BACHELOR ASSIGNMENT

Validating results regarding changes in data strategies for Techspread

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S2397919

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TECHSPREAD.

Technische databronnen slimmer inzetten

i Research information

Bachelor thesis:
Validating results of changes for Techspread

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ii Preface

Dear reader,

At the moment you are looking at the report I have written for my bachelor's thesis Industrial Engineering and Management at the University of Twente. The research has been done at Techspread, a data consultancy located in Enschede, The Netherlands.

I am grateful for all help I received and the opportunities that were handed to me. Techspread handed me the opportunity to perform my research and gain a bit of working experience. I want to thank everyone at Techspread for taking the time to help me and for letting me experience what it is like to be part of the Techspread team. In particular, I want to thank Fleur Bake for being my supervisor and putting in hours to help me and my research to go forward.

I also received help at the university. I want to thank Abhistha Abhistha for being my first supervisor. Besides receiving a lot of useful feedback, I found it particularly helpful to talk about the problems occurring in my research and to get help with determining the next steps. I would also like to thank Dennis Prak for being my second supervisor and therefore putting in time and effort to give me feedback on my work.

Lastly, I would like to thank all people around me that helped me out when starting my thesis during the holiday. In particular Ipek Seyran Topan, for giving me the opportunity to start early with my thesis, and Monique Willems and Marrit Flach for making time for me during the holiday and giving a lot of feedback.

Have fun reading this thesis!

Anniek Pelleboer

April 2023

iii Management summary

Techspread introduced

Techspread is a data consultancy firm located in Enschede. It is a start-up which was founded in 2021. They believe many organisations have room for improvement when it comes to using their own data. Therefore, they help other companies in becoming “data-driven”. The goal is to makes changes in their data strategy, which will result in more efficiency. As improving the data strategy is a constant process, Techspread aims to become a partner of these organisations instead of ending collaboration after finishing a project. Techspread is mainly active in organisations with at least 75 employees in the manufacturing industry, healthcare, transport, wholesale, and business services. Techspread works with budgets, not with cost calculations in hindsight.

They achieve maximal efficiency by developing data models which can provide data insights. These insights can be used to effectively arrange the working processes of that organisation. An example is gathering certain data and visualising this in a dashboard. Then implementing the use of this insight into a process. This can result in more educated decisions and a more time-efficient process, as employees now do not have to search in excel sheets to make a decision which might have been the case before.

There are two types of changes Techspread suggests: changes in processes and changes regarding data insights. The changes in processes actually change the working processes within the organisation. For example replacing a physical complaint paper by an online one. Changes regarding data insights solely focus on creating a new data insight or improving an existing data insight. They are connected, because creating a new data insight is only beneficial when the use of this insight is also implemented in the processes of the organisation. It makes no sense to create a perfect dashboard which provides many new data insights, but then not implementing the use of it in any of the working processes. Many decisions regarding processes can be based on what data insights show to be beneficial.

Problem Techspread experiences

The problem Techspread experiences is that they cannot validate the outcomes of the changes which they suggest implementing in the data strategy of their customers. Therefore, it is difficult for Techspread to show their customers what the results of their service is. Next to that, it is difficult to show what progress has been made during the implementation phase.

Finding the solution

To overcome this problem, we researched possible solutions. The goal was to make a tool which enables Techspread to gather data and visualize this. To do this we had to decide what data should be gathered, how it should be gathered and in what way it should be displayed. For this we used literature, the input from Techspread and our own ideas. Before starting the development of the tool we set several conditions:

- The tool should be adjustable, so it can be better used for all the different organisations they have as clients. With this we mean that as not every company shares values equally, it is important that the tool makes it possible to reflect this.
- The tool needs to be well-defined, we do not want any uncertainties in context.
- The tool should be easy and efficient to use.

- We need to be able to show improvement over time. In this case, it would enable Techspread to compare different moments in time with each other and track progress.
- After a while, the tool should be usable for comparisons between other organisations.
- Representable for the customer so they will be able to use results in their reports.

This resulted in an excel tool to easily gather data on several variables. These variables differ per type of change. This data is visualized in five different dashboards which each have a different purpose:

1. Dashboard for processes: Shows the progress of implementing changes regarding processes and enables users to compare the outcomes of changes.
2. Dashboard reflecting on processes: Shows the difference between the expected outcomes and the final outcomes of the changes in processes.
3. Dashboard for comparing scenarios: Can be used to select which scenario to implement.
4. Dashboard for the chosen scenario: Shows the progress of implementation of the chosen scenario.
5. Dashboard for reflection on the scenario: Shows the difference between the expected outcomes and the final outcomes of the chosen scenario.

Result of implementing the tool

Before developing the tool, we have set certain conditions the tool should meet before it would be considered a good tool. These were that the tool should be adjustable per organisation, be well-defined, be easy and efficient to use, be able to compare different situation over time to show progress, be able to compare situation between different organisations, and be representable for the customer. Our evaluation shows that the tool performs well towards these conditions.

Recommendations

Based on the results from this research we have the following recommendations:

- Implement the tool according to the framework we provided. We recommend to combine the ADKAR framework with the two supporting factors, being open to change and having a well organised plan to implement the change.
- Keep evaluating the tools variables
- Improve user-friendliness of the tool
- Keep evaluating the visualisations
- Learn from the expected results vs the final results

For further research we recommend the following:

- Standardize data
- Include implementation costs
- Further define the social score
- Further define the data quality level
- Ways of comparing between different organisations
- Ways of making the tool more customisable

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1. Introduction

In this chapter, we will introduce the company where this research is performed at, Techspread. The initial problem is explained, and we will determine an action problem. In the end, we will find a core problem and define the scope of our research.

1.1 Company description

Techspread is a data consultancy firm located in Enschede, founded in 2021. They believe many organisations have room for improvement when it comes to using their own data. Therefore, they help other companies in becoming "data-driven". The goal is to makes changes in their data strategy, which will result in more efficiency. As improving the data strategy is a constant process, Techspread aims to become a partner of these organisations instead of ending collaboration after finishing a project. Techspread is mainly active in organisations with at least 75 persons in the making industry, healthcare, transport, wholesale, and business services. Techspread works with budgets, not with cost calculations in hindsight.

They achieve maximal efficiency by developing data models which can provide data insights. These insights can be used to effectively arrange the working processes of that organisation. An example might be creating a certain data insight and implementing the use of this insight into a process. This results in more educated decisions and a more time-efficient process, as employees now do not have to search in excel sheets to make a decision which might have been the case before. Many of these changes results in optimal use of the assets.

You can divide their changes over two types: changes in processes and changes regarding data insights. Changes regarding data insights solely focus on creating a new data insight or improving an existing data insight. The changes in processes are changes which actually change the working processes within the organisation. They are connected, because creating a new data insight is only beneficial when the use of this insight is also implemented in the processes of the organisation. Many decisions regarding processes can be based on what data insights say is beneficial.

1.2 Background of the problem

When a new customer comes to Techspread to become their data partner, Techspread generally follows the processes illustrated below to come up with a data strategy.

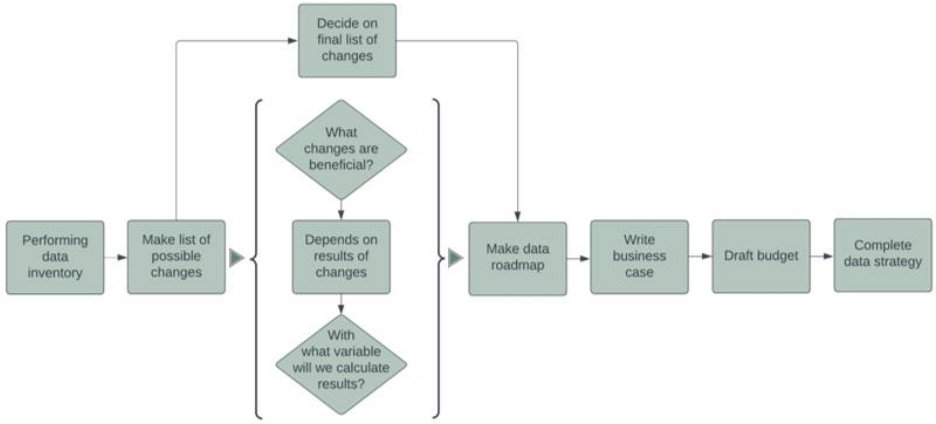


Figure 1: General process flow

The square blocks represent processes. When the first one is finished, we follow the arrow to the next process which can then start. The diamond shapes represent decision points. Decisions need to be made before we can continue. In this figure we depicted where the problem lies by putting it between brackets.

Techspread starts with performing a data inventory. After this they make a list with possible changes. Together with the company they choose what the final list of changes will be that need to be implemented. On this list they can base a data roadmap, write a business case, and draft a budget. When this is all done, they can present the final data strategy they want to implement.

