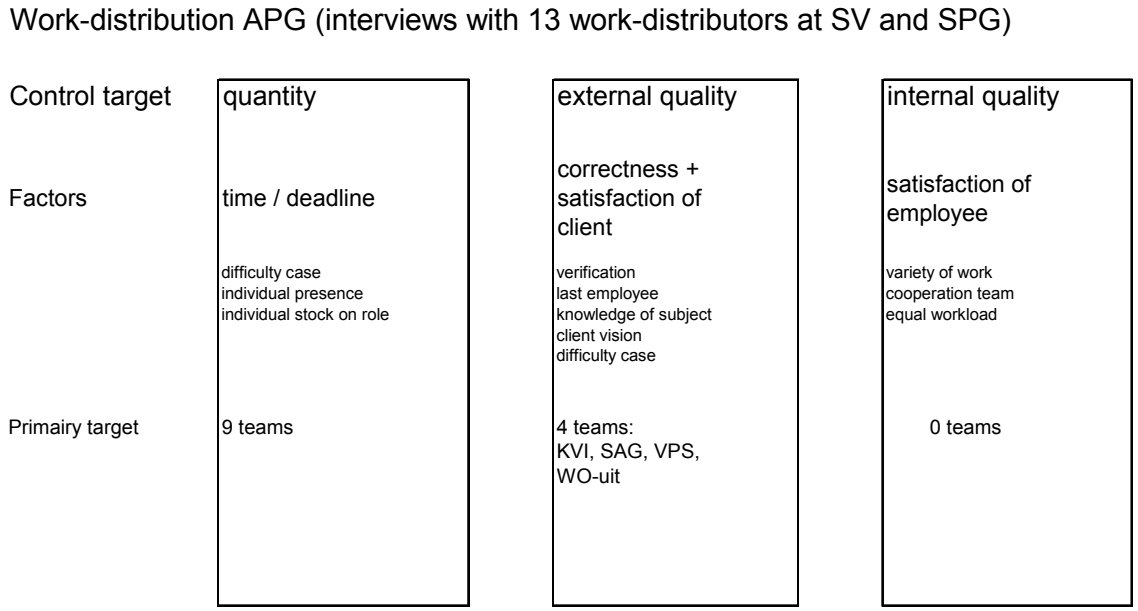


Figure 33: Teams grouped in performance criteria

The split between quantity and external quality is clear. It depends on two factors according the distributor:

- It depends on the work item, the kind of process and
- It depends on the personal factor

The director advised to uphold the current split and provide the support for distribution of work for the teams within on of the targets.

J. Score tables, used for diagnosis

In determining which team belongs to which classification, the score tables are used.
For the variables: distribution, employees, decision factors, performance criteria and opinion, special score tables are created. The table is divided in two aspects: quantity and quality.

Table 36: Score tables of the different variables

Distribution

Quantity					Quality			
Rank	Semi-auto	Batch	One by one		Rank	Semi-auto	Batch	one by one
1	5	3	-		1	-	3	5
2	4	2	-		2	-	2	4
3	3	1	-		3	-	1	3

Employees

Quantity					Quality			
Rank	Generalists	Some specialists	Only specialists		Rank	Generalists	Some specialists	Only specialists
1	5	3	-		1	-	3	5
2	4	2	-		2	-	2	4
3	3	1	-		3	-	1	3

Decision factors

Quantity							Quality						
Rank	Presence	Individual stock	Work item properties	History	Authorization	Knowledge & skills	Rank	Presence	Individual stock	Work item properties	History	Authorization	Knowledge & skills
1	5	5	3	3	-	-	1	-	-	3	3	5	5
2	4	4	2	2	-	-	2	-	-	2	2	4	4
3	3	3	1	1	-	-	3	-	-	1	1	3	3
4	2	2	-	-	-	-	4	-	-	-	-	2	2

Performance criteria

Quantity					Quality			
Rank	Time	Internal quality	External quality		Rank	Time	Internal quality	External quality
1	5	3	-		1	-	3	5
2	4	2	-		2	-	2	4
3	3	1	-		3	-	1	3

Opinion

Quantity					Quality			
Rank	Negative	Neutral	Positive		Rank	Negative	Neutral	Positive
1	5	3	-		1	-	3	5
2	4	2			2	-	2	4
3	3	1	-		3	-	1	3

These tables provide a score to a variable based on the rank. E.g. on the quantity side, for the decision factors variable: when the interviewee ranked the decision factor 'individual stock' as 3rd, a score of 3 is given. For all the variables in this score table, the scores are based on a scale (1-5) in which a 1 represent a low score and a 5 a high score on the aspect. When the

scores are higher ranked, the scores are higher (i.e. on the quantity side of the variable performance criteria, a first rank on time receives a 5, whereas when the rank is 2nd, the score is a 4).

Set up of the score tables

1. During the interviews, the answers are obtained and are converted into table X.
2. From the literature is gathered that there is a tradeoff between quantity and quality.
3. For each variable, the answers are classified to one of these aspects: quantity or quality:
    a. Variable distribution
        i. Semi-auto is more quantity oriented, because the items are distributed without any interaction of employees.
        ii. A case based distribution (i.e. distributed one by one) is classified as quality based, since the distributor assess the work item on several aspects before it is distributed.
        iii. A batch distribution (e.g. 10 work items equally distributed to one employee) could be used for specific processes to one employee (to a specialist), or the first 10 work items could selected and distributed to a generalists. Therefore the batch distribution is not classified, but is in both aspects used, but received lower scores.
    b. Variable employees
        i. Teams that consist of generalists are classified as quantity, because they could perform all the work items and thus the distribution is simple.
        ii. When specialists are in a team, the distributor allocates the items based on a more quality aspect, since the specialists could receive special work items.
        iii. There are some teams that contains of generalists and specialists. In such a team, the work is quantity and quality based, so in both aspects these ‘some specialists’ are taken into account, but received lower scores.
    c. Variable decision factors
        i. For the decision factors, assumed is there is a distinction in the variables given during the interview. In total 6 factors are given. Assumed is that 2 of them: ‘presence’ and ‘individual stock’ are linked to quantity side, since when both factors are used by the distributor the distribution to the employees is based on a planning (i.e. the distributor determines which item could be finished). It is time-based, and thus classified to the quantity side.
        ii. In contrast, assumed is that two factors: ‘knowledge & skills’ and ‘authorization’ are both dealing with the experience and performance of the employees. These factors are dependent on the quality of the employees and are linked to the quality side.
        iii. Two factors are left, which could not be linked to one of the aspects. Factors ‘history’ and ‘work item property’ could be either quantity oriented, if the distributor take both account to allocate the items so that the lead time is improved, or quality oriented, if the history of the item determines who of the employees is suitable and if the work item property is for instance difficult. Since the factors could be used at both aspects, they are linked on both, but with lower scores.

d. Variable performance criteria
    i. Since the performance criteria are more or less the same as the aspects, the classification is quite simple. The time performance is linked to the quantity side.
    ii. In addition, the external quality is linked to the quality aspect.
    iii. Finally, the internal quality is not directly linked to the quality aspect, since it represents the satisfaction of the employee. When the employee is satisfied, the item could be finished earlier. Internal quality could also be linked to the quality aspect, because when an employee is satisfied, he/she could produce work with more consistency. Internal quality is therefore is to both aspects linked, but with lower scores.
e. Variable opinion
    i. When the opinion is negative answered by the distributor, the distributor does not like his job which is linked to the quantity side, because the internal quality is low. In addition, when there is an algorithm that provides the distribution, the distributor could execute another more satisfied job.
    ii. If the opinion is positive, the distributor likes his job, and the internal quality is high. The distributor uses the information of the employees to determine who of the employees receive which item. It is therefore quality oriented.
    iii. When the opinion is neutral, it could be both aspects: quantity or quality, so it is on both aspects linked, but receives lower scores.
    iv. When no opinion is given, the score is a zero.

4. The scores are determined on a scale (1-5). A one means the answer has less linkage with one of the aspects quantity or quality, whereas a 5 means the linkage is assesses as high. Dependent on point 3, the scores are added.
5. The answers given by the interview are collected and receive an average score, based on the score tables.

K. Diagnosis of the teams

During the analysis, several differences and similarities of the teams are found. The general workflow model is used by 9 teams, whereas the decision factors of teams differ by all. The performance criteria of the teams are obtained and have similarities among teams. In addition, the opinion has been asked of the distributor, if he/she likes the job, without the introduction of possibilities for automatically distribution of the work items. The answers given by the interviewees are converted to general variables see next table:

Table 37: Answers given by the interviewees

Variable	Teams	KTD	Register partner	CBV - GBA	SBG - DO	SBG - WO-uit	SBG - Vupo	MPG	IPHPT	SVP	VPS	SBO/SAN	GVP	KVI	SAG
General workflow diagram		X	X	X	X		X			X		X	X		X
Distri-bution	Semi-auto							X	X						
	Batch	X	X	X			X			X		X			X
	Case				X	X				X	X	X	X	X	X
Emplo-yees	# empl. in team	14	10	7	8	11	12	28	70	12	14	40	32	40	27
	Generalists	X	X	X	X	X	X	X							
	some Specialists								X	X	X				
	only Specialists											X	X	X	X
Decision factors	Presence	2	1	2	2	1	1			3	2	1	2	3	3
	Individual stock	1		1	3	2	2			2		4	4	4	1
	Work item property							1	1						
	Authorization					4			2				1		2
	Knowledge & Skills				1					4	1	3	3	1	4
	History				4	3				1		2		2	
Perfor-mance criteria	Time dimension	1	1	1	1	2	1	1	1	1	2	1	1	3	3
	External quality		2		2	1			2	2	1		2	1	1
	Internal quality				3	3						2		2	2
Opinion	Negative (-)			X	X	X	X		X	X	X				X
	Neutral (+/-)	X													
	Positive (+)											X	X	X	

For each team, several variables are used to identify the team, such as if the team uses the general workflow diagram, how is the distribution of work items performed, kind of employees, the decision factors and the performance criteria and finally the opinion. The decision factors and the performance criteria are ranked by the interviewees and so in Table 37 (e.g. a 1 means that the interviewee ranked that decision factor or performance criteria as most important).

