Process improvement intelligence

a framework for measuring alignment in business process improvement projects

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Process Improvement Intelligence: A framework for measuring alignment in business process improvement projects

by

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"When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind: it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the state of science."

William Thompson, Lord Kelvin, 1824 –1907

Abstract

While a performance measurement framework (such as the Balanced Scorecard) helps to translate (strategic) objectives into KPIs (which describe the 'as-is' situation), it does not provide any guidance to a business process improvement project. There is no framework translating these organizational goals into performance dimensions which can be used to direct a business process improvement initiative.

In this thesis, a Process Improvement Intelligence framework was proposed to measure the alignment between project goals and process improvements. This framework was applied to six cases in the public domain. Results showed that Process Improvement Intelligence could be measured by matching the project goals to the process improvement.

Implementing this framework into the proposed way to process improvement improves the way these projects are undertaken in practice. This will ensure a continual linkage of organizational goals and business processes.

Executive summary

While a performance measurement framework (such as the Balanced Scorecard) helps to translate (strategic) objectives into KPIs (which describe the 'as-is' situation), it does not provide any guidance to a business process improvement project. The KPIs, defined in the performance measurement framework, are organization specific and often constructed at the start of a business process improvement project, therefore project-specific (see Figure 3.1). Therefore, the following research objective was the goal of this thesis:

> *Ultimately, by measuring the alignment of business process improvement projects, improving the way these projects are undertaken in practice. To achieve this goal, the selection of process improvement heuristics will be guided the project goals. By examining the statistical relationship between the two, this thesis established that guidance.*

Identified as the most important gap in the literature (Jenniskens, 2011), there is no framework translating strategic objectives into performance dimensions which can be used to direct a business process improvement initiative. Such a framework enhances the way business process improvement projects are undertaken. Following the research objective presented above, the main research question for this thesis was formulated as follows:

> *How can the project goals guide process improvements to ensure the continual tight linkage of organizational goals and business processes?*

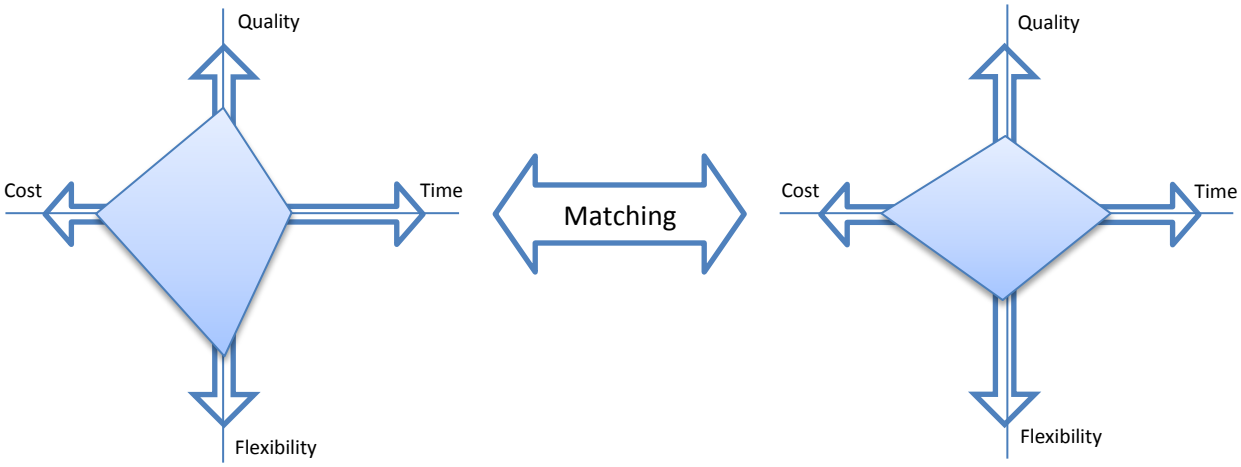
On a lower level, to examine the relationship between the organizational goals and process improvements, the following sub research question was proposed:

> *How can the alignment of a business process improvement project be measured?*

By providing an answer to this sub research question, this thesis establishes the guidance in selecting the process improvement heuristic(s) as mentioned above in the research objective.

By answering this research question, this thesis extended the current field of research in the following ways. The regulative cycle (van Strien, 1997) was adapted to describe the way business process improvement projects are undertaken in practice. It was proposed to enhance this way by creating a shortlist of process improvement heuristics based on the project goals. Alignment between the project goals and the process improvement heuristics therefore played an important role. Because (project) objectives were translated into performance dimensions using the devil's quadrangle, this research extended the business performance management literature, as indicated by Neely, Gregory, and Platts (2005). These performance dimensions were proposed to guide a business process improvement initiative, adjoining Reijers and Liman Mansar (2005) research on best practices in business process redesign. This research validated the research of Reijers and Liman Mansar (2005) in the public domain, using business process improvement projects conducted at Berenschot.

In this thesis, the term '*Process Improvement Intelligence*' was proposed as a framework for measuring the alignment between project goals and process improvement:



Project goals Process improvements

This framework was applied to six cases from Berenschot, all in the public domain. Therefore, this research validated the research of Reijers and Liman Mansar (2005) in the public domain. The goals of these projects were evaluated by municipality employees, while the process improvements of the projects were evaluated by process experts from Berenschot. Both evaluations involved scoring the item on the four dimensions of the devil's quadrangle: time, costs, quality and flexibility. Based on the project documentation, the pairs of project goals and process improvement were examined statistically for alignment. It was hypothesized that all pairs aligned significantly.

The results supported this framework, mainly showing significant alignments. In total, eleven misalignments were identified correctly, while it labelled one pair misaligned wrongfully. This process improvement violated one of the properties of the devil's quadrangle (i.e. it is impossible to improve on all four dimensions), which could explain the failure of the framework. Three misalignments could be explained by misinterpretation of the best practice 'Order types' by the process experts. After investigating the alignment scores of the process improvement heuristics, this best practice had the lowest alignment score. This indicated that in practice, there is a serious misalignment between what performance the best practice enhances and what project goal it fulfils. The results were complicated due to the high number of not significant correlations, which could be explained by the very small sample.

In short, the framework showed that Process Improvement Intelligence could be measured by matching the project goals to the process improvement. The framework indicated well aligned projects, as was expected, but was also able to rightfully indicate most misalignments. Implementing this framework into the proposed way to process improvement improves the way these projects are undertaken in practice. This will ensure a continual linkage of organizational goals and business processes. By evaluating their business process improvement projects, Berenschot can improve the alignment of their process improvements to the objectives of a client, thereby improving its service level. Based on the findings of the research, an outlook for future research could be provided.

Preface

This report is the result of my graduation project for the degree of Master of Science in Operations Management and Logistics at Eindhoven University of Technology. The research was conducted from November 2010 to September 2011 in collaboration with Berenschot, a management consulting firm in the Netherlands. This project would not have been successful without the contribution of a number of people, who I would like to express my gratitude to.

First of all, I would like to thank my supervisors. As my mentor during the last two years, I would like to thank Hajo Reijers for his enthusiasm and support during the project. His critical view on my work as well as valuable input contributed significantly to this result. Also, I would like to thank Ad de Jong for his valuable feedback on my work and his help when I could not see the wood for the trees in nonparametric statistics.

Second, I would like to thank Berenschot for giving me the opportunity to conduct this graduation project in a real-life consulting setting. Thanks to the Information Management group and its members for providing the necessary facilities, data, information and the great time I had. Special thanks to Gemma Post, who supervised me during this project and helped me collect the necessary data for the project.

Finally, but most importantly, I would like to thank my family, girlfriend and friends for providing me the support for successfully finishing my graduation project.

Already having one foot in the working life, now it is time to move on, once again in the management consulting industry.

Nick Jenniskens

Eindhoven, September 2011

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1. Introduction

In today's dynamic business environment, the ability to improve business performance is a critical requirement for any organization. So, many enterprises have recently been pursuing process innovation or improvement to attain their performance goals.

To comprehensively support business process execution, the concept of business process management (BPM) has been proposed. The strategic importance of BPM is becoming more important as a means of optimizing business performance. The ultimate goal of BPM, therefore, is performance management, which includes activities that ensure business goals are consistently being met.

Gartner, in their Business Unit (BU) CIO's 2010 Agenda, showed that, just as in 2009, business process improvement is the top business priority of BU CIOs of large organizations (Meehan, 2010). Linking business and IT strategies and plans ranks second in the top BU CIO Strategies for 2010 and is expected to stay there in 2013.

Hardjono and Bakker (2006) state that business process management requires a clear relationship between process objectives and strategic objectives. Process objectives should be directed by strategic objectives, such that an (operational) process will always be in harmony with the strategy of the organization. The key question in this relationship is:

> *"What does a strategic choice mean for an operational process?"*

Continuously relevant in practice, this topic of Process Improvement Intelligence is proposed in the scientific literature to describe the strategic alignment of a business process and its (strategic) objectives. This research extended the current state of research in this topic. The outline of this introduction is as follows. Firstly, the problem statement is discussed and motivation for this research is given. This research was done in collaboration with Berenschot, which is introduced next. Lastly, the outline of this report is presented.

1.1. Problem statement and motivation

The literature review (Jenniskens, 2011) revealed a substantial gap in the literature in the topic of strategic alignment of BPM. In short, there is no framework translating strategic objectives into performance dimensions which can be used to direct a business process improvement initiative. As a result, in the diagnosis phase of BPM, it is difficult to decide which process should be improved to achieve a specific performance goal of which performance index is influenced when a specific business process is executed successfully.

Therefore, the following research question was addressed in this thesis:

> *How can the project goals guide process improvements to ensure the continual tight linkage of organizational goals and business processes?*

By answering this research question, this thesis extended the current field of research in the following ways. Using the regulative cycle (van Strien, 1997), a Process Improvement Intelligence framework was developed for measuring alignment in business process improvement projects in general. Because (project) objectives were translated into performance dimensions using the devil's quadrangle, this research extended the business performance management literature, as indicated by Neely et al. (2005). These performance dimensions were proposed to guide a business process improvement initiative, adjoining Reijers and Liman Mansar (2005) research on best practices in business process redesign. This research validated the research of Reijers and Liman Mansar (2005) in the public domain, using business process improvement projects conducted at Berenschot.

By evaluating their business process improvement projects, Berenschot can improve the alignment of their process improvements to the objectives of a client, thereby improving its service level. Next, Berenschot's company profile is introduced.

1.2. Company profile

The research performed in this thesis has been conducted in collaboration with Berenschot. Berenschot has been an independent organizational consulting firm for over 70 years in both the public and private sector in the Netherlands. Nowadays they are still mainly focused on the Dutch market, but with an office in Brussels and as a partner in the E-I Consulting Group, they are now an independent consulting agency in the Benelux with 500 employees.

This thesis has been written during an internship at Berenschot's expertise group Information Management, which helps the public sector keeping control of their ICT and related projects, achieving the best results and saving on costs. They are often involved in the computerization of processes, which improves services, makes processes more efficient and in some cases, cuts costs.

In the public sector, Berenschot uses a project-based approach. The public sector thereby consists of the Dutch government, provinces, regional water authorities and municipalities. In this thesis, only projects within provinces and municipalities were analysed. These will be referred to as projects within *local governments*.

Many of these projects can be characterized as business process improvement projects. As laid out in the chapter 3, they therefore follow the Process Improvement Intelligence framework. Using this adaptation of the regulative cycle, this thesis reflected on the way these projects are conducted by Berenschot.

Usually, these projects are done by multidisciplinary teams. These teams consist of experts from various field of expertise. The experts, which were asked to take part in this research, are presented in section 4.3.

1.3. Research structure

The remainder of this report is structured as followed.

Chapter 2 describes the literature review conducted before this research. The literature review methodology is described, the status quo of the performance measurement and strategic alignment literature is addressed briefly and the relevant gaps in the literature are identified.

Chapter 3 discusses the research design and methodology. Using the research objective, a conceptual model for business process improvement projects is adapted from the regulative cycle (van Strien, 1997) and the research questions are derived. Next, the research methodology is described in detail, including the case selection, scoring experiments and the derivation of hypotheses.

Chapter 5 explains the statistical methods used before presented the results obtained. Chapter 6 follows a discussion of those results and the report is concluded in chapter 7 with recommendations, future research and limitations.

2. Background

The research was based on a systematic literature review (Jenniskens, 2011), in which the field of alignment of organizational strategy and business process performance was explored. The literature review consisted of several steps. First, to scope the search of relevant literature, the following research questions were formulated:

- **How can the effects of a process improvement project be measured?**
    1) What frameworks for measuring process performance (in general) exist?
    2) How to develop a (specific) process performance measurement system?
- **How can we associate process performance measurements to strategic objectives and stakeholder measures?**
    1) What frameworks for modelling strategic objectives exist?
    2) What links are there between strategic objectives and performance measurements?
    3) How can we derive performance measurements from strategic objectives?

The first research question focused on the measurement of business process improvements in general; this research question was divided into two sub questions, focusing on (1) the measures of (process) performance in general and (2) the development of a process performance measurement system. The second research questions focused on the association of process performance measurements to strategic objectives and stakeholder measures; the sub-questions focused on (1) strategic objective frameworks, (2) the relationship between strategic objectives and performance measurements and (3) tools that make this relationship explicit.

The scientific search engines ABI/Inform, Springerlink and Google Scholar were used to generate a long list of potentially useful articles. ABI/Inform was selected for its large availability of journals in numerous fields of research (e.g. business). Springerlink was selected for its availability of journals specifically in computer science. Google Scholar was used to cross-check the references with the other two search engines and to complement the search results. The long list, consisting of 52 articles, was scored on relevance, recentness and quality of the source. The resulting 20 articles served as input to the literature synthesis. A more detailed description of the literature research methodology can be found in Jenniskens (2011).

This chapter summarizes the literature review, beginning with an explanation of the concepts used throughout this report. Then, the results of the literature review are presented.

2.1. Processes

A process can be identified by four key features (Zairi, 1997):

1) Predictable and definable inputs
2) A linear, logical sequence or flow
3) A set of clearly definable tasks or activities
4) A predictable and desired outcome or result

In an organizational context, a process is an approach for converting inputs into outputs. In the context of Berenschot (section 1.2), the process 'providing subsidiaries' of a municipality converts subsidy requests (inputs) into accepted or rejected subsidies (outputs). In the next section, this notion of a process is used to evaluate the *performance* of a process, by using performance indicators related to inputs and outputs.

Specifically, in this report, *business* processes are the subject of interest. One of the fundamentals of BPM is the following definition of a business process, which is used in this report (Hammer & Champy, 1993):

> *"A business process is a collection of activities that takes one or more kinds of input and creates an output that is of value to the customer. A business process has a goal and is affected by events occurring in the external world or in other processes"*

Next, the performance dimensions used in this report are described and related to the process concept described above.

2.2. Process performance

As can be concluded from the literature review (Jenniskens, 2011), there are two classifications of performance dimensions: time, cost, quality and flexibility and efficiency, effectiveness and adaptability. Graphically, these are presented as the devil's quadrangle (Brand & van der Kolk, 1995) and the three dimensions of performance (Moseng & Bredrup, 1993):

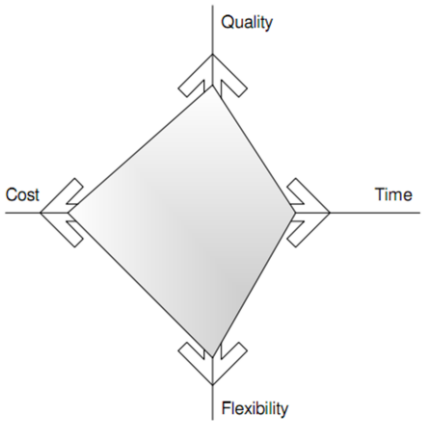

Figure 2.1 The devil's quadrangle (adopted from Jansen-Vullers, Loosschilder, Kleingeld & Reijers, 2007)

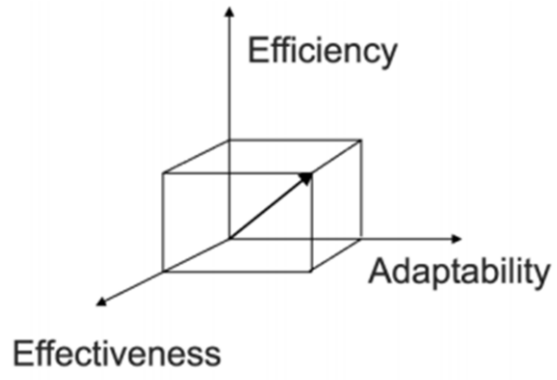

Figure 2.2 The three dimensions of performance (adopted from Moseng and Bredrup, 1993)

These two functions of performance dimensions are similar in their calculation of the performance of a system. The devil's quadrangle's area is a direct function of the measurements in the indicator groups: time, cost, quality and flexibility. The volume of the rectangular prism is a direct function of the measurements in the indicator groups: efficiency, effectiveness and adaptability. However, the two frameworks differ in their application. Because the devil's quadrangle explicitly states that a trade-off must be made (i.e. it is impossible to improve on all four dimensions at once), it is more suitable to decision-making processes e.g. business process improvement projects (Jansen-Vullers,

Loosschilder, Kleingeld, & Reijers, 2007). In chapter 3, a conceptual model is proposed to describe these business process improvement projects; the devil's quadrangle has a key role in this model.

Efficiency, effectiveness and flexibility can be used to adopt a process-based perspective on performance, by regarding resources as inputs (cf. efficiency), process results as outputs (cf. effectiveness), and viewing flexibility as an inherent aspect of process execution (cf. adaptability) (Beamon, 1999). This process-based perspective on performance corresponds to the process-oriented performance framework developed by Brown (1996):

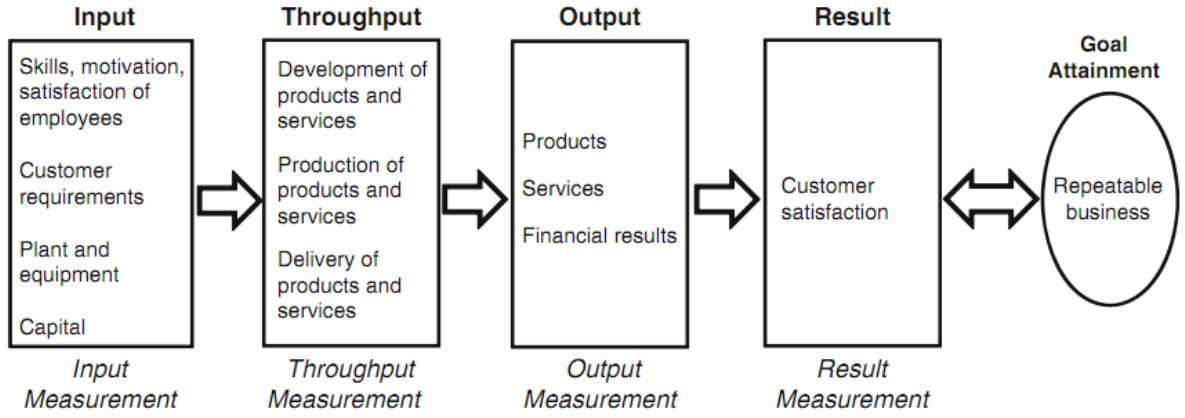

Figure 2.3 Process-oriented framework proposed by Brown (1996) (adopted from Heckl & Moormann, 2010)

Brown adds performance indicators related to the result, which is important because the customer is the ultimate stakeholder of the process. This view is implemented in several current management paradigms such as Lean Management/Kaizen, Michael Porter's Value Chain and Kaplan & Norton's Value Proposition. In the example process 'providing subsidiaries' subsidy requests are the input of the process; throughput would be the judgement activities of the municipality to decide whether or not to accept the request; outputs are the accepted or rejected subsidies and the outcome would be the customer (who applied for the subsidy) satisfaction.