The problem lies by deciding on the final list of changes. To select a part of the changes we want to know which changes are beneficial, this depends on what implementing these changes results in. To determine the results, we need variables with which we can measure and express the results.

Currently, Techspread does not validate the outcomes of changes. For the changes regarding processes, they do keep track of how much time they expect to save because of implementing this change, but this does not give a complete image of the results. Next to that, at the moment they do not visualise any results. For changes regarding data insights, they do not validate any outcomes. Another important point is that they do not note the realised gains after implementing the change.

Because the outcomes of the changes are not validated Techspread cannot easily show to their customers what implementing the changes delivers them. In their data strategy they ask for certain budgets which are needed to implement the data strategy, but they cannot argue what the results will be of using this budget specifically. Based on experience they can argue what their expectations will be and what will happen broadly speaking.

Besides not being able to fully argue the outcomes, there is another downside. If they want to treat every company the same and base each budget on the same experience, only one person can do this. Currently, only the founder of Techspread can argue results broadly speaking. This is the action problem we experience. Having one person who can decide on the list of optimal changes is not scalable.

1.2.1 Problem cluster

Figure 2 shows a cluster of the problems described above. In a problem cluster, you can see how all problems are connected (Heerkens & van Winden, 2017). When two blocks are connected with an arrow this means they have a causal relationship. The arrow starts at a fact which is the reason for the next block occurring.

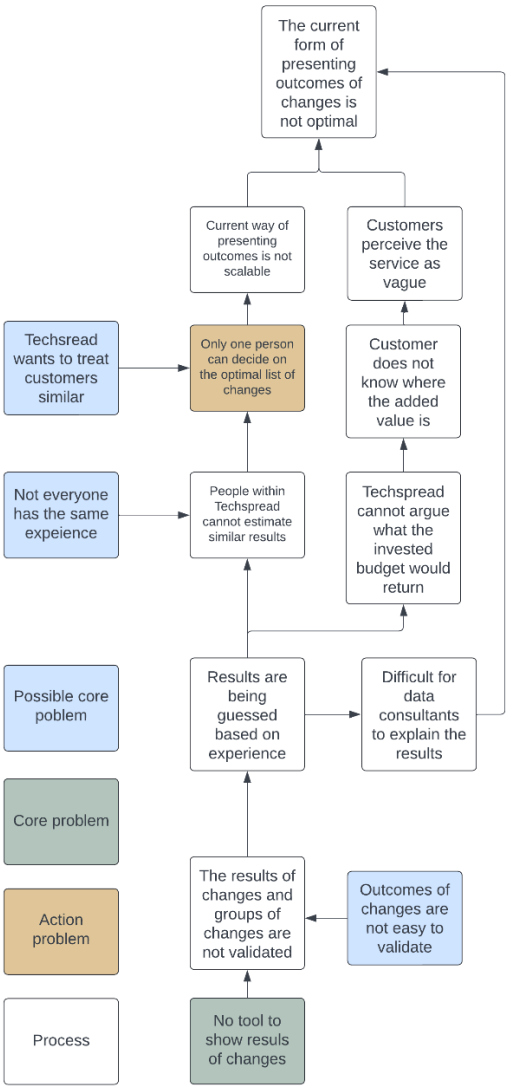


Figure 2: Problem cluster Techspread research

1.2.2 Core problem

Heerkens & van Winden (2017) explain that problems which you cannot influence should not be chosen as the core problem. Outcomes of changes not being easy to validate is not something we can influence, just like people not having the same experience. Therefore, we will not choose these as core problems. Techspread wanting to treat customers in similar ways is something they value and therefore will not be changed. In the cluster above we can see that not having a tool to show results of changes is the core problem. The norm is to have a tool that can show the results of changes, reality is that there is no such tool.

1.2.3 Stakeholders

The external stakeholders are the customers of Techspread. They would like to get a good idea of what Techspread will do and what this will result in. They would like Techspread to be able to argue what the return would be of investing certain budgets.

The internal stakeholders are the data consultants within Techspread. At the moment, not all of them are able to decide on a list of optimal changes. Currently, it is also difficult for the data consultants to explain what a certain change or group of changes will result in. Another internal stakeholder is the founder of Techspread. It would save her time if more people would be able to decide on what changes are most optimal. This would make the whole process more scalable.

1.3 Problem-solving approach and research design

To solve the problem at Techspread, we need a problem-solving approach. The aim of this research is to find out how to develop and implement the use of a tool that can validate the outcomes of changes and groups of changes. Therefore, the main research question will be:

"How can we develop a tool that can validate the outcomes of changes in the data strategy of an organisation and how can the tools use be incorporated in the business process?"

We performed our research with the help of the Managerial Problem-Solving Method (Heerkens & van Winden, 2017). As can be seen in the figure below this approach follows seven steps. When a step in a block is finished, we can continue to the next block by following the arrow.

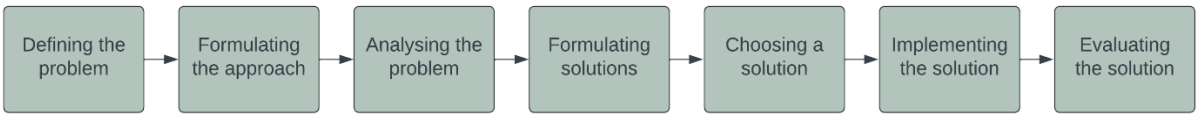


Figure 3: Managerial Problem-Solving Method

1.3.1 Part 1: Background information

We will start with retrieving background information. The goal is to get to know where the problem comes from and what the current situation is. Furthermore, we will try to find answers to certain questions in literature. These answers could help us when finding a solution in Chapter 3 and when giving advice on implementation in Chapter 4.

1. What is the current process of presenting a business case at Techspread?
    a. What factors are currently considered when deciding on the optimal list of changes?
2. What are useful variables for measuring results of organisational changes?
3. How can you define possible scenarios usable for predictions?
4. What approaches can be useful to predict outcomes of changes in an organisation?
5. What are useful theories on implementing change in working processes from organisation?
6. On what principals do companies need to report following the Corporate Sustainability Reporting Directive?
7. What are useful theories about determining the quality of data insights?
8. What are useful theories about designing a dashboard?

1.3.2 Part 2: Finding the solution

We will try to find a solution for the problem of Techspread. With some input from Techspread, the information we found in literature, and our own ideas we will come up with a solution. To do this we constructed some questions which will help us in this process.

9. How can we best define the scenarios in a tool that validates outcomes of changes?
10. Which variables should be used in the tool?

11. What conditions should be met by the tool?
12. How can you build a tool that validates outcomes of changes regarding data insights of processes in an organisation?

1.3.3 Part 4: Implementing the solution

Due to the restriction of time, we cannot implement the solution we find, but we do want to give an advice on implementing the use of the tool. With the help of literature and by observing the organisation within Techspread we will answer the following question:

13. How can the use of a tool that validates outcomes of changes in a data strategy be incorporated in the business process?

1.3.4 Part 5: Evaluation

In the end we also want to evaluate our tool. With the help of the data consultants at Techspread and our own input we will answer the following questions:

14. How well does the tool comply with the conditions?

1.4 Research scope

The goal is to deliver a tool which can validate outcomes of changes in the data strategy of Techspreads customers. There are several important factors which need to be defined for this tool to work:

1. The scenarios
2. The variables
3. The output of the tool
4. Conditions for the tool

The focus of this research will be on defining these four factors and on getting a working tool. Furthermore, we will be evaluating our solution.

1.5 Document outline

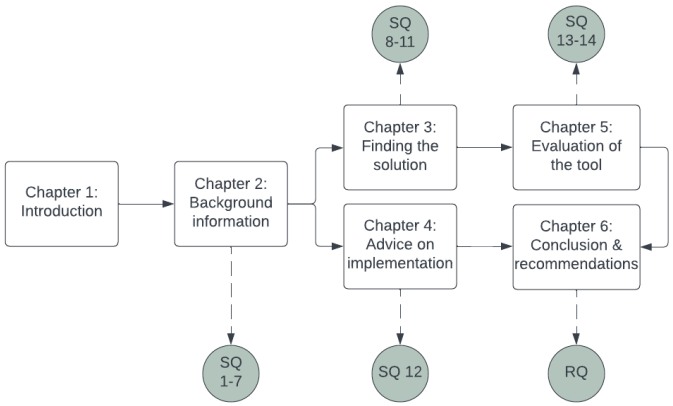


Figure 4: Overview document outline

2. Background information

In this chapter we will find the background information we need to continue our research and partly base our deliverables on. We will start with research the current situation in Section 2.1. Then we will look into literature to answer some of the questions mentioned in Section 1.3.1. Below you can find an overview of the construction of this report.