The performance criteria differ per team and since these criteria influence the targets of the organization; management is interviewed to define which direction of performance criteria is desired for the organization and so for the teams. In Appendix I the interview with management is summarized.
The manager of the Pensions department advised to uphold the current split in the performance criteria obtained from the interviewees (see Appendix I, e.g. for 9 teams, the time dimension is important, whereas for 4 teams the external quality is the most important target).

Work distribution is a tradeoff between performance (i.e. the throughput time, or time in general) and quality, according to [Kumar et al., 2001]. The goal is to determine if teams belong to either time or quality. Since the performance criteria is just one of the variables

from table X, the variables left are taken into account too, to determine the right classification for each team. Although most distributors take both (time and quality) into account, one of these received more attention than the other and so teams are classified either as quantity or quality oriented. The different variables are used from Table 37 to determine an interval score (1-5) for both the aspects. A low interval score (1) means that teams have low linkage with the specific aspect, whereas a high score (5) represents a high linkage.

Variable: distribution

The distribution of a work item could influence the time or the quality. How work items are distributed differs per team: it could be semi-automatic (i.e. the distribution depends on the client number), distribution by batch (i.e. an X-number of work items are distributed at once to an employee), or finally distribution by case (i.e. work items are distributed one by one).

Table 38: Variable: distribution

Distribution	Team	KTD	Register partner	CBV - GBA	SBG - DO	SBG - WO-uit	SBG - Vupo + uitruil	MPG	IPHPT	SVP	VPS	SBO/SAN	GVP	KVI	SAG
Semi-automatic								x	x						
Batch		x	x	x			x			x		x			x
Case					x	x				x	x	x	x	x	x
Quantity score		3	3	3	0	0	3	5	5	2	0	2	0	0	2
Quality score		3	3	3	5	5	3	0	0	3,5	5	3,5	5	5	3,5

The different scores in this table are obtained with use of the score table, which is explained in Appendix J. Teams SVP, SBO/SAN and SAG use all batch and case distribution. During distribution, first, the post is distributed (case based) and as second, the items that could be distributed by batch (This ranking is used in determining the right score see Appendix J).

Variable: employees

A team consists of employees who are generalists, specialists or teams have some specialists as employees.
Depending on the type of the employee, the distributor allocates items of all processes (to generalists), or just some to specialists.

Table 39: Variable: employees

Employees	Team	KTD	Register partner	CBV - GBA	SBG - DO	SBG - WO-uit	SBG - Vupo + uitruil	MPG	IPHPT	SVP	VPS	SBO/SAN	GVP	KVI	SAG
Generalists		x	x	x	x	x	x	x							
Some specialists									x	x	x				
Only specialists												x	x	x	x
Quantity score		5	5	5	5	5	5	5	3	3	3	0	0	0	0
Quality score		0	0	0	0	0	0	0	3	3	3	5	5	5	5

The different scores in this table are obtained with use of the score table, which is explained in Appendix J.

Variable: decision factors

The decision factors are important for the classification of the teams, because they are the antecedents of the function work distribution and influence directly the performance (and so the classification) of the teams. The decision factors are obtained from the interviews and are ranked by the distributors.

Table 40: Variable: decision factors

Decision factors	Team	KTD	Register partner	CBV - GBA	SBG - DO	SBG - WO-uit	SBG - Vupo + uitruil	MPG	IPHPT	SVP	VPS	SBO/SAN	GVP	KVI	SAG
Presence		2	1	2	2	1	1			3	2	1	2	3	3
Individual stock		1		1	3	2	2			2		4	4	4	1
Work item property								1	1						
History					4	3				1		2		2	
Authorization						4			2				1		2
Knowledge & Skills					1					4	1	3	3	1	4
Quantity score		4,5	5	4,5	3,5	3,33	4,5	3	3	3,33	4	3	3	2,33	4
Quality score		0	0	0	5	1,5	0	0	3,5	2,5	5	2,5	4	3,5	3

The different scores in this table are obtained with use of the score table, which is explained in Appendix J. A number of teams have multiple decision factors and the scores are the average of the scores obtained from the score table: e.g., team KTD had factor 'individual stock' on the 1st rank, so receives a score of 5 and on the 2nd rank 'presence' which means a score of 4 for quantity. On average this gives a 4,5 for quantity and a zero for quality.

Variable: performance criteria

The performance criteria are important for the classification of the teams, because they are the consequences of the function work distribution. Since the performance could be directly linked to the classification, the score on the classification is quite straightforward:

Table 41: Variable: performance criteria

Performance criteria	Team	KTD	Register partner	CBV - GBA	SBG - DO	SBG - WO-uit	SBG - Vupo + uitruil	MPG	IPHPT	SVP	VPS	SBO/SAN	GVP	KVI	SAG
Time dimension		1	1	1	1	2	1	1	1	1	2	1	1	3	3
External quality (i.e. consistency)			2		2	1			2	2	1		2	1	1
Internal quality (i.e. satisfaction in work)					3	3						2		2	2
Quantity score		5	5	5	3	2,5	5	5	5	5	4	3,5	5	2,5	2,5
Quality score		0	4	0	2,5	3	0	0	4	4	5	2	4	3,5	3,5

The different scores in this table are obtained with use of the score table, which is explained in Appendix J. Again, for this variable, some teams have multiple scores, which are averaged and presented in the quantity score or in the quality score row.

Variable opinion:
As last variable, the opinion of the distributors is taken into account. During the interview, there is asked, if he/she likes the job of distribution of work, without the introduction of possibilities for automatically distribution of the work items. Most of the distributors do not like the job of the distributor (i.e. a negative sign in the next table), since everyone could perform the distribution. The function distribution of work is not challenged the distributors and assumed is that the distribution is easy and could be executed automatically. If that is the case, it is more quantity focused.

Table 42: Variable: opinion

Opinion	Team	KTD	Register partner	CBV - GBA	SBG - DO	SBG - WO-uit	SBG - Vupo + uitruil	MPG	IPHPT	SVP	VPS	SBO/SAN	GVP	KVI	SAG
negative (-)				x	x	x	x		x	x	x				x
neutral (+/-)		x													
positive (+)												x	x	x	
Quantity score		3	0	5	5	5	5	0	5	5	5	0	0	0	5
Quality score		3	0	0	0	0	0	0	0	0	0	5	5	5	0

The different scores in this table are obtained with use of the score table, which is explained in appendix J.

Diagnosis:
All the variables of Table 37 have been converted to an interval score see Table 43. The quantity and quality scores are averaged per team, and based on those average scores the classification is made. All teams have an average quantity and quality score. When the average score of an aspect is higher than 3.0 (the mean of the interval scale (1-5), the aspect is important for this team. In addition, teams that have a small difference between both scores do not clear focus on one aspect.

Classification: quantity
The first group (the quantity group), nine teams are classified. This group scores high on variable: distribution (i.e. distribution via semi-automatic or batch); employees (i.e. are generalists); decision variables (i.e. presence and individual stock are important); performance criterion (i.e. the time dimension is important) and finally the opinion, since the distributor does not like the job and also assumed is that the distribution is rather easy to perform.

Classification quality
In the second group, it is the other way around. This group is more focused on a case-distribution, specialists in a team, decision factor knowledge & skills and authorization, performance criterion external quality and the distributor likes the job. This group consists of five teams.

Table 43: Results of analysis

	Team	KTD	Register partner	CBV - GBA	SBG - DO	SBG - WO-uit	SBG - Vupo	MPG	IPHPT	SVP	VPS	SBO/SAN	GVP	KVI	SAG
General workflow		x	x	x	x		x			x		x	x		x
Distribution	QNTY	3	3	3	0	0	3	5	5	2	0	2	0	0	2
	QLTY	3	3	3	5	5	3	0	0	3,5	5	3,5	5	5	3,5
Employees	QNTY	5	5	5	5	5	5	5	3	3	3	0	0	0	0
	QLTY	0	0	0	0	0	0	0	3	3	3	5	5	5	5
Decision variables	QNTY	4,5	5	4,5	3,5	3,33	4,5	3	3	3,33	4	3	3	2,33	4
	QLTY	0	0	0	5	1,5	0	0	3,5	2,5	5	2,5	4	3,5	3
Performance criteria	QNTY	5	5	5	3	2,5	5	5	5	5	4	3,5	5	2,5	2,5
	QLTY	0	4	0	2,5	3	0	0	4	4	5	2	4	3,5	3,5
Opinion	QNTY	3	0	5	5	5	5	0	5	5	5	0	0	0	5
	QLTY	3	0	0	0	0	0	0	0	0	0	5	5	5	0
Average	QNTY	4,10	3,60	4,50	3,30	3,17	4,50	3,60	4,20	3,67	3,20	1,70	1,60	0,97	2,70
	QLTY	1,20	1,40	0,60	2,50	1,90	0,60	0,00	2,10	2,60	3,60	3,60	4,60	4,40	3,00
Classification	QNTY	x	x	x	x	x	x	x	x	x	x				
	QLTY										x	x	x	x	x

Explained in more detail are team VPS, which scores on both aspects, and team SAG, which have a small difference between both aspects.

- Team VPS scores on both aspects and the difference between the scores is low (0,40). From the interview summary (see Appendix H), it is concluded that the team consists of two sub-teams. The distribution of this team is in the first team, push based, whereas in the second team it is pull based. Hence, this team scores on both aspects. Since the score of the quality is slightly higher, this team is classified as quality, although the difference is small.
- The difference in team SAG is also small (0,30). The scores on the variable 'opinion' have an impact in this team. Of team SAG, the sub-distributor (substitute of daily distributor) was interviewed, who does not like the distribution, whereas the daily distributor does.