2.3. Objectives and targets

In general, an objective can be defined as *"something that one's efforts or actions are intended to attain or accomplish"*[1]. It this report, it is used as a synonym to 'goal'. Organizational objectives can be strategic objectives, for example 'improve customer satisfaction' or 'increase profits'. On a lower level (operational level), these objectives could be translated into 'decrease error rate' or 'decrease throughput time'. Objectives are usually accompanied by targets. Targets are numerical values which are pre-determined as indicators success or failure. Examples of targets for the objectives above could be '5% error rate' or '7 week throughput time'.

A key performance indicator (KPI) is a metric that helps you understand how you are doing against your objectives. In the examples above, the corresponding KPIs would be the (current) metrics for 'error rate' and 'throughput time'.

[1] http://www.definitions.net/definition/objective

Performance measurement frameworks provide a categorization of performance indicators (KPIs), similar to the process-oriented framework developed by Brown (1996) discussed above. One potential approach is to think of individual KPIs not just as a single metric, but as a balanced metric that incorporates several alternative dimensions. Most common in practice, the Balanced Scorecard provides a set of measurements from four perspectives: financial, internal business processes, customer and learning & growth (Kaplan & Norton, 1992). By giving information from four perspectives, the number of measures is limited and it forces managers to focus on the handful of measures that are most critical. As a performance management tool, the balanced scorecard is designed to assist management in aligning, communicating and tracking progress against on-going business strategies, objectives and targets. The main weakness of this approach is that it is primarily designed to provide managers with an overall view of performance, but does not direct improvement projects on the business operational level. Thus, the balanced scorecard is primarily designed as a monitoring and controlling tool rather than an improvement tool (Neely et al., 2000). In practice therefore, there is a significant gap between performance indicators and improvement initiatives. This strategic alignment of BPM has become an emerging topic in Business Process Management literature. It is introduced in the next section as well as some tools to make this relationship between strategic goals and business processes explicit.

2.4. Strategic alignment of BPM

A definition of strategic alignment of BPM is given by de Bruin and Rosemann (2006):

> *"Strategic alignment of BPM is the continual tight linkage of organizational priorities and enterprise processes enabling the achievement of business goals."* (de Bruin & Rosemann, 2006, p. 4)

'Alignment' can be defined as *"the act of adjusting or aligning the parts of a device in relation to each other"*[2]. In this case, the device is BPM and the parts are organizational priorities and enterprise processes. Organizational priorities are a function of an organization's objectives and corresponding KPIs. Strategic alignment of BPM thus examines the alignment of business processes and (strategic) objectives. To align processes with corporate strategy, Brenner and Coners (2010) introduce an instrument known as the Strategic Process Alignment matrix (SPA matrix). The SPA matrix establishes formal, KPI-based relations between strategy and those processes with strategic relevance. A matrix is used to systematically compare the strategic goals. In this way, the contribution of process capital to strategy is assessed based on the criteria of 'process relevance' and 'degree of target achievement'. Process relevance represents a weighting in per cent of how relevant a process is for reaching the strategic goal; degree of target achievement compares the actual value of a performance indicator and a target value.

The SPA matrix, however, does not answer our key question:

> *"What does a strategic choice mean for an operational process?"*

[2] http://www.definitions.net/definition/alignment

As a result, in the diagnosis phase of BPM, it is difficult to decide which process should be improved to achieve a specific performance goal of which performance is influenced when a specific business process is executed successfully. Therefore, it is necessary to establish a process-based performance measurement model (Han, Choi, Kang, & Lee, 2010). Their Process-Based Performance Measurement Model (PPMM) therefore holds an integrated view of the KPI model, process model and K-P model, which represents the relationship between KPI and business processes. This correlation scheme between business process and KPIs is not clearly established in the current measurement practices (Han et al., 2010).

2.5. Literature review conclusions

Process performance can be measured in two classifications performance dimensions, which differ in their application. The devil's quadrangle (Brand & van der Kolk, 1995) constitutes a trade-off between the indicator groups time, costs, quality and flexibility (i.e. it is impossible to improve on all four dimensions at once); therefore, it is more suitable to decision making processes (e.g. business process improvement projects). On the other hand, efficiency, effectiveness and flexibility can be used to adopt a process-based perspective on performance, by viewing resources as inputs (cf. efficiency), process results as outputs (cf. effectiveness), and viewing flexibility as an inherent aspect of process execution (cf. adaptability) (Beamon, 1999); therefore, it is more suitable to performance measurement systems.

Strategic objectives are high-level goals of an organizational, while targets provide a measurable value for success or failure in reaching those goals. A key performance indicator (KPI) measures your current performance against those targets. KPIs can be categorized in a performance measurement framework. Recalling, the balanced scorecard is a valuable framework suggesting important areas in which performance measures might be useful, but it provides little guidance on how the appropriate measures can be identified, introduced and ultimately used to manage business (Neely et al., 2000). In practice therefore, *there is a significant gap between key performance indicators and business process improvement initiatives*. This strategic alignment of BPM has become an emerging topic in Business Process Management literature.

Strategic alignment of BPM examines the alignment of business processes and (strategic) objectives. A correlation scheme between business process and KPIs is not clearly established in the current measurement practices (Han et al., 2010). Therefore, they developed a K-P model, which represents the relationship between KPIs and business processes. However, this tool does not include the performance *improvement* of a business process and its measurable effect on the KPIs.

As a result, in the diagnosis phase of BPM, it is difficult to decide which process should be improved to achieve a specific performance goal of which performance index is influenced when a specific business process is executed successfully.

In short, while a performance measurement framework (such as the Balanced Scorecard) helps to translate (strategic) objectives into (organizational) targets (KPIs), it does not provide any guidance to a business process improvement project. There is no framework translating strategic objectives into performance dimensions which can be used to direct a business process improvement initiative.

3. Research design and methodology

This chapter outlines the research design and approach. First, business process improvement projects are discussed using a conceptual model. A separate section is devoted to business process improvement heuristics, which are part of the conceptual model. Next, the research objective and research questions are presented. Then, the research model which was adopted in this thesis is presented. Lastly, the research methodology used to provide an answer to the research questions is described.

3.1. Business process improvement projects

In general, a business *problem solving* project is undertaken to improve the performance of a certain business system or organizational unit. A typical business problem solving project consists of three parts (van Aken, Berends, & van der Bij, 2006):

- A *design* part in which a redesign of the business system or organizational unit is made on the basis of a problem definition, analysis and diagnosis, plus a plan of action for changing the organization to implement the proposed redesign.
- A *change* part in which the redesign is realized through an intervention in the current organizational roles and routines, plus the implementation of new tools or information systems.
- A *learning* part in which the organization evaluates the performance of the business system or organizational unit after the redesign intervention has been undertaken. This performance evaluation can be compared to the project goals.

A logical set-up of the classic problem solving cycle is the so-called regulative cycle (van Strien, 1997). The regulative cycle is designed for business *problem solving* projects in general. In this thesis, the regulative cycle was adapted to business *process improvement* projects and used as a framework of reference; presented in this section, this conceptual model improved the understanding of business process improvement projects and the research objective and the corresponding research questions. Contrary to business problem solving projects, which solve a business *problem*, business process improvement projects involve the improvement of a business *process*. The scope of these projects is narrow and short-term (Davenport, 1993) (as opposed to business process reengineering projects). The object of improvement is usually a single business process.

An overview of the adapted regulative cycle is shown in Figure 3.1 below. By explicitly visualizing the relationship between two steps of the regulative cycle, they assist modellers in conducting business process improvement projects. Next, each of steps in the cycle will be reviewed briefly and research gaps will be identified.

(Strategic) objectives are regarded as the starting point of the cycle. An organization wants to improve a business process and chooses to intervene by starting a business process improvement project. The objectives resemble the goals of the project (cf. a problem statement in the regulative cycle). As discussed in section 2.3, objectives can be translated into Key Performance Indicators (KPIs), which reflect the current performance by means of a performance measurement framework (e.g. the Balanced Scorecard). Therefore, the KPIs reflect the performance of the ‘as-is’ situation.

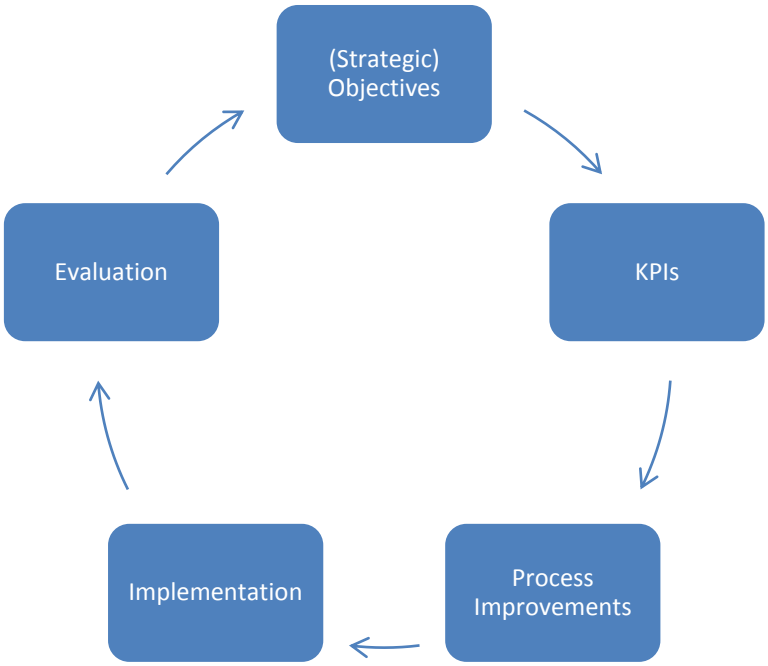

Figure 3.1 The regulative cycle adapted to a business process improvement project

The transition from the 'as-is' situation to the 'to-be' situation constitutes a significant gap in the literature. Or, to put it in the words of Sharp and McDermott (2001): "How to get from the as-is to the to-be isn't explained, so we conclude that during the break, the famous ATAMO procedure is invoked – And Then, A Miracle Occurs". *Therefore, the focus of this thesis is on that transition (from KPIs to Process Improvements)*.

Rosemann (2010) provides four ways to process improvement:

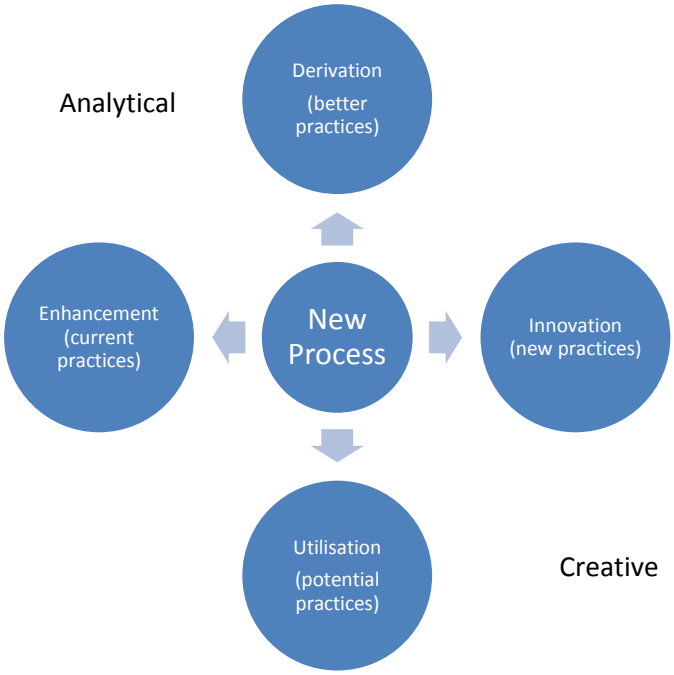

Figure 3.2 Four ways to process improvement (adopted from Rosemann, 2010)

Limam Mansar, Reijers, and Ounnar (2009) provide the following overview of the creative, analytical and their proposed way to process improvement:

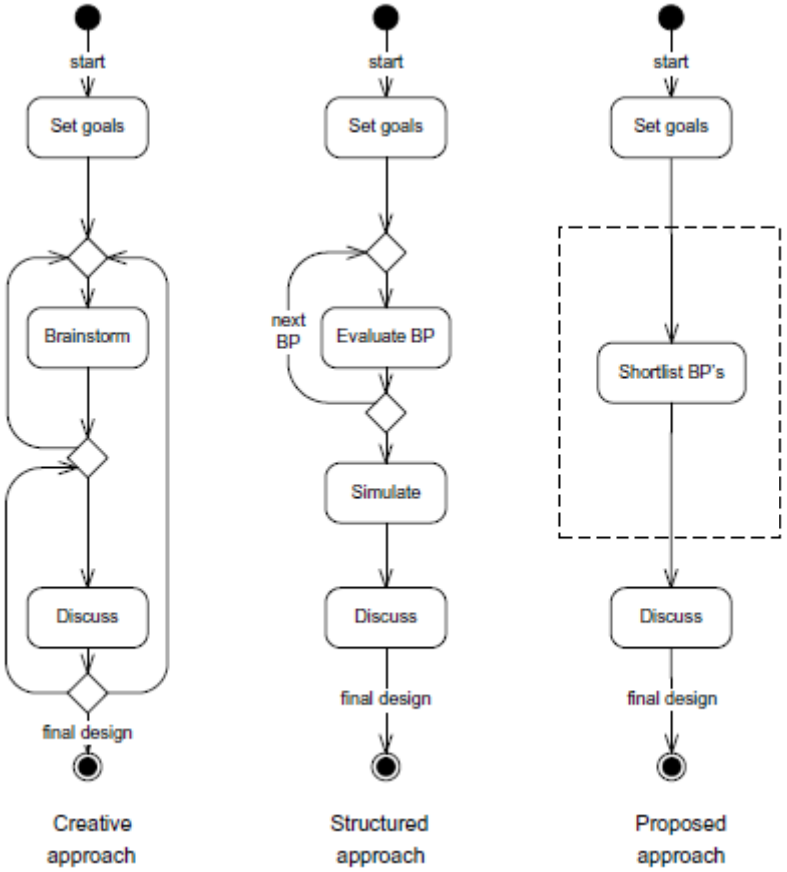

Figure 3.3 Overview of the creative, analytical (label 'structured') and proposed way to process improvement

The creative approach corresponds to Rosemann's creative ways to process improvement, namely innovation and utilisation. Starting from a set of goals, brainstorming sessions and discussions will be held to create an improved process design. As mentioned above, these are more suitable to business process reengineering projects (which require radical innovation). The structured approach corresponds to Rosemann's analytical ways to process improvement, namely derivation and enhancement. Because business process improvement projects involve incremental improvement taken the current process as starting point, a structured approach is adopted in these projects. This approach builds on an extensive list of potentially effective practices to improve the current process. Key element in this approach is the 'best practices' (BP), which are evaluated for their applicability on improving the current process. Simulation can be used to measure the effect of the process improvement. The best practices are a predefined list of process improvement heuristics. These are introduced next, before discussing the proposed approach of this thesis.

3.1.1. Process improvement heuristics

Process improvement heuristics prescribe how a process can be improved. These prescriptions are general, so they can be replicated in any situation or setting. These heuristics are applied to the current process to improve its performance. Taking the current process as a starting point contrasts sharply with so-called clean-sheet approaches, i.e. where the process is designed from scratch. The 'best practices', as presented in Reijers and Liman Mansar (2005), provide a set of process improvement heuristics which have proved to be useful in improving business processes. To measure the impact of the best practices on performance, they are evaluated qualitatively using the dimensions of the devil's quadrangle (as described in section 2.2). However, most of the best practices lack the support of an analytical or empirical study. The authors indicate that additional work should point out the conditions or domain validity where a best practice would give the expected results in terms of cost/time reduction or quality/flexibility improvement. Taking this research as an example, in this thesis, the performance impact of the process improvements was scored. Since these business process improvement projects were conducted in the public domain, this thesis validated the research of Reijers and Liman Mansar (2005) in this sector. The best practices are added as appendix A and will be used in the discussion of the results. Contrary to the original paper (Reijers & Liman Mansar, 2005), in this report the *effect* of the best practices was evaluated qualitatively (instead of the *impact* of the best practices). Thus, a best practices may have a *negative impact* on time and costs (i.e. it decreases time and costs of the process); in this thesis, this was reported as a *positive effect* on time and costs (i.e. it enhances the time and costs dimensions).

Returning to the approaches to process improvement (as displayed in Figure 3.2), in this thesis, an approach was proposed that involved shortlisting the best practices. This shortlisting is done using the goals of project, the (strategic) objectives in the first step of the adapted regulative cycle. It thereby filled the literature gap as identified in chapter 2:

> *There is no framework translating strategic objectives into performance dimensions which can be used to direct a business process improvement initiative.*

The shortlist gives a focus to a set of best practices that could potentially be applied to improve the performance of the current process (Limam Mansar et al., 2009). By providing such a shortlist, it cuts out a number of best practices and narrows the scope for the discussion. The result of this discussion is a decision which process improvement heuristic(s) will be applied to the current process.

The next steps of the adapted regulative cycle (implementation and evaluation) fall outside the scope of this thesis. During the implementation phase, roles and work processes are changed on the basis of the solution design and change plan. A formal evaluation compares the performance after the project to the targeted performance to evaluate if the improvement indeed has been realized. This can be done using the KPIs as discussed in section 2.3. This may lead to another business problem solving project.

3.2. Research objective

While a performance measurement framework (such as the Balanced Scorecard) helps to translate (strategic) objectives into KPIs (which describe the 'as-is' situation), it does not provide any guidance to a business process improvement project. The KPIs, defined in the performance measurement framework, are organization specific and often constructed at the start of a business process improvement project, therefore project-specific (see Figure 3.1). Therefore, the following research objective was the goal of this thesis:

> *Ultimately, by measuring the alignment of business process improvement projects, improving the way these projects are undertaken in practice. To achieve this goal, the selection of process improvement heuristics will be guided the project goals. By examining the statistical relationship between the two, this thesis established that guidance.*

In the previous section, the regulative cycle (van Strien, 1997) was adapted to describe the way business process improvement projects are undertaken in practice. To recall, in this thesis it is proposed to enhance this way by creating a shortlist of process improvement heuristics based on the project goals. Alignment between the project goals and the process improvement heuristics therefore plays an important role. In this thesis, the term '*Process Improvement Intelligence*' is proposed to describe this matching of project goals and process improvement heuristics. The research methodology, presented in section 3.6, describes how this relationship was examined. First, however, the research questions are presented.

3.3. Research questions

Identified as the most important gap in the literature (Jenniskens, 2011), there is no framework translating strategic objectives into performance dimensions which can be used to direct a business process improvement initiative. Such a framework enhances the way business process improvement projects are undertaken, as illustrated with the adapted regulative cycle in the section 3.1. Following the research objective presented above, the main research question for this thesis was formulated as follows:

> *How can the project goals guide process improvements to ensure the continual tight linkage of organizational goals and business processes?*

In terms of the adapted regulative cycle presented in the previous section, this research question resembles the transition from the KPIs to the process improvements. On a lower level, to examine the relationship between the two, the following sub research question was proposed:

> *How can the alignment of a business process improvement project be measured?*

By providing an answer to this sub research question, this thesis establishes the guidance in selecting the process improvement heuristic(s) as mentioned above in the research objective. The next sections present the research methodology, which was used to provide an answer to this sub research question.

3.4. Research model

To provide an answer to the research questions proposed in the previous section, the following research model is followed.