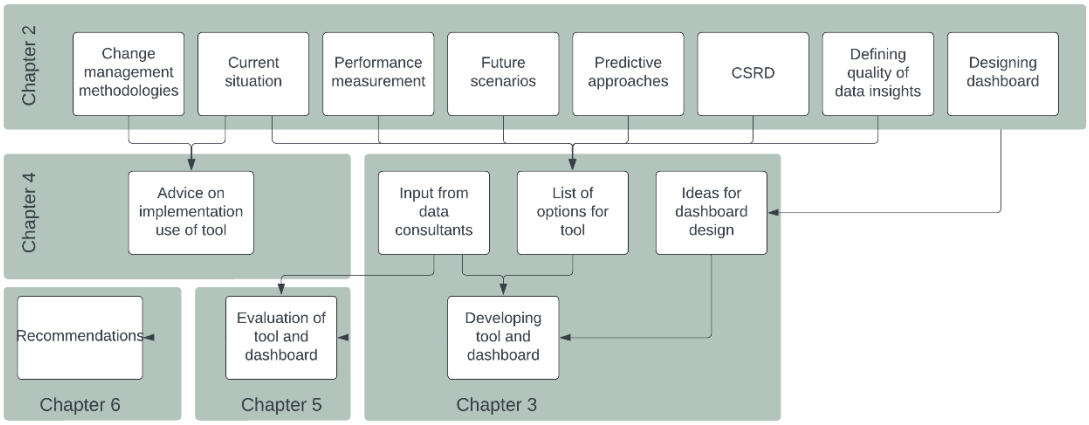


Figure 5: Report construction overview

In this chapter we will answer the following questions:

1. What is the current process of presenting a business case at Techspread?
    a. What factors are currently considered when deciding on the optimal list of changes
2. What are useful variables for measuring results of organisational changes?
3. How can you define possible scenarios usable for predictions?
4. What approaches can be useful to predict outcomes of changes in an organisation?
5. What are useful theories on implementing change in working processes from organisation?
6. On what principals do companies need to report following the Corporate Sustainability Reporting Directive?
7. What are useful theories about determining the quality of data insights?
8. What are useful theories about designing a dashboard?

2.1 Current situation

In this section we will research how Techspread currently presents their business case and what factors they consider when deciding on the list with optimal changes. This information can be later used to determine what strategy is useful when implementing the solution and to evaluate the changes compared to the old situation. The research strategies we use in this section are informal interviews and semi-structured interviews with employees.

We start by describing the general process in Section 2.1.1. Then we will look into “Phase 0” in Section 2.1.2. Lastly, in Section 2.1.3 we will discuss the process of making a business case in more detail.

2.1.1 General process

The general process of Techspread is depicted in Figure 6. Each square block represents a process, each diamond shape represents a decision point. When one process is completed, you can follow the arrow to

see the next process in line. At the diamond shape you can choose an answer and follow the arrow with this answer to see the next process in line.

When Techspread starts a new project with a customer they start with “phase 0”. Phase 0 consists of making a data inventory, making a data roadmap, a business case, a budget and defining a data strategy. The result is the first version of a data strategy. This strategy shows the current situation of a company and the “dream situation”, meaning all kinds of data-related changes are suggested which should make the organisation more efficient. In phase 0, all processes within an organisation get mapped in detail. Huge files with data are the result. Based on these maps and data it is determined what changes are possible. The business case is constructed with the proposed changes. Techspread together with the customer then decides which part of the strategy to implement. The next step is the implementation of the changes.

Visualisation of the current process

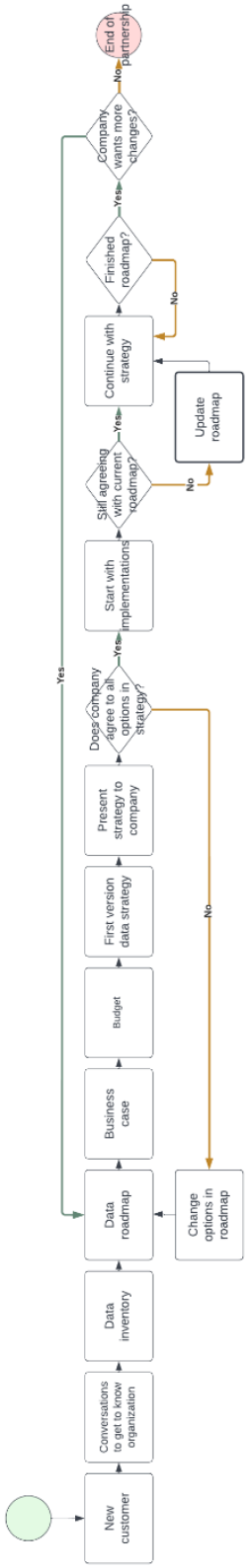


Figure 6: Visualisation of the current processes

2.1.2 Phase 0

In this section, we will go by each of the steps in phase 0. These are five steps: data inventory, data roadmap, business case, budget, and data strategy. A while ago Techspread did not have a “Phase 0”. In Phase 0 they get to know the organisation of their customer in detail and come up with a strategy to implement. After Phase 0 they present what they found, and the customer can choose whether or not they want the strategy implemented. Techspread asks a separate price for this, because developing a strategy costs a lot of time and effort, even if an organisation does not want to implement it. The benefit of having phase 0 is being able to charge this separately when a company does not want what Techspread is offering. Before introducing phase 0, they did do all these steps, but it was a waste when an organisation did not want to be their customer.

Data inventory

The first step of Phase 0 is making a data inventory. The goal is to get insight into the current data sources, challenges, and points of improvement. They look at the working processes, strategic goals, and desired insights. To draft this inventory people are sent to the organisation of the customer and spend time there to map what happens in many detail. One of the results of this step is a huge flowchart of all processes that happen within an organisation. For each process, they also find out what tasks are included, how much time each task takes, and how frequently this task is performed. The progress of this step is kept track of in a Google Sheet.

Data roadmap

A data roadmap looks like a big planning of implementing changes. An example can be found in Figure 7. Techspread works with “sprints”, these are blocks of ten weeks. The roadmap shows an overview of what will happen when and where.

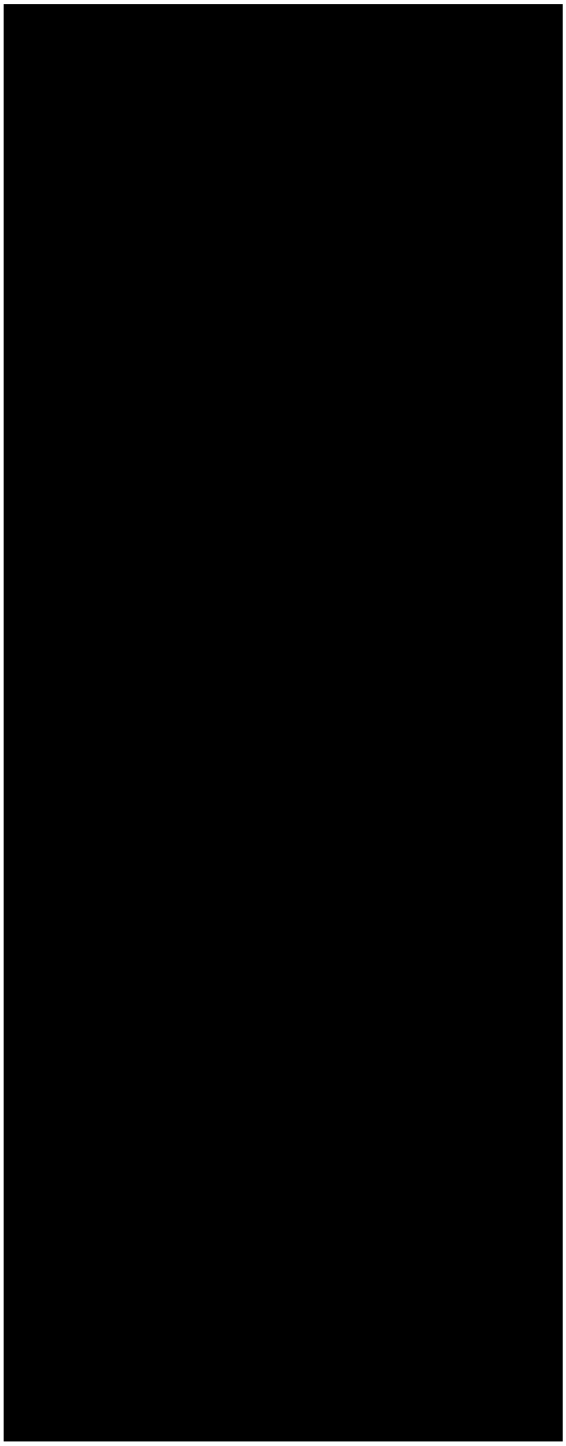


Figure 7: Example data roadmap

Business case

When making the business case Techspread looks at the possible changes and what they would cost and what it would deliver. In this part, Techspread can explain why a customer would have to implement a certain change and why they think it would be beneficial for the organisation. Together with the customer Techspread can alter the list of to-be-implemented changes presented in the business case.