L. IBM Websphere supported resource patterns

Table 44: IBM Websphere supported resource patterns - [Russell et al., 2004]

Group	nr	Pattern name	Score	Motivation
Creation patterns	1	Direct allocation	+	Directly supported
	2	Role based allocation	+	Directly supported
	3	Deferred allocation	+	Directly supported
	4	Authorization	-	Not supported
	5	Separation of duties	+	Directly supported via task linking between activities in the process model that cannot have the same resources allocation at runtime within a case
	6	Case handling	-	Not supported
	7	Retain familiar	+	Common resource allocation can be specified for specific tasks in the process model requiring the same resource allocation at runtime within a case
	8	Capability based allocation	-	Not supported
	9	History based allocation	-	Not supported
	10	Organizational allocation	+	Directly supported
	11	Automative execution	-	Not supported
Push patterns	12	Distribution by offer single resource	-	Not supported
	13	Distribution by offer multiple resources	+	Work queues combine work item items specifically offered to this resource and those offered to multiple resources
	14	Distribution by allocating single resource	+	Directly supported for work items allocated to a single resource
	15	Random allocation	-	Not supported
	16	Round robin allocation	-	Not supported
	17	Shortest queue	-	Not supported
	18	Early distribution	-	Not supported
	19	Distribution on enablement	+	Standard mechanism for work item distribution
	20	Late distribution	-	Not supported
Pull patterns	21	Resource initiated allocation	-	Not supported
	22	Resource initiated execution allocation work item	+	Standard means for a resource to initiate a work item is to select one from those allocated to it
	23	Resource initiated	+	Supported for work items distributed via

		execution offered work Item		shared work queues
	24	System determined work queue content	-	Not supported
	25	Resource determined work queue content	+	Work queues can be sorted or filtered on any work item attribute at the discretion of individual resources
	26	Selection autonomy	+	Resources can select the next item for execution from those on their work queue
Detour patterns	27	Delegation	+	Work items can be manually redirected by resources
	28	Escalation	+	Directly supported via reminders
	29	De-allocation	-	Not supported
	30	Stateful reallocation	+	Supported for pending and suspended items
	31	Stateless reallocation	-	Not supported
	32	Suspension / resumption	+/-	Indirectly supported via case suspension
	33	Skip	+	Directly supported in the worklist handler
	34	Redo	-	Not supported
	35	Pre-do	-	Not supported
Auto start patterns	36	Commencement on creation	-	Not supported
	37	Commencement on allocation	+	Resources can configure work queues to initiate work items on arrival
	38	Piled execution	-	Not supported
	39	Chained execution	-	Not supported
Visibility patterns	40	Configurable unallocated work item visibility	-	Not supported
	41	Configurable allocated work item visibility	-	Not supported
Multiple resource patterns	42	Simultaneous execution	+	Resources can execute multiple work items simultaneously
	43	Additional resources	-	Not supported

Note:
This list is based on a survey of existing workflow systems and business-processing languages see [Russell et al., 2004]. In this paper IBM Websphere MQ workflow 3.4 is used.

M. Time frame of a work item

For the time to complete a work item, several different time-slots are added up. Te work item is started at (0) and is finished (i.e. verified) at (11). In the mean time, the work item could be on several places as is indicated in next figure:

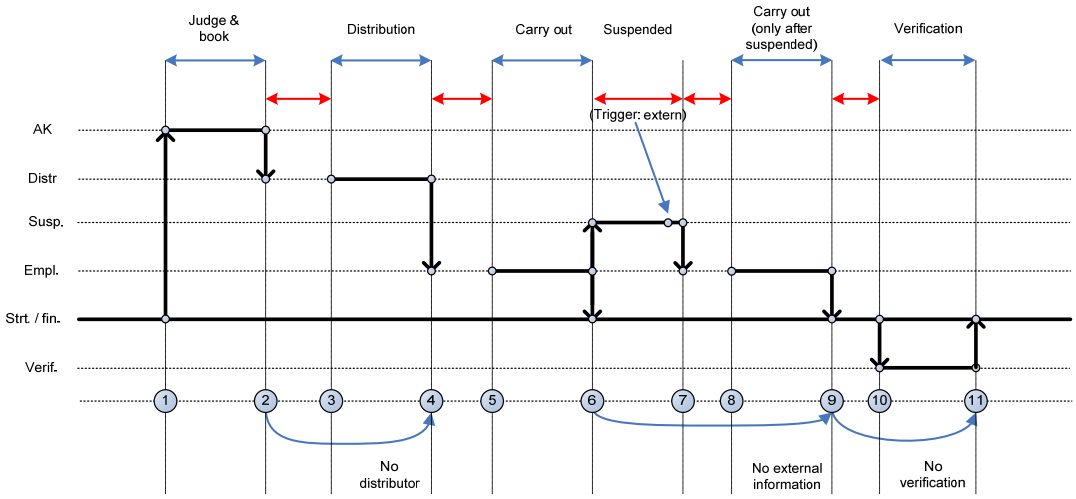


Figure 34: Overview timeframes in allocating work

In this figure, different time points are indicated to gain insight in the different wait or service times of the tasks. On top of this figure, red arrows indicate a wait time, while the blue arrows are the service times per task. If we sum up the different times, between time-points (1) and (11), we receive the lead time of the work item. A work item is registered at (1): the moment the AK starts to judge the work item and finishes his/her job at (2). The work item is moved to the 'to allocate stock' and waits until the distributor starts the distribution of the work item at (3) and ends it at (4). Then the work item is moved to the individual stock of the employee and waits until the employee starts at (5) and is completed at (6, arrow down) or has to wait for additional information, so the work item is suspended at (6, arrow up). If the latter is the case, the work item waits for an external trigger (i.e. the additional information) and at (7) the work item is removed from suspended and placed in the individual stock. At (8) the employee carries out the next part of the work item and it is completed at (9). Verification starts at (10) and is completed at (11).

Table 45: Time description of a work item

Time-point	Description		Time (between)	Description
1	Work item is received at team CBV. An AK can start now task booking		1-2	Book time; time that an AK is busy with booking a work item
2	End time of booking work item by AK		2-3	Wait time; time a work item is in stock of distributor before it is distributed
3	Start time of distribution work item by distributor		3-4	Distribution time; time that a distributor is busy with allocation a work item
4	End time of distribution work item by distributor		4-5	Wait time; time a work item is in stock of employee before it is started
5	Start time of carrying out work item by employee		5-6	Carrying out time; time that an employee is busy with executing a work item
6	End time of carrying out work item		6-7	(if any) Suspended time; work item is

	by employee = (if any) Start time of work item in transition suspended			suspended and waits for an external trigger. This external trigger could be additional information of a client
7	(if any) End time of work item in transition suspended		7-8	(if any) Wait time; time a work item is in stock of employee before it is started again
8	(if any) Start time of carrying out work item by employee		8-9	(if any) Carrying out time; time that an employee is busy with executing a work item
9	(if any) End time of carrying out work item by employee		9-10	Wait time; time a work item is in the verification stock
10	(if any) Start time of verification of work item by employee		10-11	Verification time; time a work item is verified by a verification employee
11	(if any) End time of verification of work item by employee			

The aim of the new design is to gather some profit in the overall lead time. This time is measured from 1-11. In the most teams, a distributor is present that allocates the work items to the employees. If the distributor is replaced by a system, the allocation could be performed on run time. The time that is saved is the time between 2-3, (i.e. it is the wait time before the distribution starts).

N. Tool description

Microsoft Excel is used as tool in which scenario 2 is programmed and provide an employee's name based on several decision factors.

These required factors are depicted in next figure:

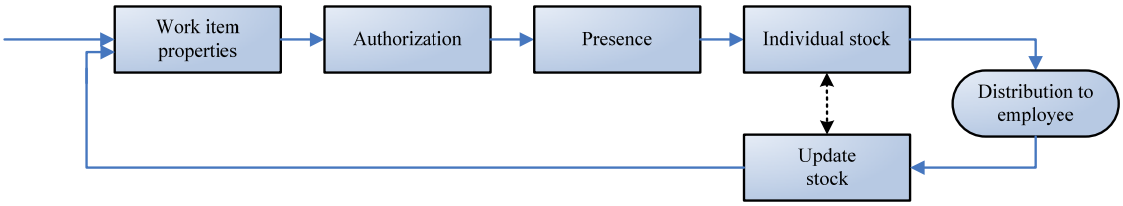


Figure 35: Process of the tool

In Figure 35, the process of the tool is depicted graphically. It starts when a work item arrives. Properties of the work item are collected and used to determine the authorization. The presence of the employees is used and the individual stocks are analyzed to determine to whom of the employees the work item is distributed. Finally, the individual stock is updated, since the new work item is allocated to one of the employees. The update stock is automatically processed: it is not a separate step.

In the remaining part of this section, the 4 factors from Figure 35 are used to describe the tool and screenshots of the tool are used to clarify the text.

1. Factor work item properties

In the as-is situation the distributor starts the process in the system of an entered work item. There are in total 20 different processes, which could be started. All the processes have a unique process ID. Per process ID, several variables are linked:

- Variable service time (e.g. 8 minutes for process ID nr 16)
- Variable max lead time (e.g. 5 working days for process ID nr 19)
- Variable "lussluiting" (e.g. Y=yes, process ID nr 20 deals with "lussluiting")

Process ID	Processs description	Service time (min)	Max lead time (days)	Lussluiting
1	Opl sign. Vm/bnu	17,14	5	Y
2	inf. Alg	6,97	5	N
3	overig herzien	39,65	5	Y
4	ziektek. Twk	22,92	5	Y
5	overig beheer	95,76	5	N
16	wijz. Opb	7,73	5	Y
18	nevenink.	68,03	5	Y
19	verz. Info eigen sit.	44,41	5	N
20	fisc. Sit twk	28,81	5	Y
21	inhoud. T b derden	35,42	5	Y

Figure 36: Screenshot: variables linked to Process ID

When a work item enters four input-variables are needed to determine all the variables of the work item. The input-variables are:

a. Process ID (e.g. nr 19 enters at first, see Figure 37)

b. Client number (e.g. ‘xxx’, is the unique client number all clients of APOG has)
c. Start date (e.g. 26-August, usually the date of today)
d. The extra variable: difficulty (e.g. /empty/, ‘x’, ‘1’)

The input-variables (copied from the distributor) are entered in the tool, and the variables of the Process ID are linked per work item (automatically). In the next figure, the input-variables are colored light-yellow, whereas the variables of the Process ID are blank.