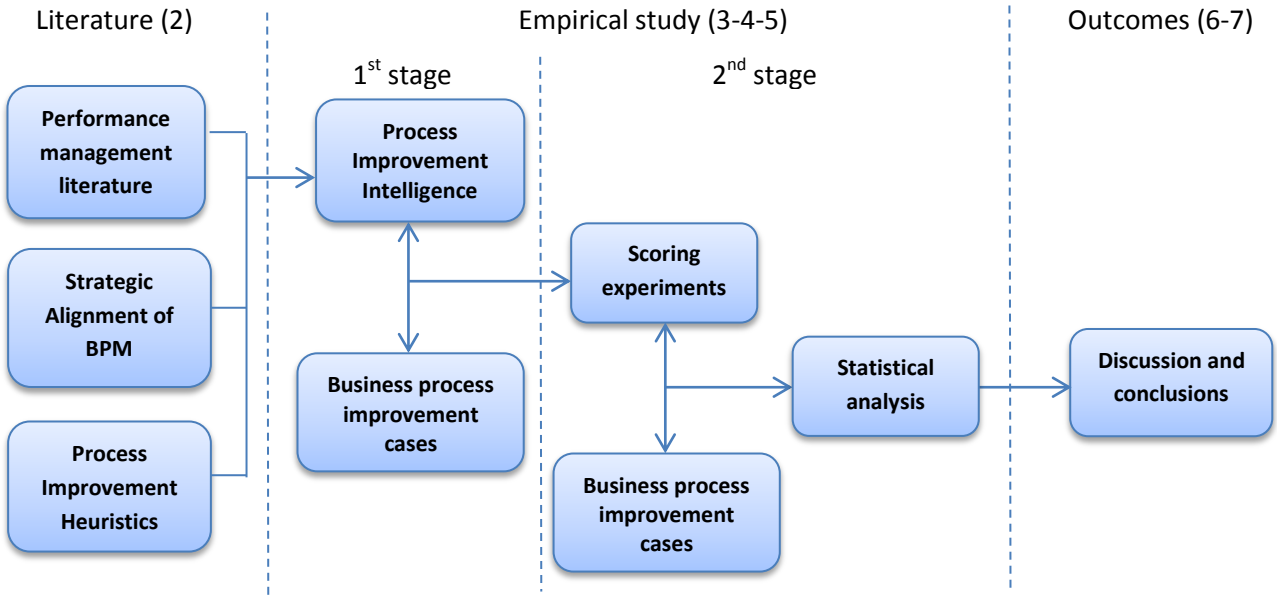

Figure 3.4 Research model followed by this thesis (between brackets indicate corresponding chapters)

Using the literature as a background and the adapted regulative cycle as a reference model, the next section builds theory about Process Improvement Intelligence, i.e. the alignment between project goals and process improvements.

A powerful research method for theory testing is case research (Voss, Tsikriktsis, & Frohlich, 2002). Case research is the method that uses case studies as its basis. By using case studies, actual data is used from practice (as opposed to a controlled setting), which increases the (practical) relevance of the theory. Furthermore, in the time frame of this thesis, it was not possible to create a controlled setting for a business process improvement project that approaches a real-life scenario.

Using multiple cases has several advantages over using a single case:

Choice	Advantages	Disadvantages
Single cases	Greater depth	Limits on the generalizability of conclusions drawn. Biases such as misjudging the representativeness of a single event and exaggerating easily available data
Multiple cases	Augment external validity, help guard against observer bias	Less depth per case

Table 3.1 Choice of a number of cases (adopted from Voss et al., 2002)

By using multiple case studies, the theory as presented above could be tested *and future outcomes could be predicted,* because the generalizability is higher than using a single case. An important prerequisite for generalizable future outcomes is a large-scale sample of population. However, this

was not available in this thesis and caused a research limitation, as will be discussed in section 6.4 ('sample issues').

Importantly, multiple case studies can help guard against observer bias. Because the research performed in this thesis required interpretation of data, observer bias could be a potential problem. As will be discussed in the next chapter, a project member was asked to validate the observations to guard against observer bias. A disadvantage of using multiple cases is that they may reduce the depth of study when resources are limited, which is the case in this time-bound thesis project. However the augmented external validity outweighs this disadvantage.

3.5. Process Improvement Intelligence

To measure the alignment of project goals and process improvements, a common platform was created to compare the two. The common platform used in this thesis is the devil's quadrangle, as described in section 2.2, because it requires a trade-off (i.e. it is impossible to improve on all four dimensions at once). Therefore, it is more suitable to decision-making processes such as business process improvement projects. By translating the project goals into the performance dimensions time, costs, quality and flexibility, this thesis created a platform for comparing project goals and process improvements. Thereby, this thesis addressed to following question, as mentioned by Neely, Gregory and Platts (2005):

> *"Do "generic" performance indicators actually exist?" (Neely et al., 2005, p. 1255)*

Neely et al. (2005) use the term 'generic performance indicators' to describe performance dimensions.

In this thesis, the following conceptual model to measure Process Improvement Intelligence is proposed:

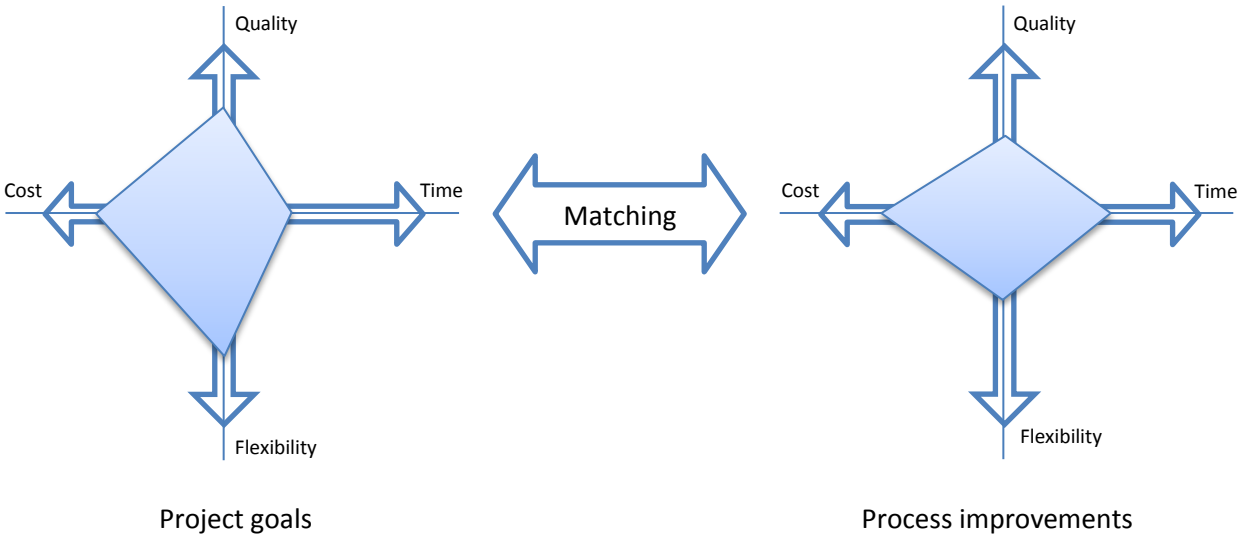

Figure 3.5 Measuring the alignment of project goals and process improvements

Both the project goals and the process improvements were evaluated using the devil's quadrangle. Their performance dimensions were matched. There are two possible outcomes:

1) Their scores matched (statistically). This will be labelled 'alignment'.
2) Their scores did not match (statistically). This will be labelled 'misalignment'.

3.6. Research methodology

To test this theory, the following case research approach was followed:

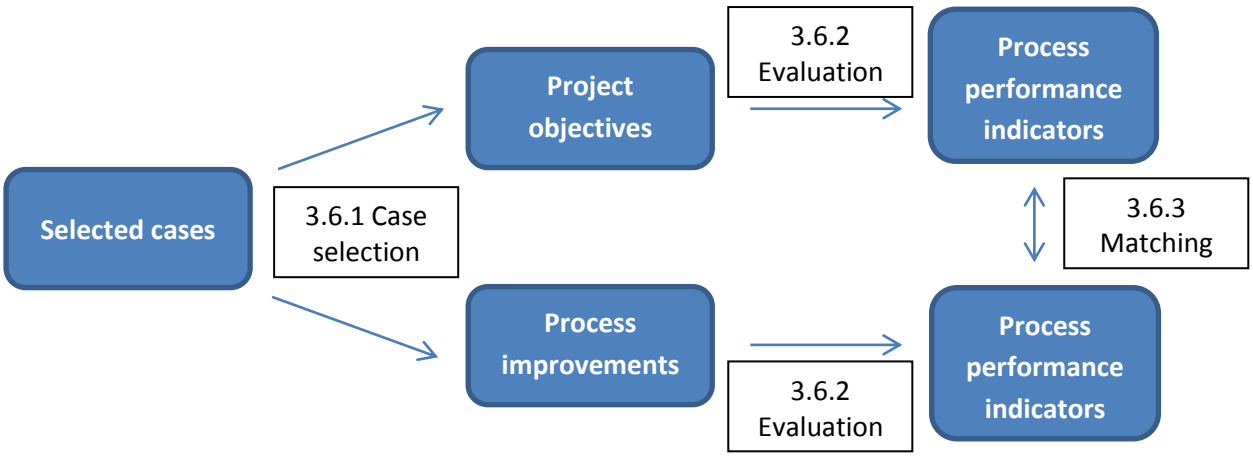

Figure 3.6 Followed case research approach

In the next sections, these steps of the case research approach are discussed extensively.

3.6.1. Case selection

The cases were selected at Berenschot, which was introduced in section 1.2. As Berenschot performs numerous projects every year, a structured manner to select which projects were suitable cases was evidently of importance. A set of criteria (C1 – C6), which was used to facilitate this selection process, is elaborated upon below.

First, the case should involve the improvement of a *business process* (C1). Recalling from section 2.1, a definition of a process is given by Hammer and Champy (1993):

> *"A business process is a collection of activities that takes one or more kinds of input and creates an output that is of value to the customer. A business process has a goal and is affected by events occurring in the external world or in other processes"*

In the municipality context of Berenschot, an example of a good business process is 'providing subsidiaries'.

Second, the project had to involve the *improvement* of a business process (C2). This is opposed to projects which are undertaken purely for documentation purposes. Because the research involved the evaluation of these process improvements, it was required that they were explicitly stated in the project documentation (this also decreased interpretation bias).

Third, the project should have one or more goals known beforehand (C3). These objectives should describe a desired future situation. They could also be documented as targets (SMART format). Again, because the research involved the evaluation of the project goals, it was required that they were explicitly stated in the project documentation.

There were a few practical criteria as well. First, at least one of the participants of the project had to be still working for Berenschot or at least contactable (C4). This was absolutely vital because the extracted data had to be verified with one of the project members. In case of disagreement or the necessity of explanation, the project should be fresh in their memory; the second criterion was that the project had been finished in the past five years (C5). Due to limited amount of scoring time of the objectives from the municipality participants, the target amount of extracted project goals was limited to 80 (the set-up of this scoring experiment is explained in section 4.2) (C6). The corresponding amount of process improvements would be scored by the process experts.

To summarize, in order to be included, a project needed to comply with all criteria (C1 – C6) below:

1. The project should involve the improvement of a *business process*
2. The project should involve the *improvement* of a business process
3. The project should have one or more objectives known beforehand
4. At least one of the participants of the project was still working for Berenschot or at least be contactable
5. The project should be finished in the past five years
6. The target amount of extracted organizational target was limited to 80

The criteria were applied to a list of projects of Berenschot Information Management group. The list consisted of 67 projects and is added as appendix B. For C1-C3, a scoring system was used (i.e. present, to some extent, not present); for C4-C6, a knockout system was used (i.e. complies, does not comply). In total, seven projects were selected, which are discussed in section 4.1. Using the project documentation of these selected processes, projects goals and process improvements were extracted. Because it was required (C2-C3) that these were stated explicitly in the project documentation, this involved little interpretation.

3.6.2. Evaluation of project goals and process improvements

The extracted project goals and process improvement are evaluated by two different groups of people. On the one hand, the project goals were scored by municipality employees. These represent the clients of Berenschot in a business process improvement project. On the other hand, the process improvements were scored by process experts of Berenschot. Both groups will score their items on the four performance dimensions of the devil's quadrangle (time, costs, quality and flexibility).

3.6.3. Matching pairs of goals and process improvements

After the goals and process improvements have been evaluated using the devil's quadrangle, they are matched and pairs are created (see Figure 3.5). To create these pairs, Han et al.'s K-P model was used (Han et al., 2010), which represents the relationship between KPIs and business processes. This K-P model was adapted to goals (cf. KPIs) and process improvements (cf. business processes). The K-

P models were added as appendix I (the data in these models is coded, which is explained in section 4.4). In order to reduce observer bias and increase replicability, one project member from Berenschot was asked to verify these pairs.

As an example, take $H1$ in the K-P model of P1-4. This pair matched the project goal 'all communicating channels should be accessible for customers' (hp_1do_1) with the process improvement 'use electronic forms for subsidy requests' (ep_2i_{13}). The Process Improvement Intelligence drawing becomes as follows (data is taken from the actual data sample):

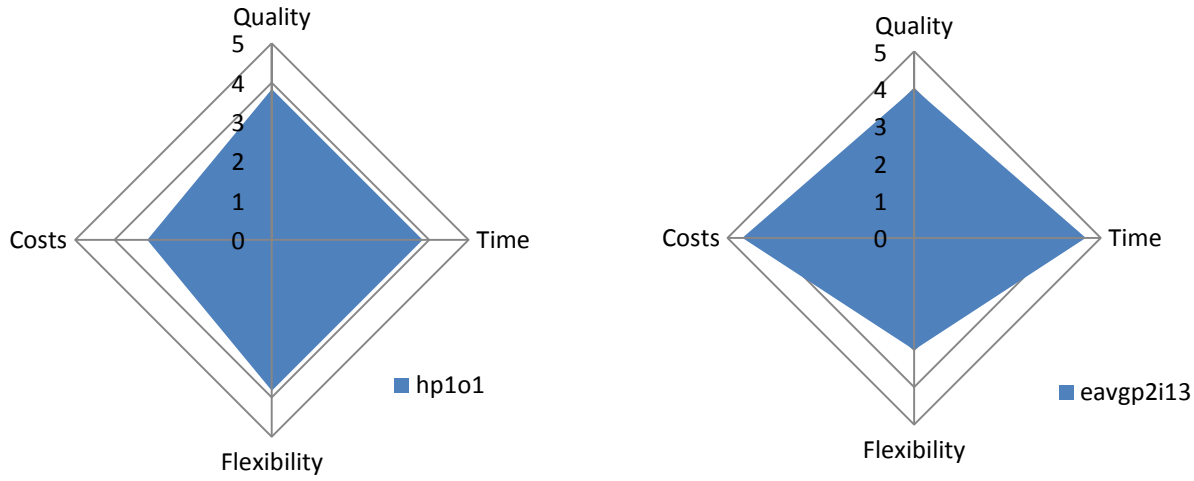

Figure 3.7 Pair (H17) of matching project goal and process improvement

Recalling the sub research question presented in section 3.3, the alignment of the pairs needed to be measured. Therefore, statistical tests were performed on these pairs to conclude whether they were aligned or misaligned. Specifically, the pair was tested for correlation, which is a measure of the linear relationship between variables (Field, 2005). It was hypothesized that project goals and process improvements correlated positively, which meant that if the project goals would be evaluated higher, the corresponding process improvement would be evaluated higher as well. This indicates alignment between the process goal and process improvement. In case of misalignment, the process improvement was evaluated using the best practices, as described in section 3.1.1. *If the misalignment could be explained by one of the best practices (e.g. misinterpretation of effect of a process improvement), the proposed method would still be valid.*

In the example above, the project goals and process improvement are negatively correlated i.e. the 'use of electronic forms for subsidy requests' has a negative influence on 'all communicating channels should be accessible for customers'. This can be explained by the loss of flexibility and the expected decrease in costs when using electronic forms. Neither is expected from the project goal.

The implementation of the research methodology described in this section will provide an answer to the sub research question.

4. Experimental design

To analyse the data following the research methodology as discussed in the previous chapter, this chapter presents the experimental design. Corresponding to the steps in the case research approach (see Figure 3.6), the following steps are part of the experimental design:

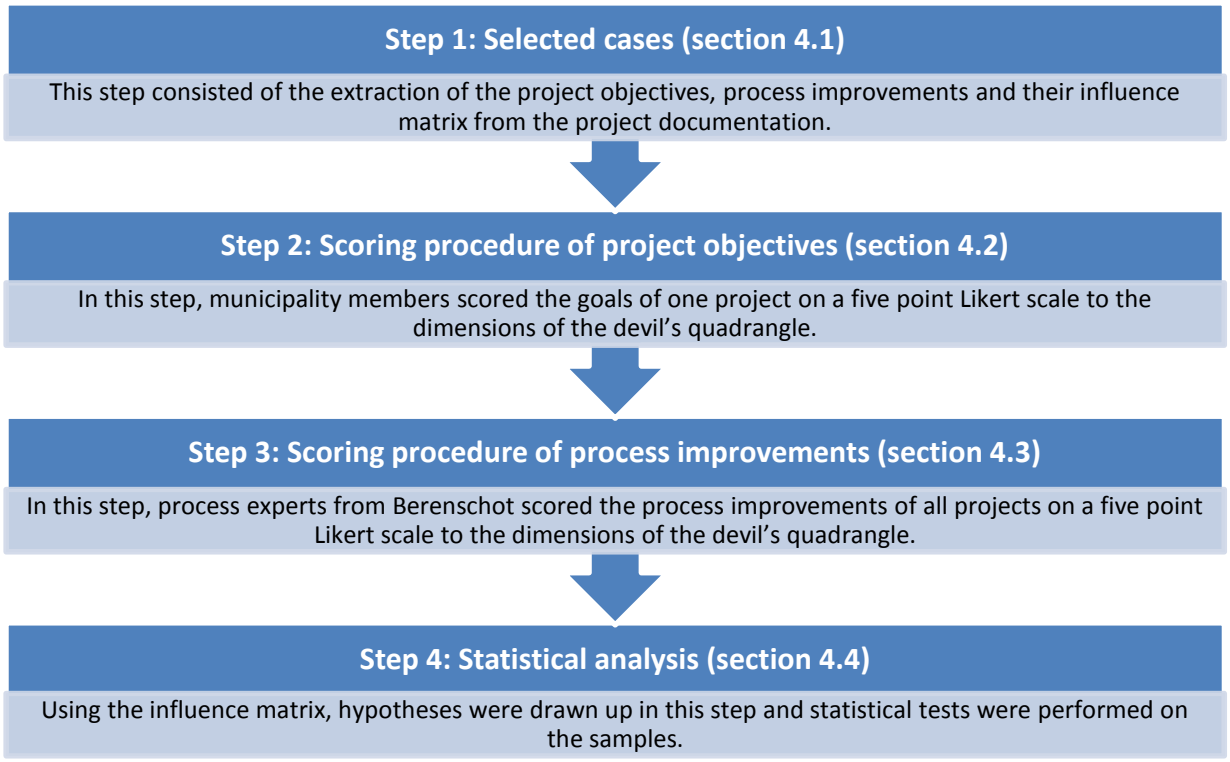

Figure 4.1 Experimental design outlined in steps

Next, each step is discussed in detail.

4.1. Selected cases

The case selection (section 3.6.1) resulted in the selection of the following seven case studies:

Code	Project name (translated)	C1	C2	C3	C4	C5	C6
P1	Workshop providing subsidies municipality Landsingerland	+	+	+	✓	✓	✓
P2	Workshop providing subsidies municipality Ouder-Amstel	+	0	+	✓	✓	✓
P3	Workshop providing subsidies municipality Eersel	+	0	+	✓	✓	✓
P4	Workshop providing subsidies municipality Aalsmeer	+	0	+	✓	✓	✓
P5	Information Plan Bureau Verkeersbeheer province Noord-Brabant	+	+	0	✓	✓	✓
P6	Granting and maintaining permits province Overijssel	+	+	+	✓	✓	✓
P7	Emergency assistance SOS International	+	+	+	✓	✗	✓

Table 4.1 Overview of the selected projects

4.1.1. P1-P2-P3-P4

P1, P2, P3 and P4 are four identical workshops (in their set-up) at different municipalities (Landsingerland, Ouder-Amstel, Eersel and Aalsmeer). The workshop involved the modelling of the current process 'providing subsidies' as well as some suggestions for improvement (which were not worked out in a to-be model). Because these workshops were held with municipality employees, the projects goals were stated explicitly in the project documentation. Furthermore, the workshops were conducted in 2010-2011 and all project members were still working at Berenschot. Because the project goals and process improvements showed great overlap, these were combined for the four workshops, thereby creating project goals and process improvement of one project, P1-4. This was justified by their relatively small size in comparison to the other projects included and their similarity in project set-up (they were identical).