Budget

Techspread works with budgets. They assign budgets to each sprint. Techspread prefers working with budgets over sending invoices afterwards. The benefit is that it is clear to the customers what the costs of hiring Techspread will be. The downside is that Techspread needs to know quite early how much budget they need and adjusting it is more difficult.

Data strategy

The final product of Phase 0 is the data strategy. Based on all the research mapped in the previous steps they constructed a strategy. This strategy explains in detail what needs to happen to go from the current situation to the dream scenario.

2.1.3 Main takeaway: Current situation

Currently, Techspread performs a data inventory on which they base a list of possible changes. Together with the company they decide on which changes to implement which gives them a final list of implementations. After this they make a data roadmap, write their business case, draft a budget, and complete the data strategy. Besides time needed to perform certain tasks, Techspread currently does not specifically collect any data on which they base the decision on which changes to implement.

2.2 Literature review on performance measurement

In this section, we will perform a systematic literature review to get more information about the possible variables which can be used when calculating the results of changes in organisations. We can use this information to decide which variables would be useful for the tool for Techspread. The key concepts in this search are performance measurement, variables, and organisational change.

We will start with a definition of performance measurement in Section 2.2.1. Variables are the measures with which you determine what a change delivered. Performance measurement is based on several variables. These variables are depending on what performance you are measuring. In Section 2.2.2 we will discuss different approaches to performance measurement. Then we will discuss the types of performance measures in Section 2.2.3.

2.2.1 Definition of performance measurement

Performance measurement is an important aid in making decisions and judgements (Parker, 2000). In literature, many different definitions of performance measurement are being used. For this research, we use the definition of (Franco-Santos et al., 2007). They explain that performance measurement is about providing an organisation with information with which they can identify strategies offering the highest potential. The exact reasons for measuring performance vary per organisation. Examples are, identifying bottlenecks, identifying success, show improvements, etc. There are various ways of measuring performance, some of these approaches are discussed in Section 2.2.2. (Parker, 2000) describes some fundamentals of performance measurement:

- Performance measures need to be aligned with the organisation's strategy.
- Sub-unit measures must aggregate into organisation-wide measures.
- There must be commitment to the measurement regime.
- Measurement must have an effect on performance.
- Measures must be reliable.

2.2.2 Approaches to performance measurement

These are several approaches to measuring performance. Those are described below:

- **Economic efficiency approaches:** In this approach, several economic variables are used to determine the performance in the financial area. These make use of quantitative performance measures. Examples are cost-benefit analysis, outcome rating scale, single outcome agreements, social audit, social accounting and audit, and social return on investment (Cordery & Sinclair, 2013).
- **Programme theory approaches:** This approach seeks to summarize how successful interventions are linked to outputs, outcomes, and impacts. Examples are intervention logic, logical frameworks, programme logic, result-based accountability, and theory of action (Cordery & Sinclair, 2013).
- **Strategic approaches:** In this approach, an organisation will measure and manage its performance in terms of the underlying strategy. An organisation identifies which activities it should carry out in order to achieve the performance they desire (Cordery & Sinclair, 2013).
- **Participatory approaches:** In this approach organisation use evaluator tools instead of accountability tools. Examples are outcome mapping and the most significant change (Cordery & Sinclair, 2013).

- **Benchmarking:** In this process, you compare your organisation to similar organisations and based on others determine how you are doing (Parker, 2000).
- **Balanced scorecard:** With this approach, you can translate a mission and strategy into a set of measures built around various perspectives. Examples of these perspectives are financial, customers, internal processes, innovation and improvement, and employees (Parker, 2000).

2.2.3 Types of performance measures

Besides having various approaches to measuring performance we also have different types of measures. These types are described below. (Parker, 2000) describes that you can divide most measures into four types: outcome measures, action measures, input measures, and diagnostic measures.

- **Financial measures:** profit margins, return on assets, return on equity. The limitations are showing a lack of relevance to the control of production and strategy. Next to that, these numbers may pressure short-term efficiency and discourage improvements which are beneficial in the long term. Furthermore, they ignore the non-monetary results from organizations and are not applicable to new management techniques (Tangen, 2003). Another example is Economic Value Added (EVA). This is the net operating profit minus the cost of having capital multiplied by the current capital (Kellen, 2003).
- **Activity-based costing (ABC):** ABC is concerned with the cost of activities within an organisation and their relationship to the manufacturer rather than to a functional base. The technique is to analyse the indirect costs within a company and to discover the activities that cause those costs. The limitation is that this technique also excludes non-monetary values (Tangen, 2003). A downside of this using this system is that it requires a high level of maintenance. This is impractical in quickly changing situations (Feurer & Chaharbaghi, 1995).
- **Traditional productivity measures:** Here the work content of a product is expressed as the time required to make the product using a given method of manufacture. Overall equipment effectiveness (OEE) is an example. The main goal is to increase equipment efficiency so that each piece of equipment can be operated to its full potential and maintained at that level. This method uses the OEE ratio. OEE is based on three aspects: time available, speed, and quality. OEE on itself is not worth much. The benefit of OEE is in linking the OEE data to identify losses in equipment (Tangen, 2003). Other variables to measure productivity are time and costs. An example is the time needed to complete a certain task or the costs made to complete a certain task. These go hand in hand as working hours need to be paid.
- **Non-cost performance measures:** You can classify performance measures into four more classifications: source of data, type of data, reference, and orientation to process. To add the intrinsic dimension, three classifications are added: decision type, aggregation level, and measurement unit (Tangen, 2003).
- **Quality management:** This includes programs that focus on improving the quality of the product or service and the processes (Kellen, 2003).
- **Customer Value Analysis:** This includes ways of measuring what value the customer receives and how the processes can be improved based on this (Kellen, 2003).
- **Action-profit linkage:** This focuses on identifying, measuring, and understanding the causal links between actions and profits within an organisation (Kellen, 2003).
- **Collaboration and culture:** This includes measures like customer satisfaction and employee satisfaction (Korpivaara et al., 2021).

- **Innovation and learning:** Measures like capability development (Korpivaara et al., 2021).

2.2.4 Challenges in performance measurement

Performance measurement knows several challenges. It is important to recognize these and take them into account when deciding on your own performance measures. (U. S. Bititci et al., 2006) states that in some contexts the use of performance measures can lead to dysfunctional behaviours and poor overall performance. (Seddon, 2008) suggests that performance measures and targets create a command-and-control culture which often generates hidden costs and demoralizes people by sub-optimizing various parts of processes.

Originally the goal of using performance measurement was to measure productivity management (U. Bititci et al., 2011). Later, when organisations became more complex, the purpose shifted towards budget control with a focus on productivity management. After a while, when global competition emerged, it shifted towards integrated performance measurement, still maintaining a focus on productivity and budget control. All these changes bring along other values, which need different measures to be taken into account when measuring performance. For example, the value of sustainability became more popular, but in the original performance measures, there was no option for measuring sustainability. Therefore, it may be difficult to get a total picture of how well an organisation is doing as there are probably no measures available to measure everything the organisation values.

2.2.5 Main takeaway: performance measurement

We wanted to answer the following question: “What are useful variables for performance measurement in organisations?” There are many different ways of measuring performance or change, the most used ones are listed above. Most of the measures focus on a certain part of the performance and therefore exclude useful insights or give a wrong image. Therefore, we might conclude that it is important to use more than one measure in our model. Also, it will be important to use non-monetary measures as some of the changes Techspread plans cannot be easily expressed in monetary values.

As discussed, there are challenges in performance measurement. The main takeaway here is that we have to keep in mind what the organisation values and know that there is no measure for everything the organisation values. Therefore, we should not only focus on getting the best value but still consider other factors.

List of possible variables:

- Profit margin
- Return on assets
- Return on equity
- Economic Value Added
- Indirect costs
- Overall Equipment Effectiveness
- Time
- Costs
- Product quality
- Employee satisfaction
- Customer satisfaction
- Capability development

2.3 Literature review on future scenarios

In this section, we want to get more information about how we can define scenarios for the future. Scenario planning is the part of strategic planning which relates to the tools and technologies for managing the uncertainties of the future (Ringland, 2010). This literature review will help us with getting an overview of different ways of defining scenarios which we would later use for Techspread. We will start off with a definition of a scenario in Section 2.3.1. Then we will discuss several approaches to defining scenarios in Section 2.3.2.