Sequence ID	Process ID	Client number	Start date	Max lead time(days)	Lussluiting	Days to deadline (internal)	Days to deadline (external)	Minimal days to deadline	Service time (min)	Status	Priority (classification)	Extra variable: difficulty
1	19	xxx.xxx.xxx	wo-26-aug	5	N	5		5	44,41	f	L	
2	18	xxx.xxx.xxx	wo-26-aug	5	Y	5	2	2	68,03	s	H	
3	18	xxx.xxx.xxx	wo-26-aug	5	Y	5	2	2	68,03	ns	H	x
4	27	xxx.xxx.xxx	wo-26-aug	5	Y	5	2	2	16,29	ns	H	x
5	19	xxx.xxx.xxx	ma-24-aug	5	N	3		3	44,41	ns	M	
6	21	xxx.xxx.xxx	wo-26-aug	5	Y	5	2	2	35,42	ns	H	1

Figure 37: Screenshot: variables per process ID

Some additional properties of the work item are calculated in Figure 37. These properties are:

- Days to deadline (internal) (e.g. 5 days left to the deadline)
- Days to deadline (external) (e.g. 2 days left to the deadline)
- Minimum days to deadline (e.g. minimum of 5; 2 = 2)
- Status (e.g. ns = Not started, s = Started, f = Finished)
- Priority (e.g. H = High, M = Medium, L = Low)

The days to the internal deadline is computed via the (start date + max lead time) minus today date. If the start date is today, the internal days left is equal to the max lead time (days).
The days to the external deadline is computed with the “lussluiting”, with “lussluiting”-date minus today. In the case of 2nd (sequenced ID) work item 2 days are left to the “lussluiting” date. The ‘minimum days to the deadline’ is the minimum of the internal and external days to the deadline, since before the deadline the work items have to be finished.
Then the status of the work item is used, to determine if the item is started, not started or is finished (distributed). When the previous work item is finished (f), the current is started (s) and the upcoming work items have to wait and are not started (ns).
Finally the priority is determined based on the minimum days to the deadline. Three groups are distinguished: High, Medium and Low:

Deadline	from	to
High	0	2
Medium	3	3
Low	4	50

Figure 38: Screenshot: classification in priority

The classification is based on priority rules defined by the manager of team SVP. When a work item enters and there are two days or less left to the deadline it is classified as ‘High’. If an item enters and the there are more than 4 days left, the priority is ‘Low’. Is the work item between these days (i.e. 3 days are remaining) it is classified as ‘Medium’, see Figure 38.
This priority is given per work item with the abbreviation: H, M or L (see Figure 38).
The different variables and properties are aggregated into one factor: the work item properties. At this moment, all the work item properties are determined, so the next factor is explained: authorization:

2. Factor authorization

The authorization of an employee depends on two variables:

- The process ID (e.g 'x' = authorized, /empty/ = not authorized)
- The difficulty of the work item (e.g. /empty/, 'x', '1')

Since the employees in team SVP are specialists and not generalists, the authorization plays an important role. Not all employees are allowed to perform all the available processes in team SVP. Therefore per process ID is listed who of the employees is authorized to perform the work items:

Process ID	Processs description		Empl. 1	Empl. 2	Empl. 3	Empl. 4	Empl. 5	Empl. 6	Empl. 7	Empl. 8	Empl. 9	Empl. 10	Empl. 11
1	Opl sign. Vm/bnu		x	x	x	x			x	x	x		x
2	inf. Alg		x	x	x	x	x		x	x	x		x
3	overig herzien		x	x	x	x	x		x	x	x		x
4	ziektek. Twk					x					x		
5	overig beheer		x	x	x	x		x (x)	x				
16	wijz. Opb		x	x	x	x			x		x		x
18	nevenink.		x	x	x	x	x	x (x)	x	x	x		x
19	verz. Info eigen sit.		x	x	x	x	x	x (x)	x	x	x		x
20	fisc. Sit twk				x	x		x (x)					
21	inhoud. T b derden		x	x	x	x	x (1)	x (x)	x	x (1)	x (1)	x	x

Figure 39: Screenshot: authorization matrix per process ID

In Figure 39, an 'x' means that the employee is authorized to perform all the work items that have the corresponding process ID (e.g. Empl 4 is authorized to perform all process IDs in Figure 39, and is a generalist).

For the difficulty of the work item an additional input-variable is entered, see figure 11). This input-variable is used to determine who of the employees is authorized, based on the authorization matrix. E.g. in Figure 39 process ID 21 could be executed by all the employees, although numbers 5,6,8,9 have additional information in the authorization matrix. Employee 6 differs again compared to the employees 5,8,9. In this specific process ID, three groups of employees are present which perform all process ID 21, but on different difficulty levels.

In the next figure, three work items arrived each with process ID 21, however, the difficulty of the work item is different. The tool shows in the column 'Name of max available time' 3 different employees. The rest of the figure is explained after the four factors are finished.

Sequence ID	Process ID	Start date	Service time (min)	Status	Priority (classification)	Extra variable: difficulty	Empl. 1	Empl. 2	Empl. 3	Empl. 4	Empl. 5	Empl. 6	Empl. 7	Empl. 8	Empl. 9	Empl. 10	Empl. 11	max available time	Name of max available time	Copy name to next cell (via VBA)	To Name distributed (copied)
1	21	wo-26-aug	35,42	s	H		-4		-4				240			220	247	247	Empl. 11	copy	
2	21	wo-26-aug	35,42	s	H	x						436						436	Empl. 6	copy	
3	21	wo-26-aug	35,42	s	H	1								140	306			306	Empl. 9	copy	

Figure 40: Screenshot: the results of the difficulty of a work item

3. Factor presence

The AKs distribute the items to the employees who are present that day. First the presence of an employee is registered per day (e.g. yes or no). If an employee is not present, no work item is distributed to him/her. Secondly, the hours an employee is available that day is important to know. This time is labeled as the time an employee is presence for APG, see Figure 41.

Since employees do not only carry out work items, but also execute some other projects, team SVP work with a "verdeelsleutel". This key is used to determine the presence for SVP (i.e. to carry out work items). E.g. employee 1 works 8 hours on 24-August, however the "verdeelsleutel" is 0.5, so the presence for SVP is just 4 hours, to carry out work items. This last time (e.g. 4 hours) is the presence time of an employee used in the tool.

Presence for APG	Empl. 1	Empl. 2	Empl. 3	Empl. 4	Empl. 5	Empl. 6	Empl. 7	Empl. 8	Empl. 9	Empl. 10	Empl. 11
ma, 24-aug	8	0	4	0	0	8	8	4	8,5	0	8
di, 25-aug	8,5	0	8	0	0	8	8	8	8,5	8,5	8
wo, 26-aug	8	0	8,5	0	0	8	8	8	8,5	8,5	8
do, 27-aug	0	0	8,5	0	0	8	8	8	0	8,5	8
vr, 28-aug	0	0	8	0	0	8	4	8	0	0	8

Verdeelsleutel:	0,5	1	0,6	0,5	1	1	0,5	1	0,6	0,5	1

Presence for SVP	Empl. 1	Empl. 2	Empl. 3	Empl. 4	Empl. 5	Empl. 6	Empl. 7	Empl. 8	Empl. 9	Empl. 10	Empl. 11
ma, 24-aug	4		2,4			8	4	4	5,1		8
di, 25-aug	4,3		4,8			8	4	8	5,1	4,3	8
wo, 26-aug	4		5,1			8	4	8	5,1	4,3	8
do, 27-aug			5,1			8	4	8		4,3	8
vr, 28-aug			4,8			8	2	8			8

Figure 41: Screenshot: Presence per day per employee (in hours)

When no hours are available, the employee is on vacation, ill, on leave, or works part time.

4. Factor individual stock

The individual stock of the employees is used to calculate the time an employee has on stock. Distinctions (categories) are made for the work items: tardy work items (R) and work items in the classification of priority which are high (H), medium (M) and low (L). Per employee, per category the work items are selected and summed up are the service times of the selected work items. The time that is calculated is the total service time per category an employee has in stock. This is the individual stock time, per category. The total individual stock time in minutes (i.e. all the categories summed up) is the total time the employee is busy to carry out the work items from his/her stock.

	Empl 1	Empl 2	Empl 3	Empl 4	Empl 5	Empl 6	Empl 7	Empl 8	Empl 9	Empl 10	Empl 11
R	199,9	41,1	141,3	0,0	0,0	0,0	0,0	136,1	0,0	35,4	232,6
H	44,4	0,0	169,0	0,0	0,0	44,4	0,0	204,1	0,0	0,0	0,0
M	476,3	24,0	277,6	0,0	0,0	0,0	0,0	0,0	120,0	0,0	16,3
L	452,9	248,5	442,6	0,0	0,0	212,5	0,0	1641,2	61,3	348,6	159,2

Figure 42: Screenshot: individual time (min) in stock per classification

E.g. employee 1 has 1175 minutes in stock, which is more than 19 hours of work! This time on average, is the employee busy to execute the work items of the individual stock. The time (200 for employee 1) is colored red, since the work items are tardy.

Since all factors are now explained, the distribution to whom of the employees is not described. As said before, the work items are distributed to the employee with the highest available time. The individual stock of the employees is used to determine the available time an employee has (i.e. the net time) for performing the work items.

Available time:
With the presence time and the individual time in stock, the available time per employee per classification could be computed. The available time is the presence time minus the individual stock time. Since work items are classified in priority, the available time differs and depends on the classification. In the following table the formulas of how the available time is computed when the priority of the arrived work item differs:

Arrival of work item	Presence time	Individual stock time	Available time =	
	code	code	Formula	nr
H	Today (T)	Tardy (R) + High (H) items	T-(R+H)	1
	Today (T) + Tomorrow (H1)	Tardy (R) + High (H) items	(T+H1)-(R+H)	2
	Today (T) + Tomorrow (H1) + Day after tomorrow (H2)	Tardy (R) + High (H) items	(T+H1+H2)-(R+H)	3
M	Today (T)	Tardy (R) + High (H) + Medium (M) items	T-(R+H+M)	4
	Today (T) + Tomorrow (H1)	Tardy (R) + High (H) + Medium (M) items	(T+H1)-(R+H+M)	5
	Today (T) + Tomorrow (H1) + Day after tomorrow (H2)	Tardy (R) + High (H) + Medium (M) items	(T+H1+H2)-(R+H+M)	6
L	Today (T)	Tardy (R) + High (H) + Medium (M) + Low (L) items	T-(R+H+M+L)	7
	Today (T) + Tomorrow (H1)	Tardy (R) + High (H) + Medium (M) + Low (L) items	(T+H1)-(R+H+M+L)	8
	Today (T) + Tomorrow (H1) + Day after tomorrow (H2)	Tardy (R) + High (H) + Medium (M) + Low (L) items	(T+H1+H2)-(R+H+M+L)	9

Figure 43: Screenshot: available time measurement

E.g. a medium (M) work item arrived. First the available time is measured with formula nr 4, and so only the presence time of today is taken into account. From the presence time, the individual stock time is distracted (in this case, the tardy, high and medium classifications. Due to an M-work item arrived and has to be finished before the L-work items in the stock, the L-work items are not used in the formula).
The result of the formula is the net time an employee has to complete the arrived work item. When the available time of the employees are all negative (i.e. the individual stock time > presence time of the employees, formula nr 5 is used, in which the presence time of today + tomorrow is used.