4.1.2. P5

P5 involved the development of an information plan for the division of a province (Noord-Brabant) that is responsible for traffic management. This involved the modelling of the current and desired business process, based on project goals en recent trends. It also evaluated the IT facilities of the division and created a roadmap for the future. Though the current process and process improvements were present in the project documentation, the project objectives were not stated explicitly. However, because the project was conducted in 2008 and a project member was still working at Berenschot, it could be included in the sample nonetheless.

4.1.3. P6

P6 involved the optimisation of the 'granting and maintaining permits' process at a province (Overijssel). This process was documented extensively and both the project goals as the process improvements were stated very clearly in the project documentation (interviewing records were included in the project documentation). The project finished in 2006, but due to the excellent project documentation and the availability of one project member, this project was included in the sample.

4.1.4. P7

P7 redesigned the emergency assistance process of SOS International. Similar to P6, the project was well documented. Therefore, it was included to fulfil C6 (80 organizational targets as will be explained in section 4.2), although the project was finished more than five years ago. However, after the scoring procedure, it was removed from analysis after all, because participants failed to score the project because of a lack of background knowledge (we will return to this in scoring procedure section).

The extracted project goals and process improvements were combined into questionnaires, so they could be scored by the municipality employees and the process experts. These two procedures are described in the next sections.

4.2. Scoring procedure of project objectives

The project objectives were scored by municipality employees. They had to score the selected project objectives on a five point Likert scale to the dimensions of the devil's quadrangle. The scores resemble the effect of a project objective to the performance dimensions time, cost, quality and flexibility, according to the participant (see Table 4.2 below).

Score	Effect	Likert scale
++	Strong positive effect	5
+	Positive effect	4
0	No effect	3
–	Negative effect	2
– –	Strong negative effect	1

Table 4.2 Likert scale for scoring the organizational targets and process improvements

In total, 20 municipality employees (head of department of civilians or IT) joined the experiment, which formed a compulsory part of a seminar program. To reduce the time asked of each participant, the target amount of project goals per participant was 20, and it was required that every project goals was scored at least five times. So, the total amount of process goals was limited to 80. The total number of extracted process goals was 76, which meant that at most four questionnaires could be created. As discussed in the previous section, the project goals of P1 to P4 were combined into one questionnaire, while P5, P6 and P7 filled one questionnaire each. The order of the project goals is similar to their order in the project documentation. All four questionnaires are added as appendices.

The procedure was pre-tested by 4 municipality employees before conducting the actual test. Based on the feedback received, two elements were added:

- A more elaborate explanation on the four performance dimensions
- An obligation to give exactly one score (i.e. not multiple scores or no score)

By shuffling the questionnaires before handing them out to the participants, the four questionnaires were distributed randomly; however, three participants indicated a lack of background knowledge to score P7. Therefore, they were given one of the other questionnaires such that in total, six people scored P1-4, P5 and P6, while only two people scored P7. After a similar situation occurred in the scoring procedure of the process improvements, it was decided to remove P7 from further analysis, because it fell outside the scope of the public sector.

4.3. Scoring procedure of process improvements

The extracted process improvements were scored by process experts from Berenschot, using a Delphi study setup. Following the method of Sánchez, Chaminade, and Escobar (1999), the following figure contains the steps in this study:

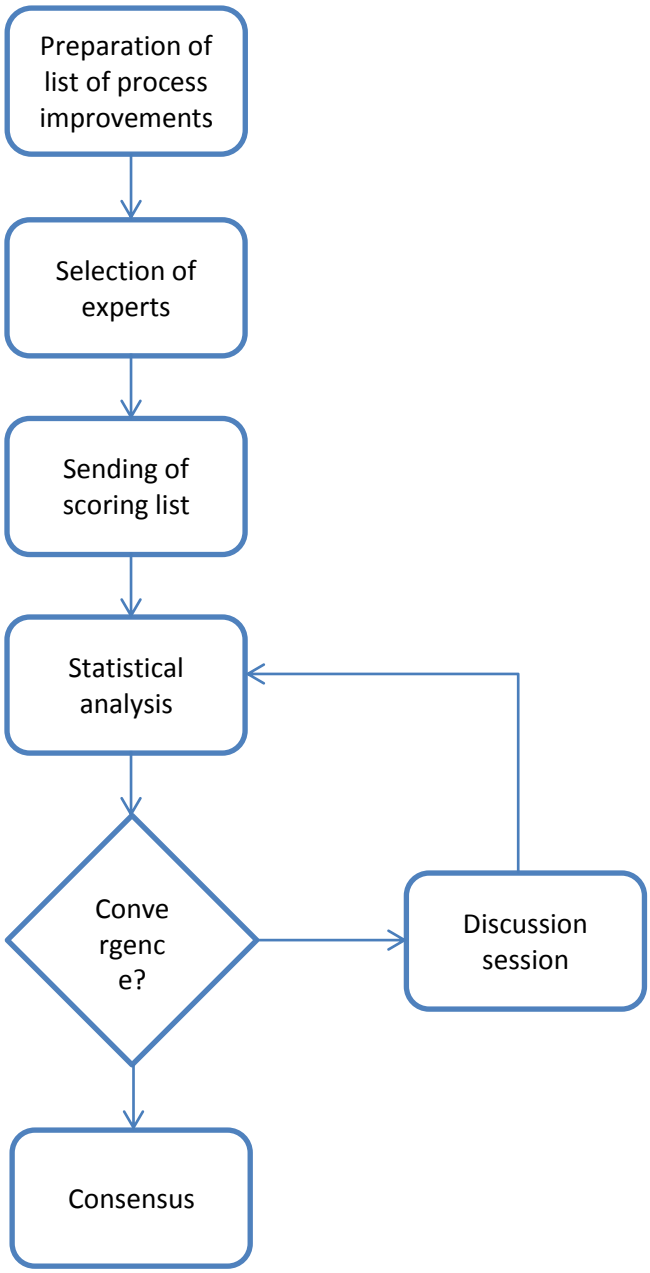

Figure 4.2 Phases in the Delphi analysis of the process improvements (adopted from Sánchez et. al, 1999)

All process improvements, which were extracted from the selected case documentation, were combined into one questionnaire (it was still clear which improvements belonged to which project), which is added as appendix G.

The following six process experts from Berenschot were prepared to score these process improvements:

- Two (managing) consultants in the Information Management expertise (R. Bakker and G. Post-Dijkstra)
- Four (managing) consultants in the Business Operational Excellence expertise (C. van der Heyden, M. Hanekamp, W. Dil and N. te Blaay)

Combined with the scoring criteria (see Table 4.2), this questionnaire, which consisted of 76 process improvements, was sent to these six people. As was the case in the scoring by the municipality employees, the process experts' feedback contained complaints about a lack of expertise in that field. As mentioned above, it was therefore decided to remove P7 from further analysis.

The answers of the process experts were combined and analysed for convergence. Interquartile ranges (IQR) provide a good measure of dispersion for achieving consensus using Likert-type scales for Delphi studies (Triola, 2001). Interquartile range was calculated by taking the difference between the 25^{th} and 75^{th} percentiles. An example scoring of one process improvement was: 3, 4, 4, 4, 5 and 5. The 25^{th} percentile (1^{st} quartile) is 4 and the 75^{th} percentile (3^{rd} quartile) is 4.75. Therefore, the interquartile range was 0.75. Consensus was assumed when interquartile range score of less than 1.2 was achieved (Triola, 2001). The results (added as appendix H) showed that 20 scores did not converge, which is approximately 10% of all scores. This result was considered reasonable. However, in case of a small sample size (n=6 in this case), IQR can inflate heavily because of outliers. Therefore, based on the 80/20 rule, the criterion that consensus is achieved by having 80 per cent of participants' scores fall within two score-range on the five point Likert scale was applied (Ulschak, 1983). In the example scoring above, 100% of the scores fell within the two score-range. The results (added as appendix H) showed that 13 scores, which is approximately 5% of all scores did not converge. These percentages indicated that there was no reason to doubt the convergence between the process experts. Thus, after the first scoring round, the workshop organized to discuss the main difference between the scores (and give the experts opportunity to score the process improvements again), was cancelled and all scores were statistically analysed.

The sample size in most Delphi studies has been study specific. If experts are selected who have similar training and general understanding of the problem of interest, a relatively small sample can be used (Akins, Tolson, & Cole, 2005). Although the process experts had different years of expertise in this field, they had similar on-the-job training and a common understanding of the problem because they had all been working for Berenschot for a number of years. The consensus scores in appendix H demonstrate their shared line of reasoning.

Both the scores for the project goals and the scores for the process improvement were saved in a dataset. To conduct statistical tests on this dataset, the scores had to be coded into variables.

4.4. Variables

Described in section 3.6.3, statistical tests were performed on the pairs of matched project goals and process improvements to assess their alignment. Therefore, the individual scores needed to be aggregated to create one (average) score per dimension. This average score needed to be coded so its name would reflect:

- Who scored the item?
- Which project did it belong to?
- Which item of that project was it?
- Which dimension of the item scored it?

Therefore, the data was coded as follows:

h_1	p_1	d_1	t
Who scored the item?	Which project?	Which item?	Which dimension?
h_{1-6}: heads of municipality e_{1-6}: process experts from Berenschot	p_{1-6}: selected cases (see Table 4.2 for details)	o_{1-n}: objectives i_{1-n}: process improvements (n depends on project)	t: time c: costs q: quality f: flexibility

Table 4.3 Coding scheme of the data elements

For example, the data element $h_1p_1d_1t$ represents the score of head 1 on the time dimension of the first objective of project 1. As mentioned above, the individual scores on each dimension were aggregated to create one score per dimension. Thus, hp_1d_1 consists of four (average) scores: hp_1d_1t, hp_1d_1c, hp_1d_1q and hp_1d_1f. These average scores were used to test for correlation between the scores of the project goals and the scores of the process improvements.

4.5. Statistical tests

Statistical tests were performed on the data to measure the alignment of the three projects (P1-4, P5 and P6). Specifically, all pairs (appendix I) were tested for correlation. It was hypothesized that project goals and process improvements correlated positively, which meant that if the project goals would be evaluated higher, the corresponding process improvement would be evaluated higher as well.

Because both the objectives and the process improvements consisted of four dimensions, sample sizes are very small. Therefore, there is no alternative than to use nonparametric statistical tests. Nonparametric tests typically make fewer assumptions about the data (Siegel & N. John Castellan, 1988). Using a very small sample size, no assumptions can be made about the distribution of the sample (unless the population distribution is known exactly). Nonparametric tests typically involve the *ranking* of data i.e. the data is sorted from low to high. Therefore, it only requires that the variables are at least measured at the ordinal level. Because the scores are measured on a five point Likert scale, this research fulfils that requirement.

Because the data set was very small and contains a large number of tied ranks, Kendall's tau, τ, was used rather than Spearman's coefficient (Field, 2005). This statistic was computed for each dimension of each objective (X) - improvement (Y) relation.

$$\tau = \frac{2S}{\sqrt{N\ N-1\ -T_x}\ \sqrt{N\ N-1\ -T_y}} \tag{3.1}$$

where $T_x = \Sigma t\ \ t-1\ $, t being the number of tied observations in each group of ties on the X variable

$T_y = \Sigma t\ \ t-1\ $, t being the number of tied observations in each group of ties on the Y variable

In each pair of project goal and process improvement, variable X was the score on the project goal item (consisting of four average dimension scores) and variable Y was the score on the process improvement item (consisting of four average dimension scores). Positive correlations were expected. So, for the example above in P1-4,

$$H17_0 : \tau = 0$$

$$H17_1 : \tau > 0$$

As mentioned before, the sample size is four which decreased the power to reject H_0; therefore, α was set to 0.1.

A number of other statistical tests were performed on the data, but provided impractical results. They will be discussed in the sample issues section at the end of chapter 6.

The next chapter presents the results of the statistical tests.

5. Results

This chapter presents the results obtained using the statistical tests as described in the previous chapter. All tests were performed using IBM SPSS Statistics 19[3]; the results are presented in an adapted format in appendix J. To present the results in a more readable format, alignment lists were created, using the following scores:

Kendall's tau	Alignment score
Positively correlated and significant	+1 (alignment)
Negatively correlated and significant	-1 (misalignment)
Not significant (positive or negative correlated)	0 (non-conclusive)

Table 5.1 Scoring of results of the statistical tests

These scores were added for each objective and each improvement. For each project, alignment lists were created for the highest and lowest scores on Kendall's tau (representing the most and least aligned). It was expected that the objectives correlated positively with the improvements (which resembles alignment). However, as is showed in this chapter, there are some negatively correlated scores and numerous not significant correlations. For example, hp_1o_{12} has two positive significant correlations, three negative significant correlations and three non-significant correlations (see appendix J). Scoring it using Table 5.1, hp_1o_{12} acquires +2 on alignment and -3 on misalignment for Kendall's tau. These remarkable outcomes will be discussed in the next chapter. Next, the results are presented per project.

5.1. P1–4

Referring to the results added in appendix J, four objectives showed mixed results (hp_1o_5, hp_1o_{10}, hp_1o_{11} and hp_1o_{12}), while nine objectives (hp_1o_1, hp_1o_2, hp_1o_8, hp_1o_{13}, hp_2o_{14}, hp_3o_{17}, hp_4o_{19}, hp_4o_{20} and hp_4o_{21}) had no (significant) correlation with any improvement. On the other hand, ep_1i_{11} had only negative correlations (of which three were significant), while ep_1i_6, ep_1i_9, ep_1i_{12}, ep_2i_{16} and ep_4i_{24} showed mixed results. Of those, ep_1i_6, ep_1i_9, ep_1i_{12} and ep_2i_{16} showed both significant positive and negative correlations. There were six improvements (ep_1i_1, ep_1i_5, ep_2i_{13}, ep_2i_{14}, ep_2i_{17} and ep_3i_{19}) with no significant correlation at all.

Table 5.2 summarizes the significant results for P1–4. The two columns labelled 'least aligned' contain the unexpected outcomes (negatively significant correlations). Specifically, the objectives (hp_1o_5, hp_1o_{10}, hp_1o_{11} and hp_1o_{12}) and improvements (ep_1i_6, ep_1i_9, ep_1i_{12} and ep_2i_{16}) appearing in both 'most aligned' and 'least aligned' lists are remarkable and will be discussed in the next chapter.

[3] http://www-01.ibm.com/software/uk/analytics/spss/

Alignment scores for P1–4					
Kendall's tau most aligned		**Kendall's tau most aligned**		**Kendall's tau least aligned**	
Objective	**Align**	**Improvement**	**Score**	**Objective**	**Score**
hp1o12	+3	ep1i4	+2	hp1o12	-3
hp1o11	+3	ep3i18	+2	hp1o5	-2
hp3o16	+2	ep1i9	+1	hp1o10	-2
hp3o18	+2	ep1i6	+1	hp1o11	-2
hp1o5	+1	ep1i12	+1	**Improvement**	**Score**
hp1o10	+1	ep2i16	+1	ep1i9	-3
hp1o3	+1	ep1i2	+1	ep1i11	-3
hp1o4	+1	ep1i3	+1	ep1i6	-1
hp1o6	+1	ep1i7	+1	ep1i12	-1
hp1o7	+1	ep1i8	+1	ep2i16	-1
hp1o9	+1	ep1i10	+1		
hp3o15	+1	ep2i15	+1		
hp4o22	+1	ep3i20	+1		
		ep3i21	+1		
		ep4i22	+1		
		ep4i23	+1		
		ep4i24	+1		

Table 5.2 Alignment scores for P1-4

5.2. P5

The correlation matrix of p_5 showed similar results. ep_5i_1, ep_5i_3 and ep_5i_9 have no significant correlation. Remarkably, three improvements (ep_5i_2, ep_5i_5 and ep_5i_6) showed significant negative correlations, as did two objectives (hp_5o_5 and hp_5o_{11}). Eight objectives showed no (significant) result (hp_5o_1, hp_5o_4, hp_5o_6, hp_5o_8, hp_5o_9, hp_5o_{10}, hp_5o_{12} and hp_5o_{13}), while one objective (hp_5o_3) showed both a significant positive and a negative correlation. The alignment scores are displayed in Table 5.3 below.

Alignment scores for P5			
Kendall's tau most aligned		**Kendall's tau least aligned**	
Objective	**Align**	**Objective**	**Score**
hp5o7	+2	hp5o5	-2
hp5o2	+1	hp5o3	-1
hp5o3	+1	hp5o11	-1
Improvement	**Score**	**Improvement**	**Score**
ep5i4	+1	ep5i2	-2
ep5i7	+1	ep5i5	-1
ep5i8	+1	ep5i6	-1
ep5i10	+1		

Table 5.3 Alignment scores for P5

5.3. P6

The correlation matrix of p_6 showed a large number of improvements with no significant correlation (fourteen). This indicated a lack of statistical power, as is discussed in the next chapter. Only one improvement (ep_6i_{18}) showed a both significant positive and negative correlation, while ep_6i_5 showed a significant negative correlation. Ten objectives had no significant correlation; two (hp_6o_{11} and hp_6o_{21}) had a negative correlation. Table 5.4 shows the alignments scores for P6.

Alignment scores for P6					
Kenoall's tau most aligned		**Kenoall's tau most aligned**		**Kenoall's tau least aligned**	
Objective	**Align**	**Improvement**	**Score**	**Objective**	**Score**
hp6o19	+4	ep6i9	+4	hp6o11	-1
hp6o14	+2	ep6i22	+4	hp6o21	-1
hp6o16	+2	ep6i17	+2	**Improvement**	**Score**
hp6o17	+2	ep6i18	+2	ep6i18	-1
hp6o7	+1	ep6i19	+2	ep6i5	-1
hp6o9	+1	ep6i11	+1		
hp6o10	+1	ep6i15	+1		
hp6o13	+1				
hp6o18	+1				
hp6o22	+1				

Table 5.4 Alignment scores for P6

In short, the correlation matrices showed remarkable results for all three projects. Specifically, four objectives and four improvements of P1-4 showed both significant positive and negative results for Kendall's tau. In P5 and P6, this occurs only once. Excluding these mixed results, alignment scores were good, indicating a good overall alignment of the projects. The large number of not significant correlations indicates a lack of statistical power. Therefore, the next chapter will discuss the sample issues as well as these results.

6. Discussion

Expecting only positively correlations, the previous chapter presented several remarkable outcomes of the statistical tests. First, both most and least aligned process improvements are categorized into process improvement heuristics, which were presented in section 3.1.1. Next, the misalignments identified in the previous chapter are discussed into detail for each project. The alignment scores are then aggregated and the process improvement heuristics are discussed. At the end of this chapter, the sample issues will be discussed.

6.1. Categorization of the process improvements

Recalling from section 3.1.1, process improvement heuristics prescribe how a process can be improved. These prescriptions are general, so they can be replicated in any situation or setting. The heuristics are applied to the current process to improve its performance. The 'best practices', as presented in Reijers and Liman Mansar (2005), provide a set of process improvement heuristics which have proved to be useful in improving business processes. Using these best practices (see appendix A), the process improvements as shown in tables 5.2, 5.3 and 5.4 are categorized. The categorization is shown in tables 6.1–6.4 below.

Improvement	Best practice	Score
ep1i4	Interfacing	+2
ep3i18	Buffering	+2
ep1i9	Order types	+1
ep1i6	Control addition	+1
ep1i12	Empower	+1
ep2i16	Empower	+1
ep1i2	Order-based work	+1
ep1i3	Interfacing	+1
ep1i7	Order types	+1
ep1i8	Interfacing	+1
ep1i10	Task elimination	+1
ep2i15	Control addition	+1
ep3i20	Knock-out	+1
ep3i21	Control addition	+1
ep4i22	Order types	+1
ep4i23	Case manager	+1
ep4i24	Control addition	+1
ep1i9	Order types	-3
ep1i11	Order types	-3
ep1i6	Control addition	-1
ep1i12	Empower	-1
ep2i16	Empower	-1

Table 6.2 Categorization of alignment table P1-4

Improvement	Best practice	Score
ep5i4	Centralization	+1
ep5i7	Centralization	+1
ep5i8	Integration	+1
ep5i10	Parallelism	+1
ep5i2	Integral Business Process Technology	-2
ep5i5	Order types	-1
ep5i6	Task automation	-1

Table 6.1 Categorization of alignment table P5

Improvement	Best practice	Score
ep6i9	Task automation	+4
ep6i22	Centralization	+4
ep6i17	Interfacing	+2
ep6i18	Case manager	+2
ep6i19	Integral Business Process Technology	+2
ep6i11	Integral Business Process Technology	+1
ep6i15	Integral Business Process Technology	+1
ep6i18	Case manager	-1
ep6i5	Task composition	-1

Table 6.3 Categorization of alignment table P6

6.2. Evaluation of the projects

Identified in the previous chapter, this section evaluates the misalignments into greater detail. They are discussed by project.