2.3.1 Definition of scenarios

(Ogilvy & Schwartz, 2004) explains that scenarios are narratives of alternative environments in which the current decisions may be played out. They are not predictions or strategies, they are more like hypotheses of different futures. The appropriate number of scenarios is generally considered to be three or four; two scenarios usually do not expand thinking enough, whereas more than four may confuse users and limit the ability to explore uncertainty (Peterson et al., 2003). Peterson, Carpenter & Cumming also explain that scenarios convert the key alternatives into dynamic stories by adding a credible series of external forces and actors' responses. Scenarios should become brief narratives that link historical and present events with hypothetical future events. Within these storylines, the internal assumptions of the scenario and the differences between stories must be clearly visible.

2.3.2 Approaches for defining scenarios

In technology planning, forecasting, strategic analysis, and foresight studies, scenarios are used to incorporate and emphasize those aspects of the world that are important to the forecast (Amer et al., 2012). There are several approaches to creating future scenarios Each approach is better suited for different situations. Below we will explain the most used approaches. These approaches can be divided into two groups: inductive approaches and deductive approaches.

The inductive approach

In this section we explain two different variants of the inductive approach: Emblematic events and the official future.

Emblematic events (Ogilvy & Schwartz, 2004)

In this variant, we start with an individual event and spin larger stories around this. An example could be that you start with the question "what if we replace all use of physical paper trails with an online version of these forms in our organisation?" You may start thinking about the monthly costs of paper use and what changing to online versions might save you. By starting with one event and building up a scenario can yield many useful insights. The downside of this technique is that it is unsystematic and depends on people's creativity.

The official future (Ogilvy & Schwartz, 2004)

In this variant, we start with something called "the official future". This is what the decision-maker really believes will occur. Often, this expected outcome is not very surprising, but it can also reflect the fears of the decision-maker. The next step is to identify the key drivers of the official future. This can be done by interviewing stakeholders. When these drivers have been identified it can be determined which ones are the most influential. The next step is to brainstorm about possible variations of the official future. These variations are based on possible but quite surprising changes in the key drivers.

The deductive approach

In this section, we explain four variants of the deductive approach: four quadrant matrix, the Wilson matrix, the morphological analysis, and the cross-impact analysis.

Four quadrants matrix – minimal approach (Amer et al., 2012)

The four quadrants matrix is a suited pick when only two criteria are enough to define the future. In each of the four quadrants, a scenario is developed. This approach targets two key uncertainties and organizes scenarios around them.

An example of this matrix is shown in Figure 8: Four quadrants matrix. You can see each quadrant represents a scenario each defined by either a low or high chance of factor one or two happening.

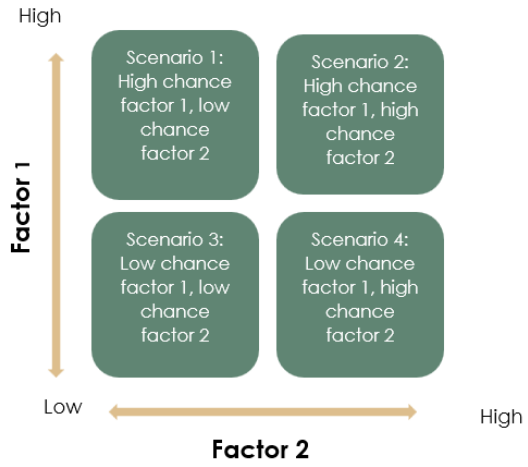


Figure 8: Four quadrants matrix adapted from (Amer et al., 2012)

Wilson matrix (Amer et al., 2012)

This approach can be used to evaluate and prioritize the influence and uncertainty of each scenario driver, concept, or factor. In the Wilson matrix, all factors are ranked against two dimensions: the degree of uncertainty and the potential impact on the future. In this matrix, it is sufficient to divide both dimensions into the categories “high”, “medium” and “low”.

The Wilson matrix has the same idea as the four quadrants matrix, but also defines “medium” besides “high” and “low”. An example is shown in Figure 9: Wilson matrix.

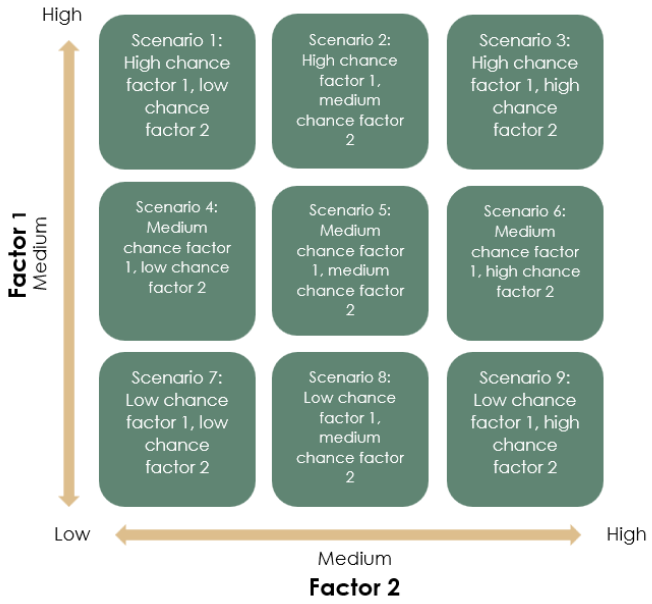


Figure 9: Wilson matrix adapted from (Amer et al., 2012)

Morphological analysis (Amer et al., 2012)

The morphological analysis can be seen as a possible solution for exploring all possible solutions to a multi-dimensional and non-quantifiable problem. It is advised to use this approach to eliminate incompatible combinations of factors and create plausible combinations. To do this each pair of factors has to be evaluated, which is a very time-consuming task, which can be better done by an automated tool (Johansen, 2017). This could be a reason which makes this approach less suited for smaller companies, as selecting the right scenarios can be expensive and very time-consuming.

Cross-impact analysis (Amer et al., 2012)

This analysis is used to identify the important chains of possible occurrences and the degree to which the occurrence of each possible event changes the probability of other events occurring. It looks at the probability of a certain event taking place given whether other events will or will not happen. This analysis identifies the impact of each factor on the rest of the factors. Figure 10: Cross-impact analysis shows an example of this analysis. In the table a score is assignment to represent the change of an event on the y-axis happening given an event on the x-axis is happening. Using this analysis can be very time-consuming.

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	Score
T1		3	3	3	2	3	3	2	1	2	22
T2	0		3	0	3	0	2	0	1	2	11
T3	1	1		0	0	0	2	1	0	0	5
T4	2	2	3		3	2	3	1	1	2	19
T5	0	2	3	0		0	2	1	1	3	12
T6	2	1	3	1	1		1	0	1	2	12
T7	1	2	2	2	2	1		3	2	3	18
T8	2	3	3	1	1	0	3		1	2	16
T9	2	1	0	2	1	2	2	2		1	13
T10	3	3	3	3	3	0	2	2	1		20

Highest Score: T1, T4, T7, and T10

0 Independent 1 Dependent
2 Slight Impact 3 Strong Driver

Figure 10: Cross-impact analysis (Amer et al., 2012)

2.3.3 Main takeaway: future scenarios

The question we wanted to answer in this section is: "How can you define possible scenarios usable for predictions?" Above we have discussed six main ways of defining scenarios, partly with the help of matrices. The morphological and cross-impact analysis can both be very time-consuming and are therefore less suited for Techspread. Both inductive approaches are time-consuming and not very concrete. The four quadrants matrix and the Wilson matrix seem to be the most useful in the case of Techspread. We can take this information to one of the input sessions to discuss possibilities.

2.4 Literature review on predictive approaches

In this section, we will look into different approaches which can be used to predict outcomes of changes in an organisation. As we want to make a tool for Techspread which predicts these results it is valuable to know what others currently use and how these methods work. In Section 2.4.1 we will focus on approaches to predict outcomes of changes in an organisation.

2.4.1 Approaches to predict outcomes of changes in organisations

Scenario model

Analysing scenarios facilitates the perception of profits and risks in taking alternative directions of action in the future. Often managements create several scenarios on which they base impact assessments (Ravic et al., 2022). They also explain the stages of making scenarios:

1. Defining the time frame and scope of analysis
2. Defining the main issues in the solution of which the scenario method should provide support
3. Identification of key factors and trends on which the observed results depend
4. Consideration of the interaction between the key factors
5. Identification of key scenarios and focus on a smaller number
6. Measuring the probability and impact of the realization of individual scenarios on the results

Scenario model in general

A model that contains conceptual participants and interrelationships is called a scenario model (Keppens, 2004). In this case, participants are factors that influence the chances of a certain outcome. The relationships are between the factors. A scenario model describes the scenario in a more detailed formalism, usually a set of variables and equations, which can be employed readily. A scenario model is an output of two other inputs. The first input is a representation that describes the system of interest by means of an accessible formalism. This model, usually consisting of real-world participants and their interrelationships are called the scenario. The second input is the task description. This is a formal description of the criteria by which the adequacy of the output is evaluated.