Distribute to employee
The available time per employee is the key decision to allocate work items on. In Figure 44 the allocation to the right employee is depicted:

Sequence ID	Process ID	Start date	Service time (min)	Status	Priority (classification)	Extra variable: difficulty	Empl. 1	Empl. 2	Empl. 3	Empl. 4	Empl. 5	Empl. 6	Empl. 7	Empl. 8	Empl. 9	Empl. 10	Empl. 11	max available time	Name of max available time	Copy name to next cell (via VBA)	To Name distributed (copied)
1	19	wo-26-aug	44,41	f	L													0	Not	copy	Empl. 7
2	18	wo-26-aug	68,03	s	H		-4		-4				240	140	306		247	306	Empl. 9	copy	
3	18	wo-26-aug	68,03	ns	H	x												0	Not	copy	
4	27	wo-26-aug	16,29	ns	H	x												0	Not	copy	
5	19	ma-24-aug	44,41	ns	M													0	Not	copy	
6	21	wo-26-aug	35,42	ns	H	1												0	Not	copy	

Figure 44: Screenshot: distribution to employee with highest available

The first work item (Process ID 19) enters on 26-August. Some variables are presented, however the additional variable: difficulty is /empty/ (i.e. blank). 11 employees are in the team of SVP, which perform together all the work items. In these columns, the tool shows the calculated available times per work item. Of these figures, the highest is selected and copied in the column ‘Max available time’. The next column provided the corresponding employee’s name and finally this name is copied into the next cell, to show the employee receives this work item and to update the individual stock with the just distributed item.

To show the tool updates the available time with the service time of the work item, the next two figures are copied:

Sequence ID	Process ID	Start date	Service time (min)	Status	Priority (classification)	Extra variable: difficulty	Empl. 1	Empl. 2	Empl. 3	Empl. 4	Empl. 5	Empl. 6	Empl. 7	Empl. 8	Empl. 9	Empl. 10	Empl. 11	max available time	Name of max available time	Copy name to next cell (via VBA)	To Name distributed (copied)
1	21	vr-28-aug	35,42	f	H													0	Not	copy	Empl. 11
2	27	vr-28-aug	16,29	s	H		-4		-4				240	140	306		212	306	Empl. 9	copy	
3	27	vr-28-aug	16,29	ns	H													0	Not	copy	
4	27	vr-28-aug	16,29	ns	H													0	Not	copy	
5	19	vr-28-aug	44,41	ns	L													0	Not	copy	
6	21	vr-28-aug	35,42	ns	H	1												0	Not	copy	

Figure 45: Screenshot: 1st work item is distributed, 2nd work item is started

Sequence ID	Process ID	Start date	Service time (min)	Status	Priority (classification)	Extra variable: difficulty	Empl. 1	Empl. 2	Empl. 3	Empl. 4	Empl. 5	Empl. 6	Empl. 7	Empl. 8	Empl. 9	Empl. 10	Empl. 11	max available time	Name of max available time	Copy name to next cell (via VBA)	To Name distributed (copied)
1	21	vr-28-aug	35,42	f	H													0	Not	copy	Empl. 11
2	27	vr-28-aug	16,29	f	H													0	Not	copy	Empl. 9
3	27	vr-28-aug	16,29	s	H		-4		-4				240	140	290		212	290	Empl. 9	copy	
4	27	vr-28-aug	16,29	ns	H													0	Not	copy	
5	19	vr-28-aug	44,41	ns	L													0	Not	copy	
6	21	vr-28-aug	35,42	ns	H	1												0	Not	copy	

Figure 46: Screenshot: 2nd work item is distributed and 3rd work item is started

The first item is already distributed to employee 11. The second work item (process ID 27) is started (ready for distribution) and employee 9 has the highest available time that is 306 minutes, so this employee receives the work item. In Figure 46, the next work item is started, since the previous is distributed, (see Figure 45) and is also proposed to employee 9. Figure 46 shows, that the available time of employee 9 is decreased from 306 to 290 minutes. The 16 minutes in between is the service time that is subtracted.

O. Authorization scheme

Table 46: Authorization of processes per employee

Process ID	Description	Empl. 1	Empl. 2	Empl. 3	Empl. 4	Empl. 5	Empl. 6	Empl. 7	Empl. 8	Empl. 9	Empl. 10	Empl. 11
		36	36	32	34	32	36	32	36	36	24	30
1	Opl sign. Vm/bnu	x	x	x	x			x	x	x		x
2	inf. Alg	x	x	x	x	x		x	x	x		x
3	overig herzien	x	x	x	x	x		x	x	x		x
4	ziektek. Twk				x					x		
5	overig beheer	x	x	x	x		x (x)	x				
16	wijz. Opb	x	x	x	x			x		x		x
18	nevenink.	x	x	x	x	x	x (x)	x	x	x		x
19	verz. Info eigen sit.	x	x	x	x	x	x (x)	x	x	x		x
20	fisc. Sit twk			x	x		x (x)					
21	inhoud. T b derden	x	x	x	x	x (1)	x (x)	x	x (1)	x (1)	x	x
22	intr. Beeind.	x	x	x	x	x		x	x	x		x
26	wijz. Aanw.	x	x	x	x	x		x	x	x		x
27	bijsp. OP/NP	x	x	x	x	x	x (x)	x	x	x		x
29	actie form. Ni			x						x		x
31	corr. Ombudsman	x			x			x			x	
33	fa nota	x	x	x	x	x		x	x	x		x
35	foutsign KM	x	x	x	x	x	x (x)	x	x	x	x	x
36	herov,/ bezwa.	x			x			x			x	
37	klacht	x			x			x			x	
42	aut.sign beh.	x	x	x	x	x		x	x	x		x
43	aut. Sign.herz.	x	x	x	x	x				x		x
99	Samenloop WIA/FPU				x							
	verdeelsleutel:	**0,5**	**1**	**0,6**	**0,5**	**1**	**1**	**0,5**	**1**	**0,6**	**0,5**	**1**

Bijzonderheden

x (1) alleen vereenvoudigde beslagen (bv belastingdienst, gemeente, waterschap)

(x) eenvoudige post

5 post onbestelbaar retour

18 eerste beoordeling van eenvoudige opgaven NI

19 werkgeversverklaring/inkomensverklaring/verzoek opgave voor hypotheek/opgaven SVB

20 loonbelastingverklaring

21 verkl. Art. 475 (inlichtingen toekomstige beslaglegger)

27 beeindigen bijsparen op verzoek klant

In this table the different processes are presented in the left column. On top of the table the employees of team SVP are identified. The second row represents the hours per week the specific employee works at this moment, however not used. The boxes are checked for those processes an employee is authorized for with an ‘x’. In the last row a special key “verdeelsleutel” is created to provide a equal workload (e.g. If 11 work items of process ID 4 enter, the “verdeelsleutel” (the key) is used to allocate the items. In this case, (5) work items are allocated to employee 4 and the rest (6) are allocated to employee 9).

This scheme is used at this moment to allocate the work items. Without any know-how of the processes and the time the different processes consumes, this distribution is quite unfair. When you are a generalist, you are authorized for these processes with an ‘x’ and will receive of the work items, which enters a (equal) part according to the key. When taking this scheme in production, you (as an employee) are better off when you only have ‘x’ for just some processes.

P. Results of the pilot run

In this appendix, the results of the pilot-run are described. First the method is explained how the data is analyzed and then the specific tests are explained. After that, the data is prepared for the analysis and finally, the results of tested hypothesis are presented.

Method

The method that is used for the statistical analysis is depicted in Figure 47:

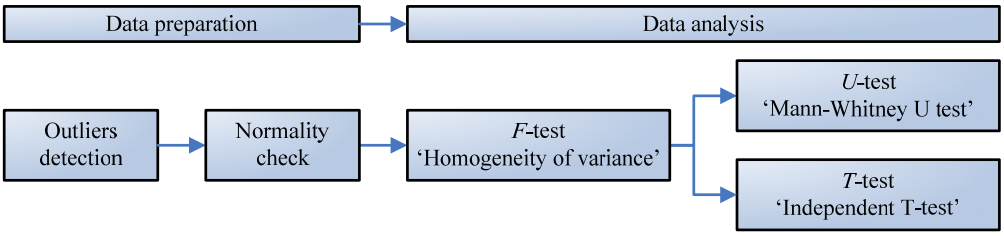


Figure 47: Method used for the statistical analysis

First, the data is gathered via a log file of APG and is prepared for the analysis. During the preparation, the processes are filtered, outliers are detected, and normality checks are executed. If the data preparation is finished the statistical tests could be executed. Of both periods tests are executed to compare the homogeneity of variance (i.e. the *F*-test) and the means are compared with two tests: (i) for non-parametric distributions (i.e. not normally distributed) the 'Mann-Whitney U'-test (i.e. *U*-test) is executed and (ii) for normally distributed variables, the 'Independent T'-test (i.e. *T*-test) is performed. The three tests are explained in more detail in section 0.

Preparation of the data

In this part, the data is prepared for the analysis. First, the data is obtained from APG and recalculated, and filtered. Second, the outliers are detected and finally, the data is checked for normality.

Data gathering

The data is gathered through queries on the database of APG. Unfortunately, nearly no time points of Figure 17 are registered in the database. Only the start time, the finish time of a work item (i.e. the time points (1) and (11) of Figure 17). In addition, the total service time and total wait time per work item are logged. These times are the sum of either the red arrows (wait time) or the blue arrows (service time) of Figure 17. The wait time was registered according to a 24-hours day, and is recalculated because work items could only be performed during a working day. Since nearly all work items started after 7:30 and were finished at 17:30, assumed is a working day of 10 hours. In the new situation, work items, which are suspended for a day, receive a wait time of 10 hours instead of 24 hours, so the wait time is more accurate than it was before.

The next step is filtering of the data: filtered are those process IDs, which are started at least 5 times during both periods. The sample size is than minimal 5 and so limited since [Hair et al., 2006] advised for statistical analysis a sample size of minimal 30 items. When taking the advise of [Hair et al., 2006] only 2 processes are taken into account, while if the sample size is minimal 5, in total 8/21 processes are further analyzed. In total there are 280 work items distributed to the employees during the pilot-run, and for just one process, there are 130 work items distributed which is 46% of the cases. This process is called "Aktieformulier Neveninkomsten" (i.e. PC29WT) and is further analyzed in this chapter.