6.2.1. P1-4

Recalling the results for P1-4 in the previous chapter, one process improvement (ep_1i_{11}) had only negative correlations (of which three were significant). Recalling the actual process improvement, this would be classified as an 'Order types' heuristic (see Table 6.2), because the process is split for different types of applications. According to Reijers and Liman Mansar (2005), the expected improvements are primarily on time and costs, with a possible negative effect on quality and flexibility. This corresponded exactly to the evaluation of the project goal (hp_1o_5). Remarkably, the process experts expected an improvement on quality, but a negative evaluation on time and costs. Therefore, ep_1i_{11} and hp_1o_5 are totally misaligned, which is displayed in Figure 6.1 below (the dashed line represents *no* effect i.e. Likert score 3).

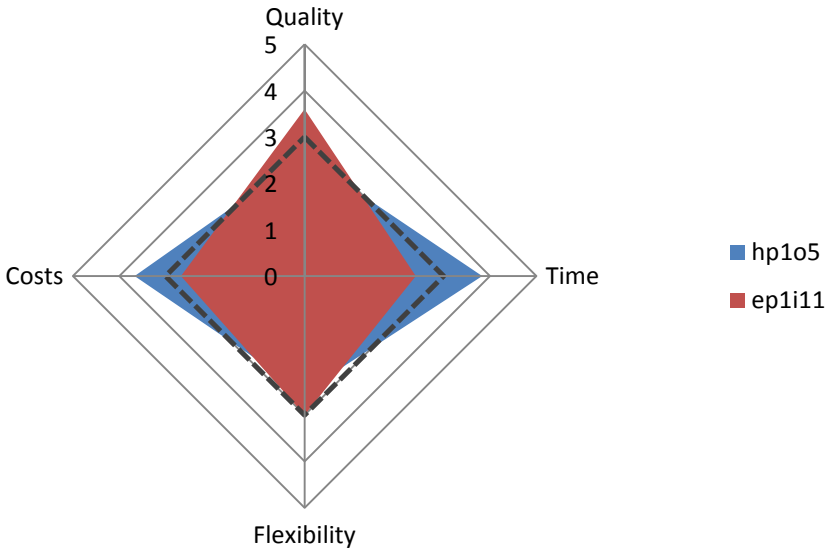

Figure 6.1 Misalignment between hp1o5 and ep1i11

ep_1i_9 faced a similar misalignment as described above. This process improvement enhances the quality, has a negative evaluation on time and costs and can be characterized too as an 'Order types' heuristic, because it splits up the process for certain requests. Its corresponding objectives expected a major improvement on the time dimension (hence the negative correlations with hp_1o_5, hp_1o_{10} and hp_1o_{12}), except for hp_1o_{11} (which explains the positive significant correlation).

Since ep_1i_6 involves the addition of a step to the process, it can be classified as a 'Control addition' heuristic. Therefore, the evaluations of the process experts were as expected, namely an improvement on quality and a minor decrease on time. Corresponding to ep_1i_9, it misaligned with hp_1o_5, hp_1o_{10} and hp_1o_{12} (these goals expected an improvement on time), but aligned well with hp_1o_{11}.

Exactly the opposite situation explains the mixed results of ep_1i_{12} and ep_2i_{16}. Both process improvements apply the same heuristic ('Empower', see Table 5.2), which main effect is a time improvement. Indeed, the process experts evaluated it very positively on time (as well as on costs and flexibility), hence the positive significant correlation with hp_1o_{12}. However, hp_1o_{11} is aimed towards quality improvement, which cannot be expected on the basis of the Empower heuristic; the misalignment is detected well by the framework.

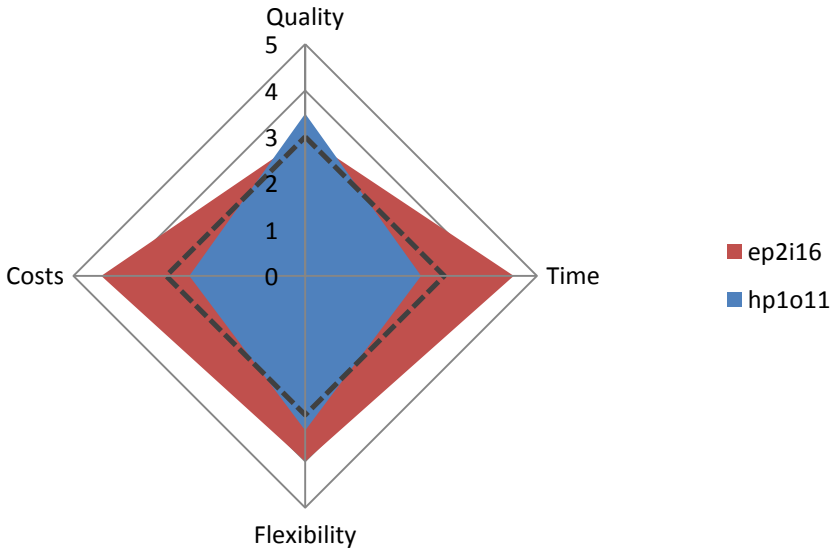

Figure 6.2 Misalignment between hp1o11 and ep2i16

In short, the results of Kendall's tau for P1-4 showed nine misaligned process improvements in total for hp_1o_5, hp_1o_{10}, hp_1o_{11} and hp_1o_{12}. Six misalignments are detected well by the framework. Three misalignments can be explained by misinterpretation of the best practice 'Order types'. This misinterpretation taken into account, the high amount of positive (significant) correlations shows that this project in general is well-aligned (see Table 5.2 for the alignment scores).

6.2.2. P5

The framework detected some misalignments in P5 as well. ep_5i_2 improves both time and costs but not quality, while hp_5o_3 and hp_5o_{11} expect only an improvement on quality (which explains the significant negative correlations). An increase in quality cannot be expected based on its categorization as 'Integral Business Process Technology' heuristic ('installing an electronic desk'). This shows a clear misalignment between those goals and the process improvement.

Other misalignments are detected between hp_5o_5 and the improvements ep_5i_5 and ep_5i_6, which can be categorized as 'Order types' and 'Task automation' respectively. Neither of these process improvements improves the flexibility of the process, but the project goal hp_5o_5 is aimed towards an improvement of the flexibility. The framework detects these misalignments well.

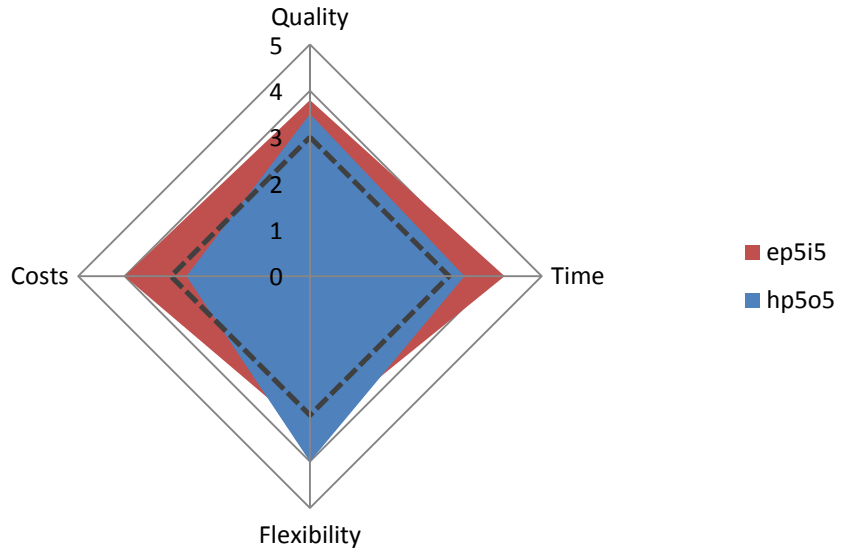

Figure 6.3 Misalignment between hp5o5 and ep5i5

In short, the framework showed four misaligned project goals and process improvements for P5. All four misalignments are justifiable by their categorization according to the best practices. Due to the high number of non-significant correlations, this project suffered from a lack of statistical power (see section 6.4).

6.2.3. P6

P6 only has two misalignments. ep_6i_5 improves all four dimensions, while hp_6o_{11} expects a quality improvement. Improving all four dimensions is contrary to the properties of the devil's quadrangle (Brand & van der Kolk, 1995) and because ep_6i_5 can be classified as Task composition, quality improvement cannot be expected. It is however incorrect that the framework labels this pair as misaligned.

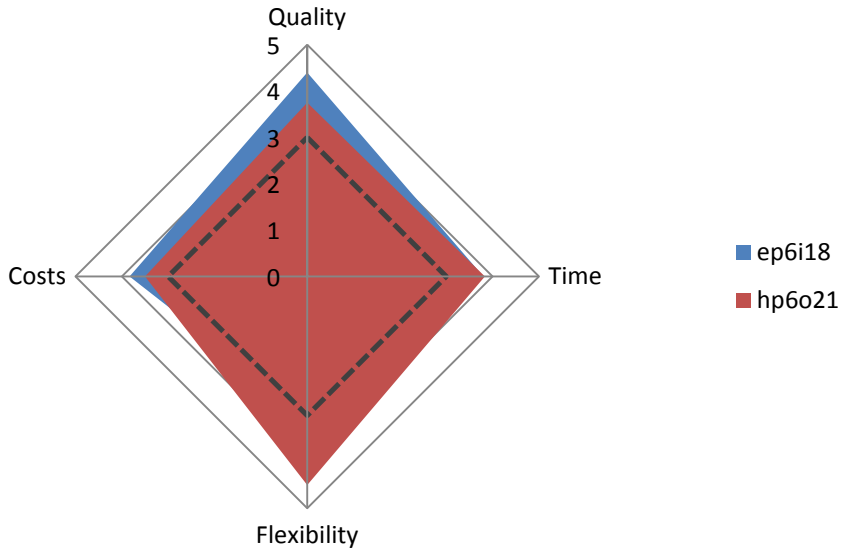

Figure 6.4 Wrongfully labelled misaligned between hp6o11 and ep6i5

ep_6i_{18} is a typical application of the Case manager heuristic, which primarily improves the quality. A major drawback is that flexibility must be compromised, which is exactly objective hp_6o_{21}. The process improvement does not correspond to the project and therefore, this is a clear misalignment in P6.

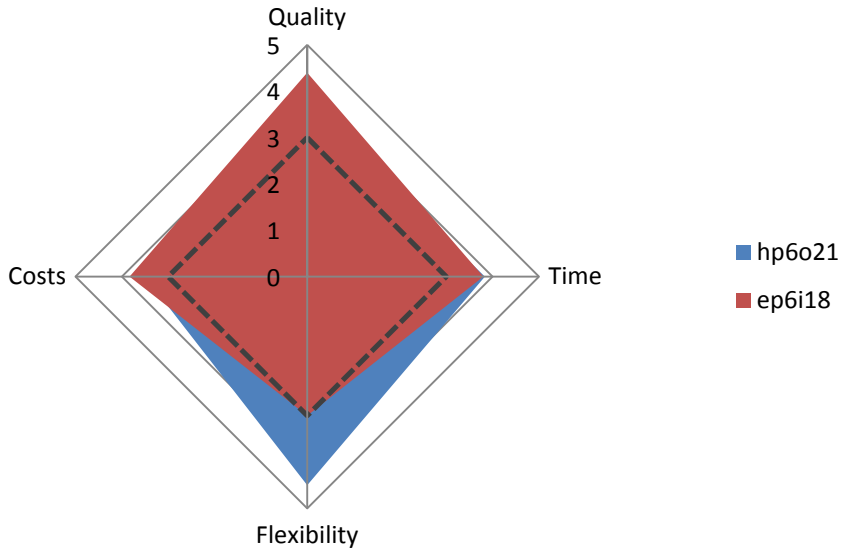

Figure 6.5 Misalignment between hp6o21 and ep6i18

In short, P1-4 showed a well-aligned project in general, with six misalignment rightfully detected by the framework. Three misalignments can be explained by misinterpretation of the best practice 'Order types' by the process experts.

P5 and P6 showed similar results. For P5, the framework indicated four misaligned project goals and process improvements, which are justifiable by their categorization according to the best practices. For P6, the framework picked up one clear misalignment. However, it wrongfully labelled a pair misaligned as well. The process improvement violated one of the properties of the devil's quadrangle (i.e. it is impossible to improve on all four dimensions), which could explain the failure of the framework.

The high number of not significant correlations in all projects can be explained by the very small sample. This sample and its issues are discussed in section 6.4. Next, the results are discussed on the level of process improvement heuristics.

6.3. Evaluation of the process improvement heuristics

To evaluate the process improvement heuristic, the alignments scores as presented in tables 6.1, 6.2 and 6.3 are aggregated for each best practice. Table 6.4 shows the total alignment scores as well as the frequencies for the best practices.

Best practice	Total alignment score	Frequency	Average alignment score
Centralization	6	3	2
Buffering	2	1	2
Interfacing	6	4	1.5
Task automation	3	2	1.5
Integration	1	1	1
Knock-out	1	1	1
Order-based work	1	1	1
Parallelism	1	1	1
Task elimination	1	1	1
Case manager	2	3	0.67
Control addition	3	5	0.6
Integral Business Process Technology	2	4	0.5
Empower	0	4	0
Order types	-4	6	-0.67
Task composition	-1	1	-1

Table 6.4 Total alignment scores and frequencies for the best practices

As can be seen in the table, the best practices 'Centralization', 'Buffering'. 'Interfacing' and 'Task automation' align very well. Their average alignment scores are higher than 1. There is one similarity between these best practices: they all expect an improvement on the time dimension (see Table 6.5).

Best Practice	Description	Time	Costs	Quality	Flexibility
Centralization	Treat geographically dispersed resources as if they are centralized	+	-	0	+
Buffering	Instead of requesting information from an external source, buffer it by subscribing to updates	+	-	0	0
Task automation	Consider automating tasks	+	0	+	-
Interfacing	Consider a standardized interface with customers and partners	+	+	+	0

Table 6.5 Overview of the best practices which align well

The best practices 'Integration', 'Knock-out', 'Order-based work', Parallelism' and 'Task elimination' have an average alignment score of exactly 1, which means that they aligned with exactly one

project goal. As can be seen in Table 6.6, all these best practices focus on an improvement on time and/or costs, while none of them improves the quality or flexibility of the process.

Best Practice	Description	Time	Costs	Quality	Flexibility
Integration	Consider the integration with a business process of the customer or the supplier	+	+	0	-
Task elimination	Eliminate unnecessary tasks from a business process	+	+	0	-
Order-based work	Consider removing batch-processing and periodic activities from a business process	+	-	0	0
Parallelism	Consider whether tasks may be executed in parallel	+	0/-	-	-
Knock-out	Order knock-outs in an increasing order of effort and in a decreasing order of termination probability	-	+	0	0

Table 6.6 Overview of the best practices which align with exactly one project goal

The best practices 'Case manager', 'Control addition', 'Integral Business Process Technology' and 'Empower' showed mixed results, as discussed in the previous section. Therefore, their average alignment score is between 0 and 1.

Best Practice	Description	Time	Costs	Quality	Flexibility
Case manager	Appoint one person as responsible for the handling of each type of order, the case manager	0	-	+	0
Empower	Give workers most of the decision-making authority and reduce middle management	+	+	-	0
Control addition	Check the completeness and correctness of incoming materials and check the output before it is send to customers	-	+	+	0
Integral Business Process Technology	Try to elevate physical constraints in a business process by applying new technology	+	+	+	0

Table 6.7 Overview of the best practices which show mixed alignment results

These process improvements have been discussed in detail in the previous section. Recalling, these process improvements showed both alignments and misalignments, which the framework rightfully distinguishes. This indicates confusion in the application of these best practices. The process experts evaluated these best practices correctly, but applied them to different goals, hence the mixed results. The only dimension they have in common in flexibility, which is not affected by these best practices.

The best practices 'Order types' and 'Task composition' show negative average alignment scores, indicating serious misalignments.

Best Practice	Description	Time	Costs	Quality	Flexibility
Order types	Determine whether tasks are related to the same type of order and, if necessary, distinguish new business processes	+	+	-	-
Task composition	Combine small tasks into composite tasks and divide large tasks into workable smaller tasks	+	+	+	-

Table 6.8 Overview of the best practices which do not align

Both best practices indicate serious issues. First, the best practice 'Order types' evaluation of the process experts does not match the description of the best practice of Reijers and Liman Mansar (2005). They expect a quality improvement (and a minor decrease on time and costs), while the best practice aims towards time and costs improvement, thereby possibly compromising quality.

Second, task composition was wrongfully labelled 'misaligned' by the framework. A possible explanation could be that it violated one of the assumptions of the devil's quadrangle i.e. it is impossible to improve on all four dimensions (Brand & van der Kolk, 1995).

6.4. Sample issues

Corresponding to the two scoring experiments described in sections 4.2 en 4.3, there are two samples: municipality employees (seminar participants) and process experts. Both samples resulted in a sample size of six for each dimension.

The sample size in most Delphi studies has been study specific. If experts are selected who have similar training and general understanding of the problem of interest, a relatively small sample can be used (Akins et al., 2005). Although the process experts had different years of expertise in this field, they had similar on-the-job training and a common understanding of the problem because they had all been working for Berenschot for a number of years. The consensus scores in appendix H demonstrate their shared line of reasoning.

Skulmoski, Hartman, and Krahn (2007) observe that a homogeneous group needs a smaller sample (10–15) but heterogeneous ones (such as in an international study) may require up to several hundred people. As argued above, the process experts are regarded as a homogeneous group, however it remains disputable if the group of seminar participants can also be regarded as a homogeneous group.

Thus, the small sample size did not cause problems for the process experts, as their group is more homogeneous than the seminar participants. Generalizability of their scores (i.e. project goals) therefore, is restricted.

Due to the small sample sizes, statistical analysis was limited to nonparametric methods. Although good results have been computed using Kendall's tau, they do not have the statistical power of methods as Pearson's correlation coefficient or a t-test. Because these nonparametric methods use

ranks instead of the actual scores, conclusions are limited (magnitude of difference cannot be discussed).

To validate the results of Kendall's tau, the data was tested for differences *between the two groups of participants*. It was hypothesized that if the groups did not differ, they could be drawn from the sample population. This would indicate a good alignment. The non-parametric equivalent of this (independent) *t*-test is the Mann-Whitney test (Field, 2005). Computing this statistic for each dimension implied calculating four times the hypothesis ($= 4 * 161$), which was unfeasible in this thesis. Therefore, the scores were aggregated on an objective (X) – improvement (Y) level.

$$W_x = \text{the sum of the ranks in the first group} \tag{3.2}$$

Assumptions:

- Data are independent random samples from two populations that have the same shape and a scale that is continuous or ordinal if discrete
- Data are measured at an interval level of measurement

The results of these Mann-Whitney tests are added in appendix K. As can be seen in the results, these tests had even less statistical power than Kendall's tau. Mann-Whitney was oversensitive to the sample size. Therefore, Kendall's tau was adopted as the only statistical test in this thesis.

7. Conclusion

This chapter presents the conclusions that can be derived from this study. First, the proposed framework is evaluated in section 7.1. Using this framework to shortlist best practices enhances the way business process improvement projects are undertaken in practice, which was the research objective of this thesis. This will be reached by answering the research questions in section 7.2. Research limitations are discussed in section 7.3; thereafter recommendations for future research are given in section 7.4. This chapter ends with a summary of the thesis.