Task description explained

The task description mentioned before is explained in further detail by Keppens & Shen (2001). The figure below described this process.

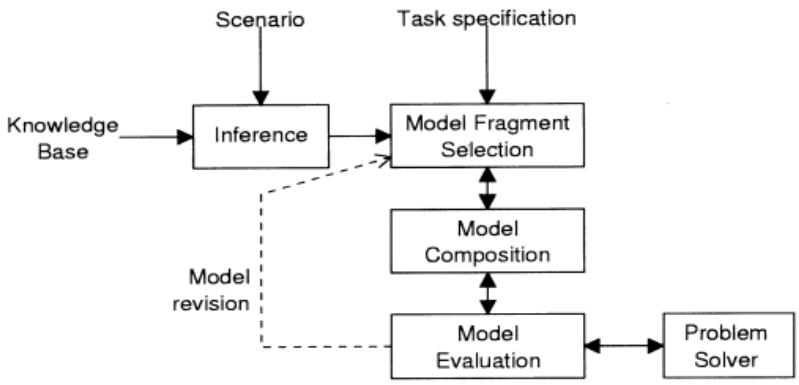


Figure 11: Task description of scenario model (Keppens & Shen, 2001)

The first step is putting the knowledge base and scenario through an inference mechanism. Inference means getting to conclusions based on evidence and reasoning. At the inference step, the constructs of the knowledge base are instantiated. These are model fragments and rules that apply to the scenario. The fragments describe how certain components, processes, or concepts can be modelled.

The second step is model fragment selection. Here we choose a subset of the instantiated model fragments by means of the task specification. These task specifications are normally specific to each implementation as many models are specialized to work with one particular type of task.

The third step is model composition. The selected model fragments are composed into a model. This phase may use various techniques.

Then the quality of the model is checked. This is done by looking at the adequacy of the underlying assumptions, and the necessity of the components, processes and/or concepts that are included in the model. In the model-evaluation phase, alternative models are assessed, and the best alternative is passed on to the problem-solver.

If during the evaluation new useful information is found. This information is fed back to the model fragment selection phase, in which the model is then revised.

Event simulation

(Srinivas et al., 2021) explains simulation can be used to determine outcomes of changes in different situations. It is often not possible to simulate the full real-life situation, therefore simplifications are needed. This is often done by stating assumptions. One version of simulation is discrete event simulation. Here you have a system where events happen at certain instances in time. These events take zero time to happen.

(Srinivas et al., 2021) describes that discrete event simulation maintains a set of future events in a data structure. An event happening starts with the initialisation. This step builds the data structures representing the simulation model, calls the right part of the code and inserts initial events into the list of future events. Then a subsequent loop consumes takes one event from the list and lets this event happen. The simulation stops when there are no events left on the list, when the time limit is reached, or when the statistics have reached the desired accuracy.

The downside of using simulation for business processes is that simulation costs a lot of time. Besides the large amount of time needed, the tools needed are often also costly.

According to (Hlupic & Vreede, 2005) simulation might be a good fit when:

1. The business process is of stochastic nature
2. There are complex interdependencies between the activities and resources in the process which lead to dynamic changes in the process
3. The business process consists of complex flows of activities, which can be understood by visual representation of its dynamics
4. Alternatives to change the business process are risky and costly, so the effects of change have to be measured as accurately as possible

The process of business process simulation can be described by the following steps:

1. **Definition of business process problem situation:** you start off with the problem situation.
2. **Definition of modelling objectives:** here you determine what is needed as outcome of the simulation.
3. **Definition of model boundaries:** here it is decided which processes should be incorporated.
4. **Data collection and analysis:** relevant data which is needed to model the processes needs to be collected and analysed.
5. **Development of business process simulation model:** the simulation model will be developed.
6. **Model testing:** each iterative step in model development should be thoroughly tested using as many models verification and validation techniques as necessary.
7. **Model experimentation:** one of the possible ways of performing a process is assigning to each experimental organisational unit, with the goal to reduce error and include a wide range of alternatives for wide recommendations.
8. **Output analysis:** the results obtained during experimentation should be analysed using standard statistical techniques.
9. **Recommendation of business process change**: based on the output analysis recommendations regarding business process change are made.

Delphi

The Delphi method is a qualitative forecasting method which predicts the probability and time of future events (Ravic et al., 2022). There are various modifications of the Delphi method. There is not one clear outline of what the Delphi method should be and what it is for. You can adjust it to several situations. When you use it as a forecasting method, it follows a basic structure (Grime & Wright, 2016). Individuals offer numerical responses to questions anonymously. An average response is then drafted and fed back to all individuals. They are given the chance to revise their answer. This is repeated until the predetermined stopping point. Then the average group opinion is shown as a result which predicts the future.

(Ravic et al., 2022) summarizes the above-mentioned steps as follows:

1. Determining the coordination group
2. Determining a group of experts
3. Compelling a questionnaire
4. Circles of the Delphi method
5. Presentation of results

It is best to use this method if the problem can benefit from group judgement and when group dynamics do not allow for effective communication.

2.4.2 Main takeaway: predictive approaches

The goal is to answer the following question: “What approaches can be used to predict outcomes of changes in an organisation?” After searching literature, we found three main approaches: using scenario models, using simulation, and using the Delphi method. In the case of Techspread, the approach will be used for several projects and used for rather small decisions. As simulation is often time-consuming and costly (Hlupic & Vreede, 2005), this does not seem the best fit for Techspread. The Delphi method requires a panel of experts and focuses on predicting whether a future event will happen. The downside for Techspread here is that they will be quite dependent on others and the process might be very time-

consuming. Besides that, Techspread focuses on the effects of a certain change in an organisation being beneficial. This might often be too specific to get opinions from others. Furthermore, it can be very time consuming to do this for each possible change separately, which will provide too little added value to compensate for the time investment. Using the scenario model is most in line with the situation of Techspread. It is important to keep in mind that the approaches discussed above are not rigid and can be adjusted based on different situations, therefore, parts of them might be useful. We will take these insights to an input session with Techspread to find out how this can help their situation.

2.5 Literature review on change management methodology

In this section, we will do a literature review to find out more about implementing change in an organisation. This will help us when we have to decide on an implementation strategy for Techspread. We will start by discussing important factors in changing working processes in Section 2.5.1. Then we will discuss approaches to changing working processes in Section 2.5.2. Lastly, we will look into the change management methods in Section 2.5.3.

2.5.1 Important factors in changing working processes

One of the bigger factors which determines whether a change in an organisation will be successful is how the employees react to it. One of the most difficult aspects of the organizational change experience for employees is the uncertainty associated with the process and outcomes of the change (Paulsen et al., 2004). This article explains six important attributes associated with change: A clear and communicated strategic vision, visible senior management involvement, people-based competitive edge, Marketing ethos, consensus-driven management, and awareness and reflection of social responsibility.

2.5.2 Approaches to changing working processes

In general, recommendations regarding change can be categorized into two categories: unilateral and shared methods (Waldersee & Griffiths, 2004)). The unilateral approach is top-down. This means that the employees will accept a certain change when they see that the change is successful. In reality, this means that changes are implemented without the employees knowing beforehand. Shared methods are participative. In contrast to unilateral the employees are included before the change is implemented. The main goal of this method is to build support for the change. This results in a feeling of ownership of the change which in turn results in commitment and motivation to make the change work (Waldersee & Griffiths, 2004).

2.5.3 Change management methods

Change management is the process, tools, and techniques to effectively manage the people side of the business change within the social infrastructure of the workplace (Nudurupati et al., 2011). (Al-Hadded & Kotnour, 2015) describe several methods which should help with a successful implementation of change in an organisation: Lewin's method, Judson method, Jick & Kanter method, Leading change method, Luecke's method, and the insurrection method.

Success factor model

(Thomas Lauer, 2019) describes one of these models in detail. He divides all factors into core factors and supporting factors. The outline of the success factor model is shown in FIGURE. The process starts with one person initiating change and developing a clear vision. This vision must be communicated to all involved parties. It is possible to get a consultant involved at this point in the process. It is important to have participation, meaning that others within the company are directly involved in the shaping of the future. Another core factor is getting integration between the involved groups. Next to that, re-education is of importance. The whole project should be well-organized throughout the whole process. One of the most important factors is that the organisation should be open to change, which is depicted by the word "evolution".