Outliers detection

Extreme values within the data have to be detected and deleted when necessary. [Hair et al, 2006] proposed to calculate the standardized z-score of the values and after that determine, based on the sample size, which items have to be deleted. The approach is presented in next table:

Table 47: Outliers detection based on [Hair et al., 2006]

Sample size	Test-statistic	Rejection criteria
$N \leq 80$	$Z = (x - \mu) / \sigma$	$-2{,}5 \leq Z \leq 2{,}5$
$N > 80$		$-4{,}0 \leq Z \leq 4{,}0$

For process PC29WT, the sample size N is more than 80 and in total 2 extreme values are detected and deleted. There are 128 work items left.

Normality check

The last step of the data preparation is the normality check of the variables. Per process, the normality plots and the test of normality is executed. In the next figures, the normality plots of process PC29WT of both periods are shown:

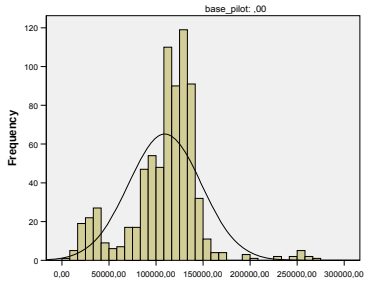


Figure 48: Normality plot: Baseline PC29WT

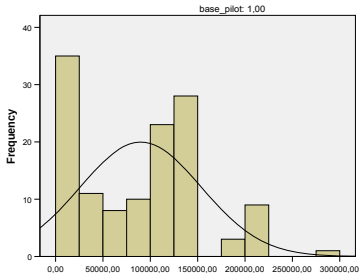


Figure 49: Normality plot: Pilot-run PC29WT

In addition, the test of normality is executed, that checks if the values of the processes are normally distributed. The data is normally distributed when the K-S Statistic (i.e. the 2nd column) is lower than 0.05:

Table 48: Test of normality

Tests of Normality

		Kolmogorov-Smirnov(a)			Shapiro-Wilk		
	base_pilot	Statistic	df	Sig.	Statistic	df	Sig.
PC29WT	,00	,125	756	,000	,898	756	,000
	1,00	,167	128	,000	,916	128	,000

a. Lilliefors Significance Correction

Unfortunately, the data of PC29WT is not normally distributed, since the Kolmogorov-Smirnov statistic is (,125) and is beyond the 0.05 see Table 48. The data is further analyzed, because also for data that is not normally distributed, statistical tests are present. In Appendix P, the tests of normality are present for the remaining processes. No one of the processes is normally distributed. In the next section, the analysis of the data and the statistical tests are explained.

Data analysis

As is described in the method of this section, three different tests are executed which are: the *F*-test, the *U*-test and the *T*-test. First the hypotheses to test are explained inclusive the rejection criteria of process PC29WT. After that, the different tests are executed. Finally, there is concluded if the hypothesis are rejected or accepted.

F-test

Before the means of both samples could be compared, first the variances of the variables are analyzed, with use of the *F*-test. The *F*-test tests the hypothesis (i.e. the Null-hypothesis) that variances in the groups (i.e. the baseline and the pilot-run) are equal. The alternative hypothesis is that the variances of both groups are unequal, so a two-tailed test is executed, since we do not know if the variance is increasing or decreasing:

Table 49: Hypotheses of F-test based on [Mongomery & Runger, 2007]

Hypothesis	**Test-statistic**	**Rejection criteria** $\alpha = 0{,}05$	**Reject H_0 for process PC29WT if:**
H_0: $\sigma_1^2 = \sigma_2^2$ H_1: $\sigma_1^2 \neq \sigma_2^2$	$f_0 = s_1^2/s_2^2$	$f_0 > f_{\alpha/2,n-1,n2-1}$ or $f_0 < f_{1-\alpha/2,n1-1,n2-1}$	$f_0 > f_{0.025,757,127} = 1{,}323$ $f_0 < f_{0.975,757,127} = 0{,}776$

When the *F*-test is executed for process PC29WT and the f_0 is between 0,776 and 1,323, we cannot reject the Null hypothesis H_0 at the 0,05 level of significance. This means that there is no evidence to indicate that the variance of PC29WT is different in the pilot-run, than in the baseline.

U-test

The Mann-Whitney U test compares two means of independent samples and test is these means are the same. The U test is a non-parametric test and is used for variables, which are not normally distributed, as is the case for process PC29WT. The Null-hypothesis tests that the means of both samples are equal, whereas in the alternative hypothesis the means are not:

Table 50: Hypotheses of U-test

Hypothesis	**Test-statistic**	**Rejection criteria** $\alpha = 0{,}05$	**Reject H_0 for process PC29WT if:**
H_0: $\mu_1^2 = \mu_2^2$ H_1: $\mu_1^2 \neq \mu_2^2$	Analyzed by SPSS, Results: Stand. Z-score	$Z < Z_{\alpha/2}$ or $Z > Z_{1-\alpha/2}$	$Z < Z_{0.025} = -1{,}96$ $Z > Z_{0.975} = 1{,}96$

In the same time as the U-statistics are computed, SPSS also computes a standardized Z-score of these test. When for the process PC29WT the Z is between -1,96 and 1,96, we cannot reject the Null hypothesis H_0 at the 0,05 level of significance. This means that there is not evidence to indicate that the mean of PC29WT is different in the pilot-run, than in the baseline. For the report, [Field, 2006] advised to report the median for non-parametric tests.

T-test

If we assume that variable PC29WT has a normal distribution, we could perform an 'independent T-test'. The *T*-test takes into account the assumption of equal or unequal variances. The *T*-test performs the same as the *U*-test, although takes into account that data is normally distributed. The Null-hypothesis tests that the means of both samples are equal, whereas in the alternative hypothesis the means are not. Again, a two-tailed test is executed:

Table 51: Hypotheses of T-test

Hypothesis	**Test-statistic**	**Rejection criteria** $\alpha = 0{,}05$	**Reject H_0 for process PC29WT if:**
H_0: $\mu_1^2 = \mu_2^2$ H_1: $\mu_1^2 \neq \mu_2^2$	Analyzed by SPSS, Results: T-value	$t_0 > t_{\alpha/2,n1+n2-2}$ or $t_0 < -t_{\alpha/2\ n1+n2-2}$	$t_0 < t_{0.025,882} = -1{,}963$ $t_0 > t_{0.975,882} = 1{,}963$

When the *T*-test is executed for process PC29WT and the t_0 is between -1,963 and 1,963, we cannot reject the Null hypothesis H_0 at the 0,05 level of significance. This means that there is no evidence to indicate that the mean of PC29WT is different in the pilot-run, than in the baseline.

Tests executed for work items of process PC29WT

In Figure 50, process PC29WT is depicted for both periods: baseline and pilot. It shows the 95% confidence interval (CI) and in Table 52, the descriptives are shown. Figure 50 shows a decrease in the wait time and the 95% CI do not overlap. Table 52 shows the mean is decreased from above 30 hours in the baseline period to 25 hours of wait time during the pilot-run.

PC29WT: "aktieformulier Neveninkomsten"

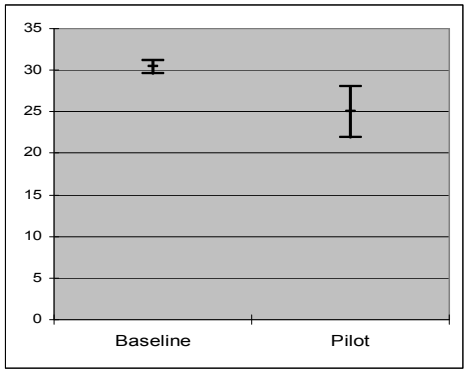


Figure 50: Mean and 95% CI of PC29WT

Table 52: Descriptives of PC29WT

Process: PC29WT (in hours)		
Period:	**Baseline**	**Pilot**
N	756	128
Upper limit	31,1696	28,0812
Lower limit	29,6402	21,8683
Mean	**30,4049**	**24,9748**
Std dev	10,7106	17,7606

In Appendix R, the results of the remaining processes are presented.

The *F*-test is executed, to test if the variances are the same. For the variable PC29WT the test result is: $F(755,127) = 0{,}364$, $p < 0.001$, see Table 53. Concluded is that the variances are significantly different and the assumption of homogeneity of variances is violated.

Table 53: F-test of PC29WT

		Descriptives			F-test					
		N	Mean	Std. Deviation	df	95% (two_tailed)	Critcal Region	F-test	P-value	Sum of P-values
PC29WT	0	756	109457,6	38558,3	755	0,025	0,776	0,364	,000	**,000**
	1	128	89909,1	63938,2	127	0,975	1,323	2,750	,000	
	Total	884	106627,0	43664,4						

Although the variances are not equal, the means are tested to draw conclusions if the goal of improvement in wait time is significant.

The *U*-test is executed for the variable PC29WT with use of SPSS. The *U*-test statistics are computed, U = 38907, N = 884

Table 54: U-test of PC29WT

Test Statistics (b)							
	Mann-Whitney U	Wilcoxon W	Critical region (two-tailed) Zo < Zα/2 0,025	Critical region (two-tailed) Zo > Zα/2 0,975	Z	Asymp. Sig. (2-tailed)	Exact Sig. [2*(1-tailed Sig.)]
PC29WT	38907	47163	-1,960	1,960	-3,548	,000	

The Z-score of the *U*-test is -3,548 and so $Z_0 < Z_{a/2}$, and therefore Null Hypothesis is rejected. Concluded from the test is that for process PC29WT the wait time in the baseline (median 32,07 hours) is significant different than the wait time in the pilot (median 27,82 hours), $U = 38907.00$, $p < .001$. If we assume that variable PC29WT has a normal distribution, we could perform the *T*-test. Since the assumption of homogeneity of variances is violated, the independent *T*-test is only a good addition, if corrected for this inequality of variance.