7.1. Evaluation of the proposed framework

In this thesis, the regulative cycle (van Strien, 1997) was adapted to describe the way business process improvement projects are undertaken in practice. To recall, it was proposed to enhance this way by creating a shortlist of process improvement heuristics based on the project goals. Alignment between the project goals and the process improvement heuristics therefore played an important role. In this thesis, the term '*Process Improvement Intelligence*' was proposed as a framework for measuring the alignment between project goals and process improvement:

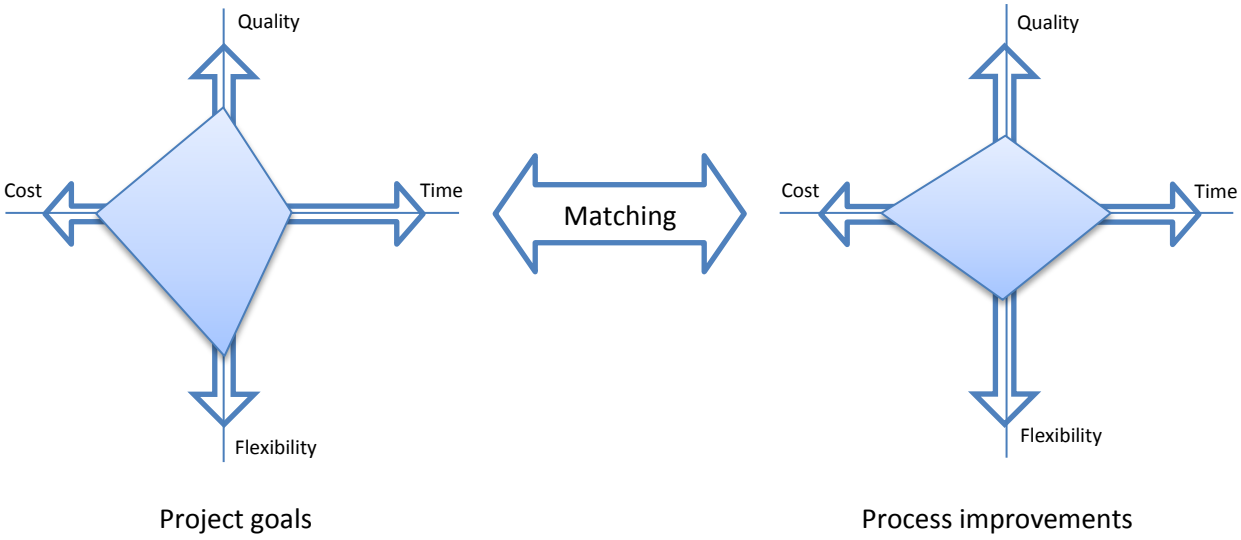

Figure 7.1 Process Improvement Intelligence framework

This framework was applied to six cases from Berenschot, all in the public domain. Therefore, this research validated the research of Reijers and Liman Mansar (2005) in the public domain. The goals of these projects were evaluated by municipality employees, while the process improvements of the projects were evaluated by process experts from Berenschot. Both evaluations involved scoring the item on the four dimensions of the devil's quadrangle: time, costs, quality and flexibility. Based on the project documentation, the pairs of project goals and process improvement were examined statistically for alignment. It was hypothesized that all pairs aligned significantly.

The results confirmed this hypothesis, mainly showing significant alignments. In total, eleven misalignments were identified correctly, while it labelled one pair misaligned wrongfully. This process improvement violated one of the properties of the devil's quadrangle (i.e. it is impossible to improve on all four dimensions), which could explain the failure of the framework. Three

misalignments could be explained by misinterpretation of the best practice 'Order types' by the process experts. After investigating the alignment scores of the process improvement heuristics, this best practice had the lowest alignment score. This indicated that in practice, there is a serious misalignment between what performance the best practice enhances and what project goal it fulfils. The results were complicated due to the high number of not significant correlations, which could be explained by the very small sample.

In short, the framework showed that Process Improvement Intelligence could be measured by matching the project goals to the process improvement. The framework indicated well aligned projects, as was expected, but was also able to rightfully indicate most misalignments.

7.2. Research questions

As evaluated in the previous section, the Process Improvement Intelligence framework measures the alignment of a business process improvement project. It thereby provides an answer to the sub research question:

> *How can the alignment of a business process improvement project be measured?*

The key element in the framework is the evaluation of both project goals and process improvements in terms of performance dimensions i.e. time, costs, quality and flexibility. Identified as the most important gap in the literature (Jenniskens, 2011), there is no framework translating project goals into performance dimensions which can be used to direct a business process improvement initiative.

> *How can the project goals guide process improvements to ensure the continual tight linkage of organizational goals and business processes?*

The Process Improvement Intelligence framework can be implemented into the proposed way to process improvement (see Figure 3.3). This approach builds on an extensive list of potentially effective heuristics to improve the current process. Project goals can thereby create a shortlist of process improvement heuristics. The shortlist gives a focus to a set of heuristics that could potentially be applied to improve the performance of the current process (Limam Mansar et al., 2009). By providing such a shortlist, it cuts out a number of best practices and narrows the scope for the discussion. The result of this discussion is a decision which process improvement heuristic(s) will be applied to the current process.

If we include this proposed way to process improvement into the adapted regulative cycle (see Figure 3.1), we improve the alignment of business process improvement projects. Using this regulative cycle in business process improvement projects, organizational goals and business process improvement will be aligned. This will ensure a continual linkage of organizational goals and business processes.

7.3. Research limitations

Research has limitations, and this research is no exception. Several research limitations can be indicated.

Firstly, as discussed in section 6.4, sample issues troubled statistical analyses. Because the correlations were computed using the averages of the four performance dimensions (n=4), statistical analysis was limited to nonparametric methods. Kendall's τ lacked statistical power, even after setting α to 0.1. Therefore, the number of not significant correlations was relatively high. So, although relatively good results have been computed using Kendall's tau, they do not have the statistical power of methods as Pearson's correlation coefficient or a t-test. Because these nonparametric methods use ranks instead of the actual scores, conclusions are limited (magnitude of difference cannot be discussed).

Project goals were evaluated by municipality employees; process improvements were evaluated by process experts from Berenschot. Both samples could be biased. The municipality employees were participants of a seminar, for which all Dutch municipalities had been invited (not limited to clients of Berenschot). These participants could be a biased sample of all municipality employees in the Netherlands. The process experts had all been working for Berenschot for a number of years. As the convergence results (appendix H) suggest, their line of reasoning was quite similar. This could be the corporate culture of Berenschot. This limits conclusions to be generalized for the management consulting industry as a whole.

By using multiple case studies, the Process Improvement Intelligence framework could be tested and future outcomes could be predicted, because the generalizability is higher than using a single case. However, because all cases were performed in the public domain, generalization is limited to the public sector.

Because the research performed in this thesis required interpretation of data, observer bias could be a potential problem. Specifically, the K-P model involved the interpretations of the pairs of project goals and process improvements. There could be bias in this approach, although three measures have been taken. First, multiple case studies were used, which can help guard against observer bias (Voss et al., 2002). Second, it was required that both the project goals and the process improvements were stated explicitly in the project documentation. Third, the cases were discussed with a project member of Berenschot to verify the matched project goals and process improvements.

Because this research only evaluated cases retrospectively, the framework has not been tested for predictive validity. Assessing the predictive validity for the Process Improvement Intelligence framework could be the motivation of a later study.

7.4. Recommendations for future research

The framework developed in this thesis filled an important gap in the literature i.e. there is no framework translating strategic objectives into performance dimensions which can be used to direct a business process improvement initiative. The outcomes of this project provided new insights into the alignment of project goals and process improvements. Because it was scoped to suit the constraints of a master thesis project, many aspects remain unknown. Therefore, several recommendations for further research are provided.

First, as mentioned above, the predictive validity was not tested for. A later study could be setup to validate the framework for a present case study. The results obtained from using the framework could be compared to the process improvements as recommended by the process experts. Thereby, the following follow-up research question could be answered:

How can these performance dimensions direct specific business process redesign actions?

Similarly, because of the project constraints, expected performance was measured (according to both samples). A future study could measure realised performance (the evaluation step in the adapted regulative cycle, see Figure 3.1).

The focus of this research has been on the prioritization of performance dimensions. Using five point Likert scales, the magnitude of the scores was not investigated. This could not be investigated either, due to the small sample and nonparametric statistical methods. Alignment scores were computed, thereby distinguishing between alignment, misalignment or non-significant results. Future research could investigate the magnitude of alignment/misalignment.

Because business process improvement projects involve incremental improvement taken the current process as starting point, a structured approach is adopted in these projects. A key element in the proposed way to process improvement is the best practices, which are evaluated for their applicability on improving the current process. This proposed way to process improvement corresponds to 'enhancement' in the figure of Rosemann (2010) (see Figure 3.2). It would be interesting to applying the proposed Process Improvement Intelligence framework to Rosemann's other ways to process improvement, namely derivation, innovation and utilisation. In particular Rosemann's creative ways to process improvement (innovation and utilisation) are interesting, because these are more suitable to business process reengineering projects (which require radical innovation). This would involve applying the Process Improvement Intelligence framework to the creative approach in Figure 3.3.

7.5. Summary

While a performance measurement framework (such as the Balanced Scorecard) helps to translate (strategic) objectives into KPIs (which describe the 'as-is' situation), it does not provide any guidance to a business process improvement project. There is no framework translating strategic objectives into performance dimensions which can be used to direct a business process improvement initiative.

This thesis extended the current field of research in the following ways. Using the regulative cycle (van Strien, 1997), a Process Improvement Intelligence framework was developed, for measuring alignment in business process improvement projects. This framework was applied to six cases in the public domain. Because (project) objectives were translated into performance dimensions using the devil's quadrangle, this research extended the business performance management literature, as indicated by Neely et al. (2005). These performance dimensions were proposed to guide a business process improvement initiative, adjoining Reijers and Liman Mansar (2005) research on best practices in business process redesign. This research validated the research of Reijers and Liman Mansar (2005) in the public domain, using business process improvement projects conducted at Berenschot.

Results showed that Process Improvement Intelligence could be measured by matching the project goals to the process improvement. Implementing this framework into the proposed way to process improvement improves the way these projects are undertaken in practice. This will ensure a continual linkage of organizational goals and business processes. By evaluating their business process improvement projects, Berenschot can improve the alignment of their process improvements to the objectives of a client, thereby improving its service level.

In short, this thesis developed a framework for measuring alignment in business process improvement. As Lord Kelvin indicates, measuring (alignment) allows it to be expressed in numbers. Only when you measure alignment, you know something about it. Therefore, by measuring the alignment in business process improvement projects, Process Improvement Intelligence can be created.

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Appendix A: Overview of the best practices

Best Practice	Description	Time	Costs	Quality	Flexibility
Control relocation	Move controls towards the customer	0	-	+	0
Contact reduction	Reduce the number of contacts with customers and third parties	+	-	+	0
Integration	Consider the integration with a business process of the customer or the supplier	+	+	0	-
Order types	Determine whether tasks are related to the same type of order and, if necessary, distinguish new business processes	+	+	-	-
Task elimination	Eliminate unnecessary tasks from a business process	+	+	0	-
Order-based work	Consider removing batch-processing and periodic activities from a business process	+	-	0	0
Triage	Consider the division of a general task into two or more alternative tasks or consider the integration of two or more alternative tasks into one general task	+	+	+	-
Task composition	Combine small tasks into composite tasks and divide large tasks into workable smaller tasks	+	+	+	-
Resequencing	Move tasks to more appropriate places	+	+	0	0
Parallelism	Consider whether tasks may be executed in parallel	+	0/-	-	-
Knock-out	Order knock-outs in an increasing order of effort and in a decreasing order of termination probability	-	+	0	0
Exception	Design business processes for typical order and isolate exceptional order from normal flow	+	0	+	-
Order assignment	Let workers perform as many steps as possible for single orders	+	0	+	-
Flexible assignment	Assign resources in such a way that maximal flexibility is preserved for the near future	+	0	+	-
Centralization	Treat geographically dispersed resources as if they are centralized	+	-	0	+

Split responsibilities	Avoid assignment of task responsibilities to people from different functional units	-	0	+	-
Customer teams	Consider assigning teams out of different departmental workers that will take care of the complete handling of specific sorts of orders	+	+	-	-
Numerical involvement	Minimize the number of departments, groups and persons involved in a business process	-	+	-	0
Case manager	Appoint one person as responsible for the handling of each type of order, the case manager	0	-	+	0
Extra resources	If capacity is not sufficient, consider increasing the number of resources	+	-	0	+
Specialist–generalist	Consider to make resources more specialized or more generalist	+ (speci-alist)	0	0	+ (generalist)
Empower	Give workers most of the decision-making authority and reduce middle management	+	+	-	0
Control addition	Check the completeness and correctness of incoming materials and check the output before it is send to customers	-	+	+	0
Buffering	Instead of requesting information from an external source, buffer it by subscribing to updates	+	-	0	0
Task automation	Consider automating tasks	+	0	+	-
Integral Business Process Technology	Try to elevate physical constraints in a business process by applying new technology	+	+	+	0
Trusted party	Instead of determining information oneself, use results of a trusted party	+	+	0	0
Outsourcing	Consider outsourcing a business process in whole or parts of it	0	+	-	0
Interfacing	Consider a standardized interface with customers and partners	+	+	+	0

Appendix B: Case selection: reviewed projects (in Dutch)

Projectnaam	C1	C2	C3	C4	C5	C6
Subsidieverlening en handhaving Provincie Overrijssel	+	+	+	✓	✓	✓
Second opinion Orpheus	-	0	-	×	✓	
Doorlichting Factorium	-	-	-	✓	✓	
Voortzetting ondersteuning Monitor Berenschot in 2008	-	0	-	✓	✓	
Anders Werken 2008	-	0	-	✓	✓	
Interprovinciale samenwerking	+	-	0	×	✓	
Informatieplan KIT	+	+	-	✓	✓	
Begeleiden aanbestedingen HV/VoM	-	+	-	×	✓	
Project Audit Provincie Noord-Brabant	+	-	0	✓	✓	
CJIB begeleiding project 'Anders Werken'	+	-	-	✓	✓	
Aanbieding ondersteuning projectleiding invoering CRM	-	-	-	×	✓	
Informatieplan SOS International	+	+	+	✓	×	✓
Marketingadvies GBO-overheid	-	-	-	✓	✓	
Audit plan van aanpak voor de conformiteitsfase invoering onderwijsnummer PO	-	-	-	✓	✓	
Portfoliomanagement	-	0	-	✓	✓	
Teamleider Technisch Applicatiebeheer	-	-	-	×	✓	
Ondersteuning planvorming conformiteit	0	0	-	✓	✓	
Positionering Digitale Bibliotheek en Informatie en Automatisering Bibliotheek Rotterdam	-	+	-	×	✓	
Informatieplan Rebo	0	+	0	✓	✓	
Versterking van de samenwerking ICT dienstverlening	-	0	-	✓	✓	
EPO IT audit 2009. Audit work board of auditors EPO	-	-	-	✓	✓	
Inzet en ondersteuning deelproject "Pilots"	+	-	-	✓	✓	
Audit dienstverlening FUeB	-	+	-	✓	✓	
Ontwikkelen informatieplan bedrijfsprocessen Bureau Verkeersbeheer	+	+	0	✓	✓	✓
Onderzoek E-goverment in Gouda	-	0	-	✓	✓	
Request for proposal evaluatie en beslisdocument GPS	-	-	-	✓	✓	
Taskforce beheer	+	0	0	×	✓	
Professionalisering Programmabueau Verbindend Brabant	0	-	+	✓	✓	
Regiemodel	0	0	-	✓	✓	
Haalbaarheidsonderzoek RUIT 'Van wil tot commitment'	-	0	-	✓	✓	
Onderaanneming benchmark ICT-projecten	-	-	0	✓	✓	
Audit PGN-scan 2	-	-	-	✓	✓	
Provincie Overijssel uitvraag consultancy voor onze programmalijn Sourcing binnen het programma Overijssel straks	0	-	0	×	✓	
ICT gebruik Primair onderwijs	-	-	0	✓	✓	
Verbetering continuiteit informatievoorziening	0	+	0	✓	✓	
Quickscan Standaardpakket Kostencalculatie	-	0	-	✓	✓	
ICT-Scan brancheorganisaties detailhandel en ambachten	-	-	-	✓	✓	

Verbetering aansturing en organisatie IT functie	-	+	0	✓	✓	
Nadere Overeenkomst Second Opinion Koers KWN	-	-	-	✓	✓	
Calamiteitenmanagement in de markt van Provincie Noord-Brabant	-	-	-	✓	✓	
Implementatie Gelders kantoorconcept	0	-	0	✓	✓	
Samenwerking NJBB - KNBB	0	+	-	✓	✓	
Onderzoek heroriëntatie Facilitair Bedrijf 'zelf doen of uitbesteden'	0	+	-	✓	✓	
Toekomstbeeld manier van werken bij PWN	0	-	-	✓	✓	
Implementatie van de nieuwe Gebruikersdienst ICT	0	0	+	✓	✓	
Overeenstemming inzet 'GPS Programmamanagment' bij de Raad voor de Rechtspraak	-	0	-	✓	✓	
KIT Herinrichting ICT	0	+	0	✓	✓	
Rekenkameronderzoek risicobeheersing grote projecten.	0	0	0	✓	✓	
Infrastructuur Gouwe Rijnland	-	0	-	✓	✓	
CBS Organisatie en Besturing	-	+	0	✓	✓	
Ontwikkeling projectmonitor CBS	-	-	-	✓	✓	
Strategische vastgoedplanning, vastgoedportefeuille in kaart, sturende meerjarenonderhoudsplanning	-	0	+	✓	✓	
Inventarisatie kansen in de informatiehuishouding in het Nederlands onderwijs	+	+	-	✓	✓	
Overhead Gemeente Landgraaf gebenchmarkt en gewaardeerd	0	+	0	✓	✓	
ISZF ICTY samenwerkingsverband ZuidWest Friesland	0	-	-	✓	✓	
Visie Provincie Overijssel op provinciale werk in de toekomst	-	-	-	✓	✓	
GGD Jeugdmonitor	+	-	-	✓	✓	
Review IT-project BIB	-	+	-	✓	✓	
Aanpak ontwikkelen informatieplan 2011-2013	-	+	-	✓	✓	
mid-term review GATE	-	-	-	✓	✓	
Ondersteuning Commissie Blauwdruk N.E.C. Nijmegen	-	0	-	✓	✓	
Audit project procesautomatisering	0	+	-	✓	✓	
Onderzoeksopdracht "Mogeljikheid eenduidige studentenpas" Verplichtingnummer: 750A0-2427 (NOD: OND 1340829)	-	-	-	✓	✓	
Workshop subsidieverlening Landsingerland	+	+	+	✓	✓	✓
Workshop subsidieverlening Ouder-Amstel	+	0	+	✓	✓	✓
Workshop subsidieverlening Eersel	+	0	+	✓	✓	✓
Workshop subsidieverlening Aalsmeer	+	0	+	✓	✓	✓

Appendix C: Scorelijst versie 1 (in Dutch)

Hieronder bevindt zich een lijst met doelstellingen die betrekking hebben op een of meerdere projecten. De projectnaam staat boven de tabel. De legenda onder de tabel geeft aan welke scores er mogelijk zijn. Vraag uzelf bij het invullen van de tabel steeds af: “wat zou deze doelstelling voor mijn gemeente betekenen? Welk effect verwacht ik dat de doelstelling heeft op de indicatoren tijd, kosten, kwaliteit en flexibiliteit?”

De indicator tijd geeft aan hoe lang het proces duurt, terwijl onder kosten alle kosten gemoeid met dit proces vallen. Onder de indicator kwaliteit valt zowel interne als externe kwaliteit. Interne kwaliteit is de kwaliteit van het proces; externe kwaliteit is de kwaliteit van het resultaat. Flexibiliteit heeft betrekking op de mate waarin het proces kan veranderen wanneer dat nodig is (kunnen mensen bijvoorbeeld taken van anderen overnemen?).