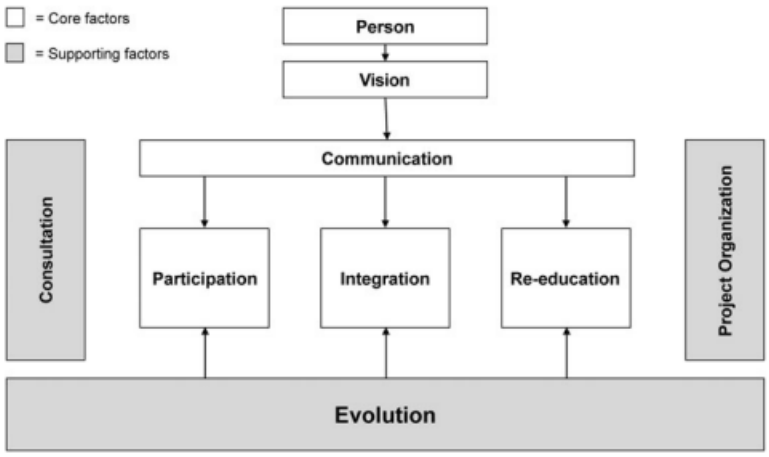


Figure 12: Success factor model (Thomas Lauer, 2019)

Kotter

Another often-used method is the one from Kotter. This method can guide changes in eight steps (Kotter, 1995). The eight steps are described below:

1. **Establishing a sense of urgency:** All stakeholders should understand why the change is necessary.
2. **Creating a guiding coalition:** Construct a group of people who are important for making the change. Make sure they are moving in the right direction.
3. **Create a vision for change:** This should summarize the reasons for the change easily and understandably.
4. **Communicate the vision:** Get all stakeholders to hear the vision.
5. **Remove obstacles:** Identify possible difficulties and look into resolving those.
6. **Create short-term wins:** Motivate people to help with rewards.
7. **Build on the change:** Repeat the steps. Reflect on everything and continue improving.
8. **Anchor the change**: Make sure the change sticks.

Nakigudde (2019) explains the benefits and downsides of Kotter's method. It is very good at getting others involved in the change. (Appelbaum et al., 2012) explains the downsides of this method. The first one is that Kotter thinks all steps must be performed in the right order which makes it a very rigid method. The second is that in some situations not all steps are relevant. Lastly, the model is not detailed enough to provide help in all stages.

ADKAR

As employees have a huge impact on the success of a change it is important to avoid resistance from this group. Nakigudde (2019) came up with five elements that prevent resistance to change. These elements can be represented by the abbreviation "ADKAR":

1. **Awareness of the need to change:** You want to get support from all stakeholders, therefore it is important that they are aware of the necessity for change.
2. **Desire to support the change:** It is beneficial when the stakeholders want to help with implementing the change. To receive this support the change and purpose should be clear to them.

3. **Knowledge of how to change:** Everyone involved in the change has to get an understanding of what has changed and adjust to new ways of doing things. To learn people new ways of doing things, training is necessary.
4. **Ability to demonstrate new skills and behaviours:** When the change is implemented and people are now working differently, this should be evaluated.
5. **Reinforcement to make the change stick:** After implementing a change it needs to be ensured that the changes have been adopted by everyone. It is important to see whether the change is fully implemented.

Nakigudde (2019) explains that ADKAR has several benefits and downsides. It focuses on the outcomes instead of what needs to be done. Progress can be measured at an individual level and the model recognizes that successful change is depending on the people involved and not only the processes. The downsides are that the model is more suited for smaller changes and that it does not focus on providing clarity of direction to get to the final destination.

2.5.4 Main take away: implementing change

In the section above the goal was to answer the following question: "What are useful theories about implementing change in working processes from organisations?" We learned that communication about the change is one of the most important factors. The approach which will be most suited for Techspread will be shared method, but with a bit of unilateral. People are aware of the problem and do want a solution, but not everyone is participating actively in finding the best solution.

There are many different methods for change management, and some of them are similar. In reality, there is no perfect model for each situation, each has positive and negative sides and most of them can be adjusted to the situation (Brisson-Banks, 2010). In the case of Techspread, the change influences the core process of Techspread. Employees will have to work with the change constantly, so the most important factor is that the change is accepted by the individuals. The ADKAR model focuses on individuals (Nakigudde, 2019), therefore using this model would be suitable for Techspread. In addition, the supporting factor of the success factor model might be beneficial to use when implementing change in Techspread.

2.6 Literature review on Corporate Sustainability Reporting Directive (CSRD)

In this section we will perform a literature review on CSRD. Getting information on this will help us deciding what variables are important to include in our model. We will start by introducing CSRD, then we will look into what areas companies will have to report on. The goal is to find out what companies will need to report on because of this directive.

2.6.1 CSRD introduced

This November, the European Parliament voted to pass the CSRD. This will make businesses more accountable by obliging them to disclose their impact on people and the planet ("New Social and Environmental Reporting Rules for Large Companies," 2022). This directive will apply to all large companies, meaning companies with over 250 employees and a 40-million-euro turnover. Companies will report on their impact on the environment, human rights, social standards and work ethics. Companies will have to oblige to this directive from 2024 onwards.

2.6.2 Reporting areas

Large companies have to report on several principles. These are divided over four standards. These are the cross-cutting standard, the environment, social factors, and governance. These standards in turn are divided in several areas. Below we have depicted an overview according to (*Public Consultation on the First Set of Draft ESRS*, n.d.)

- Cross-cutting standards
    - General principles
    - General, strategy, governance and materiality assessment disclosure requirements
- Environment
    - Climate change mitigation
    - Climate change adaptation
    - Pollution
    - Water and marine resources
    - Biodiversity and ecosystems
    - Resource use and circular economy
- Social
    - Own workforce
    - Workers in the value chain
    - Affected communities
    - Consumers and end-users
- Governance
    - Business ethics
    - Political engagements
    - Management and quality of relationships with business partners
    - Business conduct
    - Internal control and risk management systems

2.6.3 Expressing the standards

In the drafts showcased at () we can see what needs to be reported on and how some factors can be made measurable. Below we will discuss how some standards can be made measurable.

Environment (PTF-ESRS, 2022a) (PTF-ASRS, 2022; PTF-ESRS, 2022b, 2022c, 2022d)

Climate change	Pollution	Water and marine resources	Biodiversity and ecosystems	Resource use and circular economy
GHG emissions	Water pollution	Water withdrawal	Pressure metrics	Total weight of materials used
Energy efficiency	Air pollution	Water consumption	Impact metrics	% Renewable input
Material efficiency	Soil pollution	Water discharges	Response metrics	% Reused or recycled input
Fuel switching		Water recycling		Resource outflows
Electrification		Water stored		Waste
Use of renewable energy		Commodities of marine origin used		
Product change				
Process change				
Fuel consumption				

Table 1: Factors environment reporting

Groups of pollutants in air: Sox, NOx, CO, PM, heavy metals, POPs (persistent organic pollutants), VOCs (volatile organic compounds), ODS (ozone depleting substances), NH3, other chemicals regulated by REACH and CLP, other physical pollutants (heat, noise, light, radiation, odour).

Groups of water pollutants: oxygen demanding pollutants and nutrients, synthetic organic compounds, oil, pathogens, inorganic pollutants, microplastics and plastic particles, other physical pollutants.

Groups of soil pollutants: inorganic pollutants, organic compounds, nitrogen and phosphorous compounds, other pollutants

Measuring biodiversity and ecosystems is highly dependent on other parts of the environment category. Organisations are expected to know what parts of biodiversity and ecosystems they are pressuring with their current processes, then explain what plans they have for change and what this should have as results.

In measuring resource use and circular economy, the plans and preparations for reusing and recycling waste is of importance.

Social (PTF-ESRS, 2022j, 2022h, 2022i, 2022g)

Own workforce	Workers in the value chain	Affected communities	Consumers and end-users
Working conditions	Policies on value chain workers	Policies on affected communities	Policies related to consumers and end-users
Equal opportunities	Processes for engaging workings in the value chain	Processes for engaging affected communities	Processes for engaging consumers and end-users about impacts
	Channels for raising concerns	Channels for raising concerns	Channels for raising concerns

	Targets for negative impacts	Targets for negative impact	Targets for negative impacts
	Planned actions	Planned actions	Planned actions

Table 2: Factors social reporting

Working conditions: training and skills development, coverage of the health and safety management system, performance of the health and safety management system, working hours, work-life balance, fair remuneration, social security eligibility coverage

Equal opportunities: pay gap women and men, annual total compensation ratio, discrimination incidents, employment of persons with disabilities, differences in the provision of benefits to employees with different contracts

The reporting for the last three categories (workers in the value chain, affected communities and consumers and end-users) is mostly about knowing your current situation, describing plans for the future and what results these actions should have. Therefore, there are not much specific measures.