Table 55: Descriptives of the T-test of PC29WT

Group Statistics

	base_pilot	N	Mean	Std. Deviation	Std. Error Mean
PC29WT	,00	756	109457,6	38558,28073	1402,351
	1,00	128	89909,12	63938,15904	5651,388

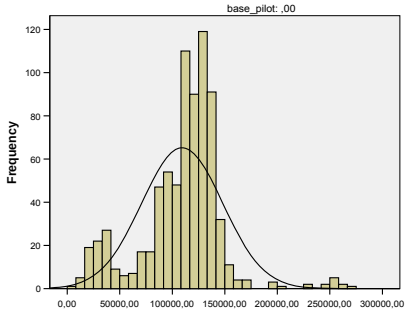
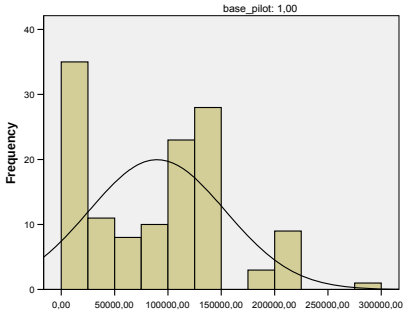
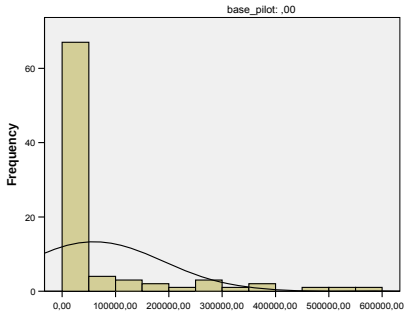
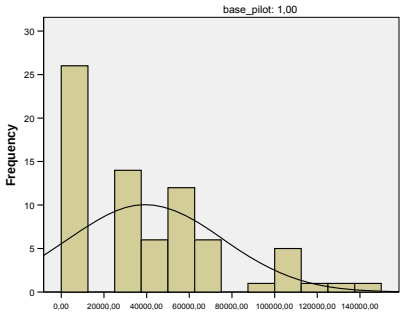
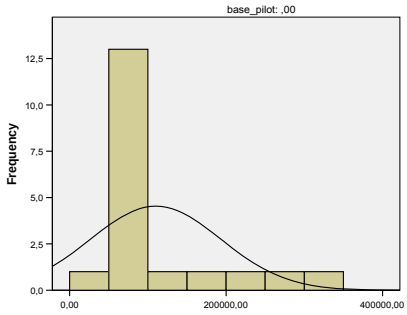
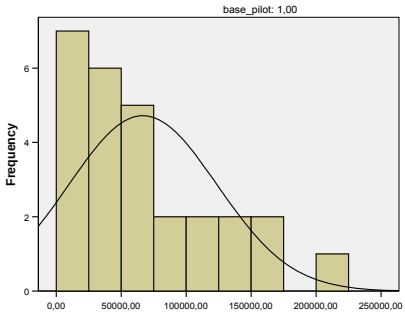
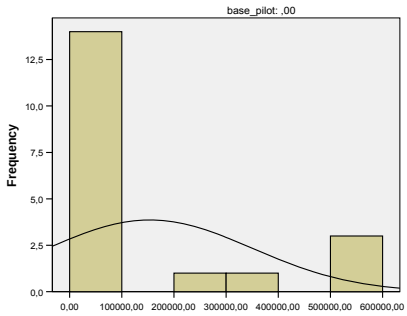
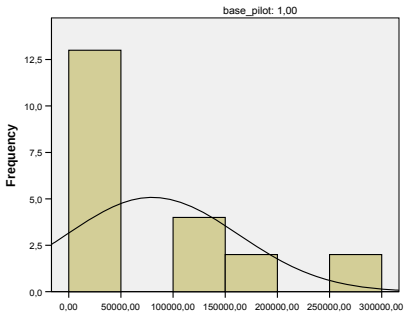
Table 56: T-test of PC29WT

		F-test (copied)		Critical region (two-tailed)		t-test for Equality of Means					Right signific. level:
		F	Sig.	to < tα/2 0,025	to > tα/2 0,975	t0	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Sig. (2 tailed)
PC29WT	Equal variances assumed	0,364	,000	-1,963	1,963	4,741	882	,000	19548,48	4123,54	
	Equal variances not assumed			-1,977	1,977	3,357	143	,001	19548,48	5822,78	**,001**

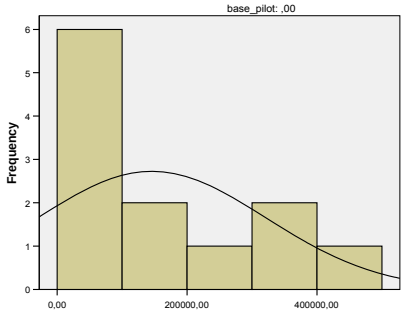
Of process PC29WT, the 'equal variance assumed' is not significant, therefore, we have to look at the T-test for 'equal variances are not assumed'. The *T*-test is executed and concluded is that for process PC29WT the wait time of the baseline is different (M = 109457.6 sec., SE = 1402.351 sec. N=756), than the wait time during the pilot-run (M = 89909.12 sec., SE = 5651.388 sec. N=128). This difference is significant $t(143) = 3.357$, $p < 0.05$.
The critical region of the two-tailed T-test depends on the degrees of freedom (df). Since the number of df's is lower for the t-test 'equal variances are not assumed', the critical region is influenced too.
The tests are executed and a conclusion could be drawn. In this section, only the work items of one process are described. In appendix S, for all processes, the different tests are executed.

Q. Normality check

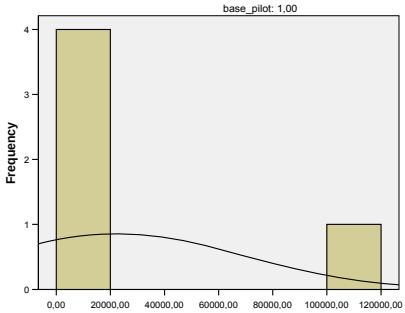
- Normality plots

Baseline results: wait time	Pilot run results: wait time
PC29WT 	PC29WT 
PC27WT 	PC27WT 
PC21WT 	PC21WT 
PC18WT 	PC18WT 
Baseline results: wait time	**Pilot run results: wait time**

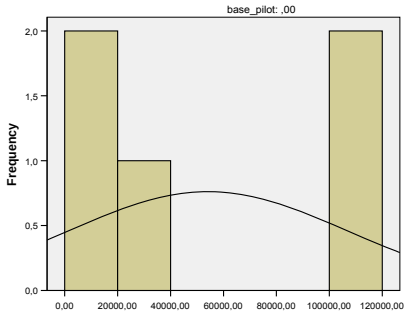
PC5WT



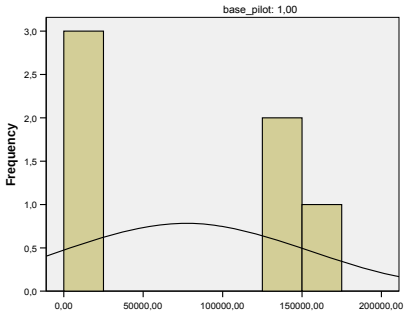
PC5WT



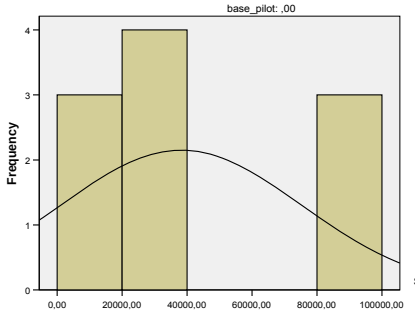
PC3WT



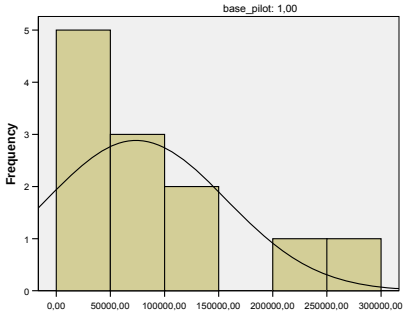
PC3WT



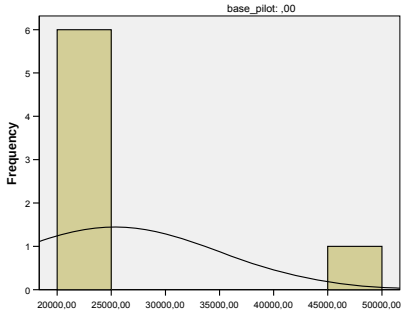
PC19WT



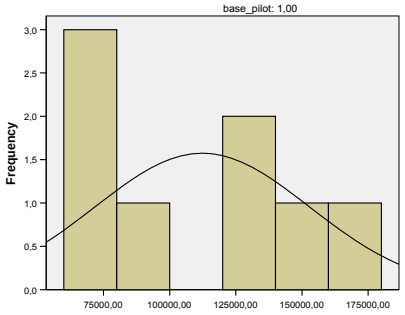
PC19WT



PC16WT



PC16WT



- Test of Normality

Table 57: Test of normality

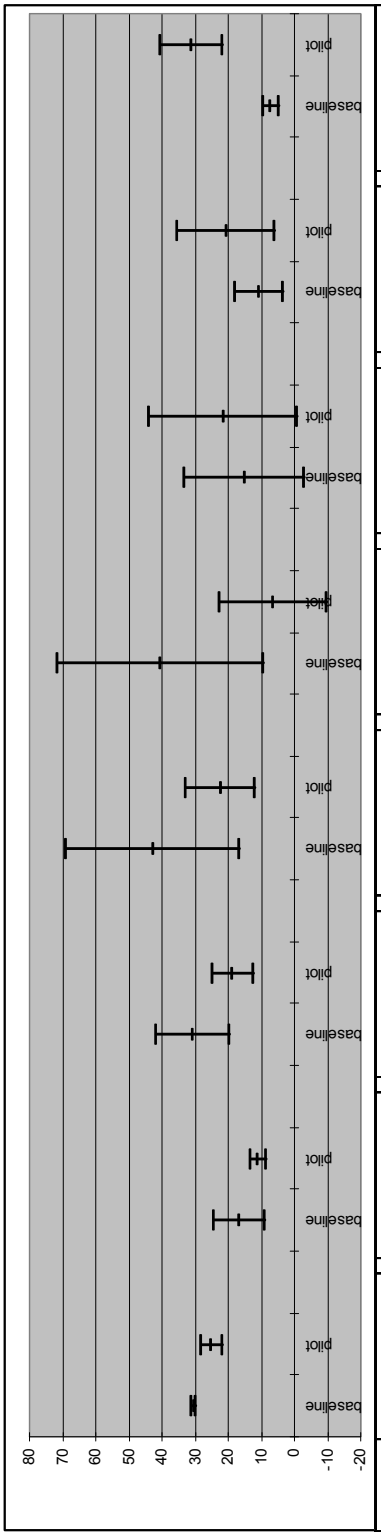
Tests of Normality

		Kolmogorov-Smirnov(a)			Shapiro-Wilk		
	base_pilot	Statistic	df	Sig.	Statistic	df	Sig.
PC29WT	,00	,125	756	,000	,898	756	,000
	1,00	,167	128	,000	,916	128	,000
PC27WT	,00	,402	86	,000	,533	86	,000
	1,00	,165	73	,000	,883	73	,000
PC21WT	,00	,302	19	,000	,768	19	,000
	1,00	,190	27	,013	,890	27	,008
PC18WT	,00	,346	19	,000	,694	19	,000
	1,00	,275	21	,000	,821	21	,001
PC5WT	,00	,256	12	,029	,784	12	,006
	1,00	,449	5	,001	,589	5	,000
PC3WT	,00	,252	5	,200(*)	,843	5	,174
	1,00	,291	6	,122	,769	6	,031
PC19WT	,00	,245	10	,092	,837	10	,040
	1,00	,197	12	,200(*)	,834	12	,024
PC16WT	,00	,454	7	,000	,500	7	,000
	1,00	,211	8	,200(*)	,877	8	,174