Het is de bedoeling dat voor elke doelstelling elke indicator één score krijgt (dus niet geen score of meerdere scores). Het invullen van deze scorelijst duurt ongeveer 10 minuten. Veel succes!

Als u uw gegevens invult, neem ik contact met u op wanneer mijn afstudeerverslag af is om de resultaten met u te delen. Uw gegevens worden niet gebruikt in het onderzoek. Mocht u contact met mij willen opnemen, mijn gegevens staan onderaan de volgende pagina.

Project optimalisatie ‘subsidieverleningsproces’

Doelstelling	**Tijd**	**Kosten**	**Kwaliteit**	**Flexibiliteit**
1. Alle kanalen moeten gebruikt kunnen worden				
2. Doelgroepen burgers en instellingen moeten specifieker bediend worden				
3. (Digitale) statusreportages moeten op ieder moment kunnen worden opgevraagd				
4. Minder subsidieaanvragen verdagen				
5. Beoordelingstijd beleidsambtenaar verkorten				
6. (Papieren) inefficiëntie verlagen				
7. Verlagen van het aantal verstrekte subsidies dat niet voldoet aan de eigen regelgeving				
8. Effectiviteit van subsidieverlening moet omhoog				
9. Verlagen van het aantal verdaagde subsidies				
10. Verkorten beoordelingstijd beleidsambtenaar				
11. Vergroten van het aantal subsidies dat aansluit bij de gemeentelijke doelstellingen				
12. Verlagen van de controle				

13. Verlagen van de administratieve lasten				
14. De ontvangstbevestiging moet binnen 2 dagen na ontvangst verstuurd worden				
15. Doorlooptijd van eenmalige subsidies verkorten				
16. Traceerbaarheid van aanvragen vergroten				
17. Kennis over subsidies binnen de organisatie vergroten				
18. Er moeten meer herstelmogelijkheden geboden worden				
19. Verminderen en versimpelen regels				
20. Verkorten van de procestijd van DIV				
21. Het aanvraagformulier moet digitaal opgestuurd kunnen worden				
22. Verkort proces voor kleine subsidies				

Score	Effect
++	Sterk positief effect
+	Positief effect
0	No effect
–	Negatief effect
– –	Sterk negatief effect

Naam:

…….....

Gemeente:

……..

E-mailadres:

……..

Bedankt voor het invullen!

Nick Jenniskens, BSc

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Appendix D: Scorelijst versie 2 (in Dutch)

Hieronder bevindt zich een lijst met doelstellingen die betrekking hebben op een of meerdere projecten. De projectnaam staat boven de tabel. De legenda onder de tabel geeft aan welke scores er mogelijk zijn. Vraag uzelf bij het invullen van de tabel steeds af: “wat zou deze doelstelling voor mijn gemeente betekenen? Welk effect verwacht ik dat de doelstelling heeft op de indicatoren tijd, kosten, kwaliteit en flexibiliteit?”

De indicator tijd geeft aan hoe lang het proces duurt, terwijl onder kosten alle kosten gemoeid met dit proces vallen. Onder de indicator kwaliteit valt zowel interne als externe kwaliteit. Interne kwaliteit is de kwaliteit van het proces; externe kwaliteit is de kwaliteit van het resultaat. Flexibiliteit heeft betrekking op de mate waarin het proces kan veranderen wanneer dat nodig is (kunnen mensen bijvoorbeeld taken van anderen overnemen?).

Het is de bedoeling dat voor elke doelstelling elke indicator één score krijgt (dus niet geen score of meerdere scores). Het invullen van deze scorelijst duurt ongeveer 10 minuten. Veel succes!

Als u uw gegevens invult, neem ik contact met u op wanneer mijn afstudeerverslag af is om de resultaten met u te delen. Uw gegevens worden niet gebruikt in het onderzoek. Mocht u contact met mij willen opnemen, mijn gegevens staan onderaan de volgende pagina.

Project proces ‘noodhulpverlening’

Doelstelling	**Tijd**	**Kosten**	**Kwaliteit**	**Flexibiliteit**
1. Het aantal afgehandelde meldingen verhogen				
2. Verlagen van de duur van afhandeling per melding				
3. Meer schadeafhandeling				
4. Vergroten procesinnovatie (processen kunnen veranderen door veranderde behoefte van opdrachtgevers)				
5. Verminderen van het aantal klachten				
6. Vaker contact met de klant				
7. Vergroten van het aantal klanten				
8. Verlagen van het aantal dossiers per klant				
9. Verlagen handling fee per dossier				
10. Snellere eventafhandeling				
11. Capaciteit beter benutten (piek/dal)				
12. Kwaliteit verbeteren				
13. Wachtrij verkorten				

14. Werkdruk verlagen				
15. 95% van de rekeningen moet binnen 14 dagen (7-28 dagen) zijn gecontroleerd				
16. Verbeteren Informatiestromen (Interne communicatie)				
17. 100% uptime				
18. Reduceren van de wachttijden aan de telefoon				
19. Verbeteren van de match tussen werkaanbod en capaciteit				

Score	Effect
++	Sterk positief effect
+	Positief effect
0	No effect
–	Negatief effect
– –	Sterk negatief effect

Naam:

…….....

Gemeente:

……..

E-mailadres:

……..

Bedankt voor het invullen!

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Appendix E: Scorelijst versie 3 (in Dutch)

Hieronder bevindt zich een lijst met doelstellingen die betrekking hebben op een of meerdere projecten. De projectnaam staat boven de tabel. De legenda onder de tabel geeft aan welke scores er mogelijk zijn. Vraag uzelf bij het invullen van de tabel steeds af: “wat zou deze doelstelling voor mijn gemeente betekenen? Welk effect verwacht ik dat de doelstelling heeft op de indicatoren tijd, kosten, kwaliteit en flexibiliteit?”

De indicator tijd geeft aan hoe lang het proces duurt, terwijl onder kosten alle kosten gemoeid met dit proces vallen. Onder de indicator kwaliteit valt zowel interne als externe kwaliteit. Interne kwaliteit is de kwaliteit van het proces; externe kwaliteit is de kwaliteit van het resultaat. Flexibiliteit heeft betrekking op de mate waarin het proces kan veranderen wanneer dat nodig is (kunnen mensen bijvoorbeeld taken van anderen overnemen?).

Het is de bedoeling dat voor elke doelstelling elke indicator één score krijgt (dus niet geen score of meerdere scores). Het invullen van deze scorelijst duurt ongeveer 10 minuten. Veel succes!

Als u uw gegevens invult, neem ik contact met u op wanneer mijn afstudeerverslag af is om de resultaten met u te delen. Uw gegevens worden niet gebruikt in het onderzoek. Mocht u contact met mij willen opnemen, mijn gegevens staan onderaan de volgende pagina.

Project proces ‘beheer provinciale wegen’

Doelstelling	Tijd	Kosten	Kwaliteit	Flexibiliteit
1. De beheerde wegen moeten continu beschikbaar zijn				
2. Intensiveren van de samenwerking met andere wegbeheerders, de markt en overige (provinciale) partners				
3. Een dienstverlenende opstelling t.a.v. weggebruikers, omwonenden en de directe leefomgeving				
4. De provinciale wegen steeds veilig toegankelijk moeten zijn				
5. Verkeersonveilige situaties moeten door het direct treffen van adequate maatregelen worden aangepakt				
6. Verkorten van de responstijden				
7. Effectief en efficiënt kunnen omgaan met diversiteit				
8. Verbeteren van de naleving van genomen besluiten				

9. Meer openstaan voor de steeds mondiger wordende burger				
10. Herkenbaarheid vergroten voor de betrokkenen				
11. Benaderbaarheid vergroten voor de betrokkenen				
12. De leefbaarheid van de provincie vergroten				
13. Vergroten productiviteit per medewerker				

Score	Effect
++	Sterk positief effect
+	Positief effect
0	No effect
–	Negatief effect
– –	Sterk negatief effect

Naam:

…….....

Gemeente:

……..

E-mailadres:

……..

Bedankt voor het invullen!

Nick Jenniskens, BSc

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Appendix F: Scorelijst versie 4 (in Dutch)

Hieronder bevindt zich een lijst met doelstellingen die betrekking hebben op een of meerdere projecten. De projectnaam staat boven de tabel. De legenda onder de tabel geeft aan welke scores er mogelijk zijn. Vraag uzelf bij het invullen van de tabel steeds af: “wat zou deze doelstelling voor mijn gemeente betekenen? Welk effect verwacht ik dat de doelstelling heeft op de indicatoren tijd, kosten, kwaliteit en flexibiliteit?”

De indicator tijd geeft aan hoe lang het proces duurt, terwijl onder kosten alle kosten gemoeid met dit proces vallen. Onder de indicator kwaliteit valt zowel interne als externe kwaliteit. Interne kwaliteit is de kwaliteit van het proces; externe kwaliteit is de kwaliteit van het resultaat. Flexibiliteit heeft betrekking op de mate waarin het proces kan veranderen wanneer dat nodig is (kunnen mensen bijvoorbeeld taken van anderen overnemen?).

Het is de bedoeling dat voor elke doelstelling elke indicator één score krijgt (dus niet geen score of meerdere scores). Het invullen van deze scorelijst duurt ongeveer 10 minuten. Veel succes!

Als u uw gegevens invult, neem ik contact met u op wanneer mijn afstudeerverslag af is om de resultaten met u te delen. Uw gegevens worden niet gebruikt in het onderzoek. Mocht u contact met mij willen opnemen, mijn gegevens staan onderaan de volgende pagina.

Project proces ‘subsidieverlening en handhaving’

Doelstelling	Tijd	Kosten	Kwaliteit	Flexibiliteit
1. Terugdringen van regels				
2. Verminderen van administratieve lasten				
3. Verhogen van kwaliteit dienstverlening				
4. Ontvangstbevestiging binnen 2 weken versturen				
5. Binnen 3 weken wordt aangevraagde informatie opgestuurd				
6. Na maximaal 2 keer doorverbinden krijgt de beller de persoon die inhoudelijk reactie kan geven				
7. De provincie is in staat aanvragers van subsidies en vergunningen en bezwaarmakers binnen twee werkdagen te informeren over de stand van zaken van een procedure en de nog benodigde tijd tot de beslissing				
8. Facturen worden binnen 30 dagen betaald				
9. Verlagen van de inzet (uren, budget) per subsidie				
10. Verbeteren kwaliteitszorg				

11. Verbeteren borging van de beleidsinformatie				
12. Verbeteren monitoring resultaten en proces (workflow)				
13. Verbeteren van de klanttevredenheid				
14. Verhogen van het percentage naleving				
15. Verlagen aantal en zwaarte geconstateerde overtredingen				
16. Efficiënter naleving bereiken				
17. Minder kwantitatief en meer kwalitatief handhaven				
18. Vereenvoudigen van vergunningen en het proces vergunningverlening				
19. Meer juridisch houdbare en snelle beslissingen				
20. Zo volledig mogelijke toezichtrapporten				
21. Zo flexibel mogelijke interne medewerkers				
22. Eerlijker en kordater handhaven bij overtredingen				

Score	Effect
++	Sterk positief effect
+	Positief effect
0	No effect
–	Negatief effect
– –	Sterk negatief effect

Naam:

…….....

Gemeente:

……..

E-mailadres:

……..

Bedankt voor het invullen!

Nick Jenniskens, BSc

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Appendix G: Scorelijst proces experts (in Dutch)

Hieronder bevindt zich een lijst met procesacties die betrekking hebben op een of meerdere projecten. De projectnaam staat boven de tabel (mocht je het project kennen, dan mag je deze kennis natuurlijk gebruiken). De legenda onder de tabel geeft aan welke scores er mogelijk zijn. Vraag jezelf bij het invullen van de tabel steeds af: “wat zou deze maatregel voor het proces betekenen? Welk effect verwacht ik dat de procesactie heeft op de indicatoren tijd, kosten, kwaliteit en flexibiliteit?”

De indicator tijd geeft aan hoe lang het proces duurt, terwijl onder kosten alle kosten gemoeid met dit proces vallen. Onder de indicator kwaliteit valt zowel interne als externe kwaliteit. Interne kwaliteit is de kwaliteit van het proces; externe kwaliteit is de kwaliteit van het resultaat. Flexibiliteit heeft betrekking op de mate waarin het proces kan veranderen wanneer dat nodig is (kunnen mensen bijvoorbeeld taken van anderen overnemen?).

Het is de bedoeling dat voor elke procesactie elke indicator één score krijgt (dus niet geen score of meerdere scores). Het invullen van deze scorelijst duurt ongeveer 20 minuten. Veel succes en alvast bedankt!

Score	Effect
++	Sterk positief effect
+	Positief effect
0	No effect
–	Negatief effect
– –	Sterk negatief effect

Project optimalisatie 'subsidieverleningsproces'

Procesactie	Tijd	Kosten	Kwaliteit	Flexibiliteit
1. Boeken en registreren op hetzelfde moment				
2. Koppelen registratienummers van verschillende documenten in één aanvraag				
3. Heldere doelstellingen opstellen (waar moet de aanvrager aan voldoen)				
4. Standaardisatie in opstellen beschikking				
5. Beoordelingstijd plannen				
6. Bijhouden lijst met veelgemaakte fouten die toetser tegenkomt				
7. Voor het opstellen van de beschikking splitsing maken tussen afwijkende en niet afwijkende aanvragen				
8. Checklist opstellen voor toetsen van het gehele proces				
9. Extra keuzemoment voor afwijkend van gevraagd bedrag (zo ja, adviesnota opstellen, zo nee beschikking opstellen)				
10. Steekproefsgewijs i.p.v. 100% toetsen				
11. Splitsen subsidieaanvragen (wel/niet aansluitend bij gemeentelijke doelstellingen)				
12. Autorisatie afdelingshoofd om laag bedrag beschikkingen goed te keuren				
13. E-formulier gebruiken voor subsidieaanvraag				
14. Ontvangstbevestiging versturen met registratienummer en behandelend ambtenaar				
15. Verdaagbericht opnemen in de planning				
16. Afdelingshoofd machtigen om incidentele aanvragen af te handelen i.p.v. college (eventueel tot een bepaald bedrag)				
17. DIV verstuurt, boekt af en archiveert beschikking i.p.v. ambtenaar				
18. Overzicht opvraagbaar van alle subsidieaanvragen, bij wie ze in behandeling zijn				

en in welke fase				
19. Aanvraag bij DIV inboeken, hoe het ook binnenkomt				
20. Compleetheidtoets vroeg in het proces uitvoeren (door subsidiemedewerker)				
21. Herstelmogelijkheden bieden				
22. Gedifferentieerde procedures voor grote en kleine subsidies				
23. Accounthouder is verantwoordelijk voor het hele proces				
24. Beschikkingen niet meer tekenen zonder B&W-advies				

Project proces 'noodhulpverlening'

Procesactie	**Tijd**	**Kosten**	**Kwaliteit**	**Flexibiliteit**
1. Vooraf inzicht in kwaliteit hulpverlenende instanties				
2. Afsluiten Service Level Agreement met klanten				
3. Afsluiten Service Level Agreement met uitvoerders				
4. Verdeling van werkdruk over de drie operationele afdelingen				
5. Vooruitzien van pieken in "events"				
6. Klanten regelmatig bezoeken				
7. Zgn. witte vlekken binnenhalen				
8. Goede centrale planner				
9. Uniformering van de aanpak van een melding				
10. Duidelijke kaders opdrachtgevers en uitvoerders; duidelijkheid in wat mogelijk en toegestaan is				
11. Standaard tools				
12. Workflow management systeem				
13. Voldoende mensen				

14. Goede controle (bij afwijking van de afspraken dient het systeem dit automatisch te signaleren)				
15. Opzetten telewerken (inzet mensen / ”stand-by”)				
16. Skill-based inzetten van medewerkers				
17. Juiste aanpassing inzet werknemers aan werkdruk				
18. Opleiden personeel (breed inzetbaar)				
19. Gemoduleerd opgebouwd systeem				
20. Systeem dwingt medewerkers om alle velden in te vullen				
21. Systeem beslist aan wie de agendaregels en acties worden toebedeeld				
22. Systeem rerout binnenkomende meldingen naar degene die al eerder met het dossier bezig is geweest				
23. Systeem stuurt werkprocessen aan				

Project proces ‘beheer provinciale wegen’

Procesactie	**Tijd**	**Kosten**	**Kwaliteit**	**Flexibiliteit**
1. Routine informatieverzoeken automatisch afhandelen (het systeem vindt de gevraagde informatie)				
2. Installeren van een elektronisch loket (geautomatiseerde front-office)				
3. Verzoeken/klachten integreren met geografische informatie				
4. Alle meldingen worden geboekt in een centraal systeem				
5. Scheiden van routine en non-routine voorvallen				
6. Standaardiseren van de verwerking van routine-voorvallen				
7. Creëren van een gemeenschappelijke dataopslag in het provinciale netwerk				

8. Integratie van de bureaus verkeersbeheer en verkeersmanagement				
9. Virtualisatie van de front- en backoffice rol				
10. Meerdere dienstverleningskanalen kunnen tegelijkertijd gebruikt worden (internet, telefoon, e-mail, fysieke post)				

Project proces 'vergunningverlening en handhaving'

Procesactie	**Tijd**	**Kosten**	**Kwaliteit**	**Flexibiliteit**
1. Gebruik e-formulieren				
2. Digitale autorisatie (DigiD)				
3. Implementeren van een workflow monitoring system				
4. Centralisatie van klant- en locatiegegevens				
5. Eén keer registreren bij binnenkomst in plaats van op elke afdeling				
6. Digitaal aanvraagformulier				
7. Centrale opslag van modules				
8. Ter plekke opstellen van toezichtrapport				
9. Gebruik van GPS bij het vaststellen van locatie van de overtreding				
10. Elektronisch beschikbaar stellen van milieu-informatie				
11. Elektronisch beschikbaar stellen van statusinformatie m.b.t. aanvragen, meldingen, etc.				
12. Digitaal doorsturen van de vraag naar de juiste persoon in de backoffice				
13. Organiseren m.b.v. workflow dat milieuklachten-hh automatisch via de juiste weg worden afgehandeld				
14. Taken verdelen naar klanten				
15. Snel identificeren en signaleren van bekende klantengegevens				
16. Centraal punt voor informatie ontvangen				

17. Meer proactief generieke informatie verstrekken				
18. Regie proces/termijnbewaking bij één persoon (één procedure planning)				
19. Workflow: van te voren bepalen wat de route is, wie wat moet doen, planning, werkprocesondersteunend				
20. Digitale aanvraag indienen en digitaal afhandelen				
21. Schrappen eindcontrole door teamleider				
22. Klachten koppelen aan bijbehorende bedrijf				

Appendix H: Convergence of process experts' scores

P1-4	IQR	% within 2 cat.
ep1i1t	0	100
ep1i1c	0	83
ep1i1q	0	100
ep1i1f	1	100
ep1i2t	0	80
ep1i2c	0	80
ep1i2q	0.75	83
ep1i2f	2	100
ep1i3t	1	100
ep1i3c	1	100
ep1i3q	1	100
ep1i3f	1	80
ep1i4t	1	100
ep1i4c	1	100
ep1i4q	0.75	100
ep1i4f	2	80
ep1i5t	1	100
ep1i5c	0.75	100
ep1i5q	1	100
ep1i5f	1	100
ep1i6t	2	60
ep1i6c	2	60
ep1i6q	1	100
ep1i6f	1	100
ep1i7t	2	80
ep1i7c	1	80
ep1i7q	1	83
ep1i7f	1	80
ep1i8t	2	60
ep1i8c	0	100
ep1i8q	1	100
ep1i8f	1	100
ep1i9t	1	100
ep1i9c	2	80
ep1i9q	1	100
ep1i9f	1	83
ep1i10t	1	100
ep1i10c	1	100
ep1i10q	0	100
ep1i10f	1	100
ep1i11t	1	80
ep1i11c	1	83
ep1i11q	0	80
ep1i11f	2	100
ep1i12t	1	80
ep1i12c	1	83
ep1i12q	0	100
ep1i12f	1	80
ep2i13t	1	100
ep2i13c	1	100
ep2i13q	0	100
ep2i13f	2.5	50
ep2i14t	1	100
ep2i14c	0	100
ep2i14q	0.75	100
ep2i14f	1	80
ep2i15t	1.5	67
ep2i15c	1	100
ep2i15q	2	60
ep2i15f	1	100
ep2i16t	1	100
ep2i16c	1	100
ep2i16q	0	100
ep2i16f	0	100
ep2i17t	0	80
ep2i17c	0	100
ep2i17q	1.75	67
ep2i17f	1	100
ep3i18t	0.75	83
ep3i18c	2	60
ep3i18q	1	100
ep3i18f	0	100
ep3i19t	0	80
ep3i19c	0	80
ep3i19q	0	100
ep3i19f	1	83
ep3i20t	1	100

ep3i20c	1	100
ep3i20q	1	83
ep3i20f	1	100
ep3i21t	1	83
ep3i21c	0	80
ep3i21q	0	100
ep3i21f	1	100
ep4i22t	1	100
ep4i22c	0	100
ep4i22q	0	100
ep4i22f	0	100
ep4i23t	2	60
ep4i23c	2	60
ep4i23q	0.75	100
ep4i23f	2	80
ep4i24t	1	83
ep4i24c	1	100
ep4i24q	0	100
ep4i24f	1	100

P6	IQR	% within 2 cat.
ep6i1t	0	100
ep6i1c	0.75	100
ep6i1q	0	100
ep6i1f	0	80
ep6i2t	0	100
ep6i2c	0	80

P5	IQR	% within 2 cat.
ep5i1t	1	100
ep5i1c	1	100
ep5i1q	1	80
ep5i1f	1	100
ep5i2t	1	100
ep5i2c	1	100
ep5i2q	1	80
ep5i2f	0	80
ep5i3t	1	100
ep5i3c	0	80
ep5i3q	1	80
ep5i3f	1	80
ep5i4t	0	100
ep5i4c	0	100
ep5i4q	0	100
ep5i4f	1	80
ep5i5t	0	100
ep5i5c	0	100
ep5i5q	0	100
ep5i5f	0	80
ep5i6t	0	100
ep5i6c	1	100
ep5i6q	0	100
ep5i6f	1	80
ep5i7t	0	100
ep5i7c	0	100
ep5i7q	0	100
ep5i7f	1	80
ep5i8t	0.5	100
ep5i8c	0	100
ep5i8q	1	100
ep5i8f	0.5	100
ep5i9t	0.25	100
ep5i9c	0.25	100
ep5i9q	0.75	75
ep5i9f	1	100
ep5i10t	0	80
ep5i10c	2	60
ep5i10q	0	100
ep5i10f	0	100

ep6i2q	0.75	100
ep6i2f	2	60
ep6i3t	0	100
ep6i3c	0	80
ep6i3q	0	100
ep6i3f	0	80
ep6i4t	0	100
ep6i4c	0.75	100
ep6i4q	0	100
ep6i4f	1	80
ep6i5t	0	100
ep6i5c	0.75	100
ep6i5q	0	100
ep6i5f	0	100
ep6i6t	0.75	100
ep6i6c	0	100
ep6i6q	0	100
ep6i6f	0	80
ep6i7t	1	100
ep6i7c	1	100
ep6i7q	0	100
ep6i7f	0.25	100
ep6i8t	0	100
ep6i8c	0	100
ep6i8q	1	80
ep6i8f	0	83
ep6i9t	0	100
ep6i9c	0	80
ep6i9q	0	100
ep6i9f	1	80
ep6i10t	0	100
ep6i10c	1	80
ep6i10q	0.75	100
ep6i10f	0	100
ep6i11t	0	100
ep6i11c	0	80
ep6i11q	0	100
ep6i11f	1	80
ep6i12t	0	100
ep6i12c	0	100
ep6i12q	0.75	100
ep6i12f	1	80
ep6i13t	0	100
ep6i13c	1	100
ep6i13q	1	80
ep6i13f	1	80
ep6i14t	0.5	75
ep6i14c	0.5	75
ep6i14q	0.25	100
ep6i14f	0.25	100
ep6i15t	0	100
ep6i15c	0	100
ep6i15q	1	100
ep6i15f	1	100
ep6i16t	0	100
ep6i16c	0.75	100
ep6i16q	0	100
ep6i16f	1	100
ep6i17t	0	80
ep6i17c	1	80
ep6i17q	1	100
ep6i17f	1	100
ep6i18t	0	100
ep6i18c	0	83
ep6i18q	1	100
ep6i18f	2	100
ep6i19t	0.75	100
ep6i19c	0	100
ep6i19q	0	100
ep6i19f	1	80
ep6i20t	1	100
ep6i20c	1	100
ep6i20q	0	100
ep6i20f	1	80
ep6i21t	0	100
ep6i21c	0.75	100
ep6i21q	3	60
ep6i21f	1	100
ep6i22t	1	100
ep6i22c	1	100
ep6i22q	1	100
ep6i22f	1	80

Appendix I: K-P models

p_{1-4}	ep_1i_1	ep_1i_2	ep_1i_3	ep_1i_4	ep_1i_5	ep_1i_6	ep_1i_7	ep_1i_8	ep_1i_9	ep_1i_{10}	ep_1i_{11}	ep_1i_{12}	ep_2i_{13}	ep_2i_{14}	ep_2i_{15}	ep_2i_{16}	ep_2i_{17}	ep_3i_{18}	ep_3i_{19}	ep_3i_{20}	ep_3i_{21}	ep_4i_{22}	ep_4i_{23}	ep_4i_{24}
hp_1o_1													$H1$						$H2$					
hp_1o_2			$H3$																			$H4$		
hp_1o_3		$H5$																$H6$					$H7$	
hp_1o_4			$H8$			$H9$	$H10$		$H11$		$H12$	$H13$				$H14$				$H15$				
hp_1o_5				$H16$	$H17$		$H18$		$H19$		$H20$													
hp_1o_6	$H21$	$H22$																						
hp_1o_7				$H23$		$H24$		$H25$	$H26$			$H27$				$H28$								$H29$
hp_1o_8			$H30$			$H31$	$H32$				$H33$											$H34$	$H35$	$H36$
hp_1o_9			$H37$			$H38$			$H39$			$H40$				$H41$				$H42$				
hp_1o_{10}				$H43$	$H44$		$H45$		$H46$		$H47$													
hp_1o_{11}				$H48$		$H49$		$H50$	$H51$			$H52$				$H53$								$H54$
hp_1o_{12}			$H55$			$H56$	$H57$		$H58$	$H59$	$H60$	$H61$				$H62$								
hp_1o_{13}		$H63$						$H64$															$H65$	
hp_2o_{14}														$H66$			$H67$							
hp_2o_{15}																				$H68$				
hp_3o_{16}																		$H69$					$H70$	
hp_3o_{17}																								
hp_3o_{18}															$H71$						$H72$			
hp_4o_{19}																								
hp_4o_{20}																				$H73$				
hp_4o_{21}			$H74$	$H75$				$H76$																
hp_4o_{22}																						$H77$		

p_5	ep_5i_1	ep_5i_2	ep_5i_3	ep_5i_4	ep_5i_5	ep_5i_6	ep_5i_7	ep_5i_8	ep_5i_9	ep_5i_{10}
hp_5o_1					$H1$	$H2$				
hp_5o_2			$H3$				$H4$			
hp_5o_3		$H5$								$H6$
hp_5o_4					$H7$	$H8$				
hp_5o_5					$H9$	$H10$				
hp_5o_6	$H11$	$H12$			$H13$	$H14$				$H15$
hp_5o_7				$H17$	$H18$			$H19$	$H20$	$H21$
hp_5o_8			$H22$							
hp_5o_9										$H23$
hp_5o_{10}										$H24$
hp_5o_{11}		$H25$								$H26$
hp_5o_{12}										
hp_5o_{13}	$H27$	$H28$	$H29$				$H30$		$H31$	

p_6	ep_6i_1	ep_6i_2	ep_6i_3	ep_6i_4	ep_6i_5	ep_6i_6	ep_6i_7	ep_6i_8	ep_6i_9	ep_6i_{10}	ep_6i_{11}	ep_6i_{12}	ep_6i_{13}	ep_6i_{14}	ep_6i_{15}	ep_6i_{16}	ep_6i_{17}	ep_6i_{18}	ep_6i_{19}	ep_6i_{20}	ep_6i_{21}	ep_6i_{22}
hp_6o_1															$H1$						$H2$	
hp_6o_2	$H3$							$H4$														
hp_6o_3	$H5$	$H6$				$H7$				$H8$	$H9$											
hp_6o_4													$H10$									
hp_6o_5													$H11$									
hp_6o_6				$H12$			$H13$						$H14$									
hp_6o_7											$H15$											
hp_6o_8				$H16$			$H17$						$H18$									
hp_6o_9					$H19$													$H20$	$H21$		$H22$	
hp_6o_{10}														$H23$				$H24$				
hp_6o_{11}					$H25$											$H26$						
hp_6o_{12}			$H27$				$H28$															$H29$
hp_6o_{13}																	$H30$					
hp_6o_{14}									$H31$													$H32$
hp_6o_{15}									$H33$													$H34$
hp_6o_{16}									$H35$													$H36$
hp_6o_{17}									$H37$													$H38$
hp_6o_{18}					$H39$													$H40$	$H41$		$H42$	
hp_6o_{19}									$H43$					$H44$	$H45$			$H46$	$H47$			$H48$
hp_6o_{20}									$H49$													
hp_6o_{21}												$H50$		$H51$				$H52$				
hp_6o_{22}																	$H53$			$H54$		

Appendix J: Kendall's tau results

Kendall's τ p_{1-4}	ep_1i_1	ep_1i_2	ep_1i_3	ep_1i_4	ep_1i_5	ep_1i_6	ep_1i_7	ep_1i_8	ep_1i_9	ep_1i_{10}	ep_1i_{11}	ep_1i_{12}	ep_2i_{13}	ep_2i_{14}	ep_2i_{15}	ep_2i_{16}	ep_2i_{17}	ep_3i_{18}	ep_3i_{19}	ep_3i_{20}	ep_3i_{21}	ep_4i_{22}	ep_4i_{23}	ep_4i_{24}
hp_1o_1													-.516 (.173)						.000 (.500)					
hp_1o_2			.183 (.359)																			-.183 (.359)		
hp_1o_3		-.333 (.248)																.667 (.087)					.333 (.248)	
hp_1o_4			.548 (.139)			-.333 (.248)	.667 (.087)		-.333 (.248)		-.333 (.248)	.000 (.500)				.333 (.248)				.548 (.139)				
hp_1o_5				.913 (.035)	.000 (.500)		.333 (.248)		-.667 (.087)		-.667 (.087)													
hp_1o_6	.333 (.248)	.667 (.087)																						
hp_1o_7				.000 (.500)		.548 (.139)		1.000 (.)	.548 (.139)			-.183 (.359)				-.548 (.139)								.548 (.139)
hp_1o_8			.400 (.222)			-.183 (.359)	.183 (.359)				-.183 (.359)											.400 (.222)	.183 (.359)	-.183 (.359)
hp_1o_9			.800 (.06			-.183			-.183			-.183				.183 (.35				.400 (.22				

			3)			(.359)			(.359)			(.359)				9)				2)				
hp_1o_{10}				.913 (.035)	.000 (.500)		.333 (.248)		-.667 (.087)		-.667 (.087)												
hp_1o_{11}				-.600 (.126)		.913 (.035)		.400 (.222)	.913 (.035)			-.913 (.035)				-.913 (.035)							.913 (.035)
hp_1o_{12}			-.183 (.359)			-1.000 (.)	.000 (.500)		-1.000 (.)	1.000 (.)	-1.000 (.)	.667 (.087)				1.000 (.)							
hp_1o_{13}		.548 (.139)						-.400 (.222)														-.183 (.359)	
hp_2o_{14}													.183 (.359)			-.548 (.139)							
hp_2o_{15}																			.913 (.035)				
hp_3o_{16}																	.667 (.087)					1.000 (.)	
hp_3o_{17}																							
hp_3o_{18}														.667 (.087)						1.000 (.)			
hp_4o_{19}																							
hp_4o_{20}																			.548 (.139)				
hp_4o_{21}			.200	-				.400															

			(.351)	.600 (.126)				(.222)															
hp_4o_{22}																					.800 (.063)		

Kendall's τ p_5	ep_5i_1	ep_5i_2	ep_5i_3	ep_5i_4	ep_5i_5	ep_5i_6	ep_5i_7	ep_5i_8	ep_5i_9	ep_5i_{10}
hp_5o_1					.000 (.500)	.333 (.248)				
hp_5o_2			-.183 (.359)				1.000(.)			
hp_5o_3		-.913 (.035)								.667 (.087)
hp_5o_4					.000 (.500)	-.333 (.248)				
hp_5o_5					-.667 (.087)	-1.000 (.)				
hp_5o_6	-.548 (.139)	-.548 (.139)			.000 (.500)	-.333 (.248)				.333 (.248)
hp_5o_7				.707 (.090)	.000 (.500)			.816 (.061)	-.183 (.359)	-.333 (.248)
hp_5o_8			.548 (.139)							
hp_5o_9										-.183 (.359)
hp_5o_{10}										.548 (.139)
hp_5o_{11}		-1.000 (.)								.548 (.139)
hp_5o_{12}										
hp_5o_{13}	.548 (.139)	.548 (.139)	.333 (.248)				.548 (.139)		.548 (.139)	

Kendall's $s\ \tau\ p_6$	ep_6i_1	ep_6i_2	ep_6i_3	ep_6i_4	ep_6i_5	ep_6i_6	ep_6i_7	ep_6i_8	ep_6i_9	ep_6i_{10}	ep_6i_{11}	ep_6i_{12}	ep_6i_{13}	ep_6i_{14}	ep_6i_{15}	ep_6i_{16}	ep_6i_{17}	ep_6i_{18}	ep_6i_{19}	ep_6i_{20}	ep_6i_{21}	ep_6i_{22}
hp_6o_1															-.548 (.139)						.333 (.248)	
hp_6o_2	.400 (.222)							.548 (.139)														
hp_6o_3	-.548 (.139)	.333 (.248)				-.183 (.359)				.333 (.248)	.333 (.248)											
hp_6o_4													-.548 (.139)									
hp_6o_5													.000 (.500)									
hp_6o_6				.183 (.359)			.183 (.359)						.548 (.139)									
hp_6o_7											.913 (.035)											
hp_6o_8				.183 (.359)			.183 (.359)						.183 (.359)									
hp_6o_9					.236 (.327)													.000 (.500)	.913 (.035)		.333 (.248)	
hp_6o_{10}														.200 (.351)				.913 (.035)				
hp_6o_{11}					-.707 (.090)											-.183 (.359)						

hp_6o_{12}			.333 (.248)				.000 (.500)														.548 (.139)
hp_6o_{13}																	.707 (.090)					
hp_6o_{14}									1.000 (.)												.913 (.035)
hp_6o_{15}									.333 (.248)												.183 (.359)
hp_6o_{16}									1.000 (.)												.913 (.035)
hp_6o_{17}									1.000 (.)												.913 (.035)
hp_6o_{18}					.000 (.500)													.183 (.359)	1.000 (.)		.183 (.359)	
hp_6o_{19}									.667 (.087)					.183 (.359)	.913 (.035)			1.000 (.)	.183 (.359)			.913 (.035)
hp_6o_{20}									.183 (.359)													
hp_6o_{21}												-.548 (.139)		.183 (.359)				-.667 (.087)				
hp_6o_{22}																	.775 (.079)			.200 (.351)		

Appendix K: Mann-Whitney results

Mann-Whitney p_{1-4}	ep_1i_1	ep_1i_2	ep_1i_3	ep_1i_4	ep_1i_5	ep_1i_6	ep_1i_7	ep_1i_8	ep_1i_9	ep_1i_{10}	ep_1i_{11}	ep_1i_{12}	ep_2i_{13}	ep_2i_{14}	ep_2i_{15}	ep_2i_{16}	ep_2i_{17}	ep_3i_{18}	ep_3i_{19}	ep_3i_{20}	ep_3i_{21}	ep_4i_{22}	ep_4i_{23}	ep_4i_{24}
hp_1o_1													0.200						1.000					
hp_1o_2			0.114																			0.200		
hp_1o_3		1.000																0.343					0.343	
hp_1o_4			0.200			0.686	1.000		0.200		0.343	0.486				0.486				0.200				
hp_1o_5				0.114	0.114		0.686		0.486		0.686													
hp_1o_6	0.686	0.486																						
hp_1o_7				0.343		0.686		0.686	0.343			0.343				0.343								0.114
hp_1o_8			0.200			1.000	0.486				0.486											0.029	0.486	0.057
hp_1o_9			0.200			0.486			0.200			0.686				0.686				0.343				
hp_1o_{10}				0.114	0.114		0.686		0.486		0.886													
hp_1o_{11}				0.114		0.686		0.343	0.686			0.114				0.114								0.114
hp_1o_{12}			0.200			1.000	1.000		0.486	0.686	0.686	0.343				0.343								
hp_1o_{13}		0.686						0.686															0.686	
hp_2o_{14}														0.686			0.343							
hp_2o_{15}																				0.114				

hp_3o_{16}																		0.886					0.343	
hp_3o_{17}																								
hp_3o_{18}															0.886						0.686			
hp_4o_{19}																								
hp_4o_{20}																				0.343				
hp_4o_{21}			0.343	0.486				1.000																
hp_4o_{22}																						0.343		

Mann-Whitney p_5	ep_5i_1	ep_5i_2	ep_5i_3	ep_5i_4	ep_5i_5	ep_5i_6	ep_5i_7	ep_5i_8	ep_5i_9	ep_5i_{10}
hp_5o_1					0.114	0.057				
hp_5o_2										
hp_5o_3			0.686				0.486			
hp_5o_4		0.114								0.486
hp_5o_5					0.200	0.114				
hp_5o_6					0.200	0.200				
hp_5o_7	0.200	0.343			0.343	0.200				0.486
hp_5o_8				0.343	0.686			0.886	0.886	1.000
hp_5o_9			1.000							
hp_5o_{10}										0.486
hp_5o_{11}										0.200
hp_5o_{12}		0.200								0.886
hp_5o_{13}	0.486	0.886	0.343				0.886		1.000	

Mann-Whitney p_6	ep_6i_1	ep_6i_2	ep_6i_3	ep_6i_4	ep_6i_5	ep_6i_6	ep_6i_7	ep_6i_8	ep_6i_9	ep_6i_{10}	ep_6i_{11}	ep_6i_{12}	ep_6i_{13}	ep_6i_{14}	ep_6i_{15}	ep_6i_{16}	ep_6i_{17}	ep_6i_{18}	ep_6i_{19}	ep_6i_{20}	ep_6i_{21}	ep_6i_{22}
hp_6o_1															0.200						0.886	
hp_6o_2	0.486							1.000														
hp_6o_3	0.486	0.686				0.486				0.486	0.686											
hp_6o_4													0.343									
hp_6o_5													0.886									
hp_6o_6				0.200			0.114						0.886									
hp_6o_7											0.486											
hp_6o_8				0.114			0.200						0.886									
hp_6o_9					0.029													0.486	0.343		0.343	
hp_6o_{10}														0.686				0.486				
hp_6o_{11}					0.029											0.114						
hp_6o_{12}			0.343				0.343															0.343
hp_6o_{13}																	0.200					
hp_6o_{14}									0.486													0.686
hp_6o_{15}									0.029													0.114
hp_6o_{16}									0.200													0.686
hp_6o_{17}									0.68													1.00

									6												0
hp_6o_{18}					0.029													1.000	0.686		1.000	
hp_6o_{19}									0.343					0.343	0.200			0.486	0.343			0.343
hp_6o_{20}									0.200													
hp_6o_{21}												0.886		0.486				1.000				
hp_6o_{22}																	1.000			0.343		