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

R. Mean and 95% confidence intervals



Process name	Aktieformuler neveninkomsten			Bijsparen OP/NP			Inhouding tbv derden			Neveninkomsten			Overige beheer			Overige herzien			Verzoek Info eigen sit extra			Wijzigen Opbouwgegeven s FPU		
Process	**PC29WT**			**PC27WT**			**PC21WT**			**PC18WT**			**PC5WT**			**PC3WT**			**PC19WT**			**PC16WT**		
Period	baseline	pilot	sign.	baseline	pilot	sign.	baseline	pilot	sign.	baseline	pilot	sign.	baseline	pilot	sign.	baseline	pilot	sign.	baseline	pilot	sign.	baseline	pilot	sign.
N	756	128		86	73		19	27		19	21		12	5		5	6		10	12		7	8	
Upper	31,1696	28,0812		24,4342	13,3296		41,7387	24,7933		68,9818	32,7078		71,4985	22,3511		33,1175	43,6335		17,9801	35,2038		9,51968	40,6153	
Lower	29,6402	21,8683		9,09102	8,62744		19,3729	12,2526		16,4666	11,8496		9,47906	-9,76298		-3,04275	-1,01547		3,22911	5,89571		4,55746	21,7772	
Mean	30,4049	24,9748		16,7626	10,9785		30,5558	18,5229		42,7242	22,2787		40,4888	6,29406		15,0374	21,309		10,6046	20,5498		7,03857	31,1963	
Std dev	10,7106	17,7606		35,7817	10,0767		23,2018	15,8507		54,4781	22,9113		48,8058	12,9319		14,5612	21,2729		10,3102	23,0638		2,68273	11,2665	
Statistical tests																								
Test	value	sign.		value	sign.		value	sign.		value	sign.		value	sign.		value	sign.		value	sign.		value	sign.	
U	38907	**.000**		2255	**.002**		171	.056		157	.250		14	.092		11	.456		50	.510		0	**.001**	
T	3,357	**.001**		1,434	.155		2,093	**.042**		1,519	.142		2,245	**.042**		-0,557	.591		-1,342	.199		-5,877	**.000**	

Figure 51: Results of the pilot

S. Statistical tests

- F-test: homogeneity of variance

Table 58: F-test: homogeneity of variance

		Descriptives			F-test					
		N	Mean	Std. Deviation	df	95% (two_tailed)	Critcal Region	F-test	P-value	Sum of P-values
PC29WT	0	756	109457,6	38558,3	755	0,025	0,776	0,364	,000	**,000**
	1	128	89909,1	63938,2	127	0,975	1,323	2,750	,000	
	Total	884	106627,0	43664,4						
PC27WT	0	86	60345,5	128814,1	85	0,025	0,642	12,609	,000	**,000**
	1	73	39522,6	36276,0	72	0,975	1,571	0,079	,000	
	Total	159	50785,3	98156,4						
PC21WT	0	19	110000,9	83526,6	18	0,025	0,403	2,143	,037	**,086**
	1	27	66682,5	57062,6	26	0,975	2,314	0,467	,049	
	Total	46	84574,9	71673,2						
PC18WT	0	19	153807,1	196121,2	18	0,025	0,391	5,654	,000	**,000**
	1	21	80203,3	82480,6	20	0,975	2,501	0,177	,000	
	Total	40	115165,1	150422,0						
PC5WT	0	12	145759,6	175700,8	11	0,025	0,234	14,244	,010	**,011**
	1	5	22658,6	46554,7	4	0,975	8,794	0,070	,000	
	Total	17	109553,4	158455,8						
PC3WT	0	5	54134,6	52420,4	4	0,025	0,107	0,469	,241	**,455**
	1	6	76712,5	76582,3	5	0,975	7,388	2,134	,214	
	Total	11	66449,8	64580,3						
PC19WT	0	10	38176,6	37116,9	9	0,025	0,256	0,200	,011	**,019**
	1	12	73979,2	83029,8	11	0,975	3,588	5,004	,007	
	Total	22	57705,3	67338,6						
PC16WT	0	7	25338,9	9657,8	6	0,025	0,176	0,057	,001	**,002**
	1	8	112306,6	40559,5	7	0,975	5,119	17,637	,001	
	Total	15	71721,7	53660,2						

- U-test: Mann-Whitney U test

Table 59: U-test: Mann-Whitney U test

Ranks

	base_pilot	N	Mean Rank	Sum of Ranks
PC29WT	,00	756	455,04	344007,00
	1,00	128	368,46	47163,00
	Total	884		
PC27WT	,00	86	69,72	5996,00
	1,00	73	92,11	6724,00
	Total	159		
PC21WT	,00	19	28,00	532,00
	1,00	27	20,33	549,00
	Total	46		
PC18WT	,00	19	22,74	432,00
	1,00	21	18,48	388,00
	Total	40		
PC5WT	,00	12	10,33	124,00
	1,00	5	5,80	29,00
	Total	17		
PC3WT	,00	5	5,20	26,00
	1,00	6	6,67	40,00
	Total	11		
PC19WT	,00	10	10,50	105,00
	1,00	12	12,33	148,00
	Total	22		
PC16WT	,00	7	4,00	28,00
	1,00	8	11,50	92,00
	Total	15		

Test Statistics (b)

	Mann-Whitney U	Wilcoxon W	Critical region (two-tailed)		Z	Asymp. Sig. (2-tailed)	Exact Sig. [2*(1-tailed Sig.)]
			Zo < Zα/2 0,025	Zo > Zα/2 0,975			
PC29WT	38907	47163	-1,960	1,960	-3,548	,000	
PC27WT	2255	5996	-1,960	1,960	-3,055	,002	
PC21WT	171	549	-1,960	1,960	-1,907	,056	
PC18WT	157	388	-1,960	1,960	-1,151	,250	,258 a
PC5WT	14	29	-1,960	1,960	-1,687	,092	,104 a
PC3WT	11	26	-1,960	1,960	-0,730	,465	,537 a
PC19WT	50	105	-1,960	1,960	-0,659	,510	,539 a
PC16WT	0	28	-1,960	1,960	-3,240	,001	,000 a

a. Not corrected for ties.
b. Grouping Variable: base_pilot

- T-test: Independent T-test

Table 60: T-test: Independent T-test

Independent Samples Test

		F-test (copied)		Critical region (two-tailed)		t-test for Equality of Means							Right signific. level:
											95% Confidence Interval of the Difference		
		F	Sig.	to < tα/2 0,025	to > tα/2 0,975	t0	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper	Sig. (2 tailed)
PC29WT	Equal variances assumed	0,364	,000	-1,963	1,963	4,741	882	,000	19548,48	4123,54	11455,39	27641,57	
	Equal variances not assumed			-1,977	1,977	3,357	143	,001	19548,48	5822,78	8038,65	31058,30	**,001**
PC27WT	Equal variances assumed	12,609	,000	-1,975	1,975	1,336	157	,183	20822,86	15582,23	-9954,98	51600,70	
	Equal variances not assumed			-1,984	1,984	1,434	101	,155	20822,86	14524,79	-7991,85	49637,57	,155
PC21WT	Equal variances assumed	2,143	**,086**	-2,015	2,015	2,093	44	,042	43318,43	20699,11	1602,11	85034,74	**,042**
	Equal variances not assumed			-2,045	2,045	1,961	30	,059	43318,43	22086,01	-1815,54	88452,40	
PC18WT	Equal variances assumed	5,654	,000	-2,024	2,024	1,574	38	,124	73603,82	46749,07	-21034,73	168242,37	
	Equal variances not assumed			-2,069	2,069	1,519	24	,142	73603,82	48459,79	-26484,72	173692,36	,142
PC5WT	Equal variances assumed	14,244	,011	-2,131	2,131	1,518	15	,150	123100,98	81104,95	-49770,13	295972,10	
	Equal variances not assumed			-2,160	2,160	2,245	14	,042	123100,98	54827,29	5453,88	240748,08	**,042**
PC3WT	Equal variances assumed	0,469	**,455**	-2,262	2,262	-0,557	9	,591	-22577,90	40527,73	-114258,00	69102,20	,591
	Equal variances not assumed			-2,306	2,306	-0,578	9	,578	-22577,90	39077,54	-111369,12	66213,32	
PC19WT	Equal variances assumed	0,200	,019	-2,086	2,086	-1,259	20	,223	-35802,57	28439,35	-95126,00	23520,87	
	Equal variances not assumed			-2,131	2,131	-1,342	16	,199	-35802,57	26688,23	-92437,96	20832,83	,199
PC16WT	Equal variances assumed	0,057	,002	-2,160	2,160	-5,514	13	,000	-86967,77	15773,42	-121044,17	-52891,37	
	Equal variances not assumed			-2,365	2,365	-5,877	8	,000	-86967,77	14797,25	-121167,23	-52768,31	**,000**