Governance (PTF-ESRS, 2022e, 2022f)

Governance, risk management and internal control	Business conduct
Description of the administrative, management and supervisory bodies in terms of age, gender, and other diversity categories	Number of anti-corruption trainings
% women/men in each body	Number of anti-corruption events
Average ratio women to men board members	Identity and percentage of ownership of largest shareholders
% Of each age category in bodies	Political contributions
	Indirect political contributions
	Expenditure data for political engagement and lobbying activities

Table 3: Factors governance reporting

2.6.4 Main takeaway: CSDR

The goal for this section was to find out what companies need to report on when this directive will obligatory. This directive forces organisations to think more about sustainability. The focus point can be summarized in four categories: cross-cutting standards, environment, social factors, and governance. For Techspread the cross-cutting standards and governance are less interesting to use as variable. These mainly focus on the characteristics of the reporting itself, the requirements, how to conduct business, and some matters that fall in between the other groups. As this will be quite specific it is difficult to set up valuable measures for this category. For the social category, the own workforce is most interesting as this is more doable to measure then the other parts of this category and of big importance for the success of an organisation.

We can use the found measures when thinking of the variables we want to use in the model. We would be mainly using variables related to environment and the own workforce in the social category. We do need to be critical in this process and perhaps think of new measures ourselves as it should be doable for Techspread to make judgements on these values.

2.7 Literature review on defining the quality of data insights

In this section we will perform a literature review on the quality of data insight. This information will help us with determining a grading scale for one of the variables in our model. We want to use a variable which shows what the quality of a certain insight is. We will do this by using a grading scale. We have to define each layer of the scale to make sure people give consistent grades. The goal of this literature review is getting a basic understanding of how we can define the quality of data insights so we can later use it in the selection of variables.

2.7.1 Definition of data quality

(Nikiforova, 2020) explains that the quality of data is usually defined as the suitability of the data for the use case. This source also describes that a data quality model consists of three components: data object, data quality specification, and the data verification process. We will explain these further in the next paragraph. ("A Guide to Data Quality Management," 2022) definition of data quality is in line with (Nikiforova, 2020). It defines it as the degree to which the data dimensions meet the requirements.

2.7.2 Defining quality of data insights

Above we mentioned the three components (Nikiforova, 2020) uses. The first is the data object, the object whose quality is assessed. The second being the data quality specification, the quality requirements defined for the data object. The third is a data quality verification process, this is the process which in the end decides what the quality of the data object is.

("A Guide to Data Quality Management," 2022) explains that data quality can be determined by following the "dimensional approach". (Nikiforova, 2020) follows a similar approach. There are various dimensions with which you can assess the quality of data. Often used dimensions are listed below.

- **Accessibility:** extent to which data is available. (Batini et al., 2009; Pipino et al., 2002)
- **Appropriate amount of data:** extent to which the volume of data is appropriate. (Batini et al., 2009; Pipino et al., 2002)
- **Believability**: extent to which data is regarded as true. (Batini et al., 2009; Pipino et al., 2002)
- **Completeness:** extent to which data is not missing and is of sufficient breadth and depth. ("A Guide to Data Quality Management," 2022; Batini et al., 2009; Pipino et al., 2002)
- **Concise representation:** extent to which data is well represented. (Batini et al., 2009; Pipino et al., 2002)
- **Consistent representation:** extent to which data is presented in the same format. (Pipino et al., 2002)
- **Ease of manipulation:** extent to which data is easy to manipulate. (Pipino et al., 2002)
- **Free-of-Error:** extent to which the data is correct and reliable. (Batini et al., 2009; Pipino et al., 2002)
- **Interpretability:** extent to which data is clear to interpret. (Batini et al., 2009; Pipino et al., 2002)
- **Objectivity:** extent to which data is unbiased, unprejudiced, and impartial. (Batini et al., 2009; Pipino et al., 2002)
- **Relevancy:** extent to which data is applicable and helpful for the task at hand. (Batini et al., 2009; Pipino et al., 2002)
- **Reputation:** extent to which data is highly regarded in terms of its course or content. (Batini et al., 2009; Pipino et al., 2002)

- **Security:** extent to which access to data is restricted appropriately. (Batini et al., 2009; Pipino et al., 2002)
- **Timeliness:** extent to which the data is sufficiently up-to-date. ("A Guide to Data Quality Management," 2022; Batini et al., 2009; Pipino et al., 2002)
- **Understandability:** extent to which the data is easily comprehended. (Batini et al., 2009; Pipino et al., 2002)
- **Value-Added:** extent to which data is beneficial and provides advantage from its use. (Pipino et al., 2002)
- **Accuracy:** extent to which the data is coherent with the actual situation. ("A Guide to Data Quality Management," 2022; Batini et al., 2009)
- **Validity:** coherence of the data in relation to a defined domain. ("A Guide to Data Quality Management," 2022)
- **Uniqueness:** whether there are duplicates in the records. ("A Guide to Data Quality Management," 2022; Batini et al., 2009)
- **Consistency:** extent to which the data is in line with itself, or does it contradict itself? ("A Guide to Data Quality Management," 2022; Batini et al., 2009)
- **Traceability:** extent to which it is possible where the data comes from. ("A Guide to Data Quality Management," 2022; Batini et al., 2009)
- **Clarity:** extent to which it is easy to understand the data. ("A Guide to Data Quality Management," 2022; Batini et al., 2009)
- **Availability:** extent to which it is easy to access the data. ("A Guide to Data Quality Management," 2022)
- **Currency:** difference between time in which data are stored in the system and time in which data are updated in the real world. (Batini et al., 2009)
- **Volatility:** volatility: extent to which data remains valid over time. (Batini et al., 2009)
- **Derivation integrity:** percentage of correct calculations of derived data according to the derivation formula of calculation definition (Batini et al., 2009)
- **Maintainability:** extent to which data is missing (Batini et al., 2009)
- **Speed:** server and network response time (Batini et al., 2009)
- **Ease of operation:** extent to which data is easy to use (Batini et al., 2009)

(Pipino et al., 2002) explains that companies must deal with both subjective perceptions of individuals involved with the data and the objective measures based on the data in question.

Subjective assessment of data quality (Pipino et al., 2002)

Subjective assessment reflects het needs and experiences of stakeholders. Their experiences can be measured by means of a questionnaire.

Objective assessment of data quality (Pipino et al., 2002)

In objective assessment there is task-independent and task-dependent assessment. Task-independent metrics reflect states of het data without the contextual knowledge of the application, and can be applied to any data set, regardless of the tasks at hand. Task-dependent metrics are developed in specific application contexts. These include the rules of an organisation, company regulations, government regulations, and constraints provided by the database administrator.

In objective assessment there are three functional forms which can be used for developing objective data quality metrics. These are simple ration, min/max operation, and weighted average. These functional forms are ways with which you grade the dimensions mentioned earlier.

- **Simple ratio:** Measures the ratio of desired outcomes of total outcomes. Free-of-error, completeness, consistency, concise representation relevancy, and ease of manipulation can use simple ratio.
- **Min/Max operation:** This is useful for dimensions that require aggregation of multiple data quality indicators. Compute the minimum or maximum value from among the normalized values of the individual data quality indicators. This could mean that one value is represented by two indicators, for example believability is represented by whether the data is true and credible. In this case we would assess how true the data is and how credible the data is and grade this. The grading can be done by using simple ratio but could also be done by giving a grade between 0 and 1. If you use min operation you select the lowest value as final value, for max operation you select the highest value. Believability, appropriate amount of data, timeliness and accessibility can make use of this.
- **Weighted average:** This is an alternative to the min/max operation. Here a value is assigned to each variable that represents a dimension. Based on how important this variable is to the value of the dimension. We do need normalized value for this, so the importance of each variable is graded between zero and one.

2.7.3 Main takeaway: defining quality of data insights

We wanted to find out how we can define the quality of data insights. In this section we did this by researching literature to find out how others did this.

There is a difference between subjective and objective assessment. Overall, assessment is done by use of dimensions. An organisation can select which dimensions are of importance to them and which ones they want to use to determine the quality of the data. Determining the quality of data can be different for each organisation as they all have different values and therefore will have a different opinion on the importance of each dimension. Next to that, grading the dimensions can be done in different ways.

For this research we will have to select which dimensions we want to use and to how we want to assign a grade to each dimension. We have a good basis of possible dimensions and ways of grading these dimensions.

2.8 Literature review on dashboard design

In this section, we will perform a systematic literature review on designing a dashboard. This is of importance as the data gathered by Techspread will be visualised. For this, we will need a dashboard. We want to find out what information is available on visualising data optimally in a dashboard.

The goal is to get a better understanding of how we can visualise the data we gather in the tool. In this case, the purpose of the dashboard is to provide insights based on the data calculated in the tool we will construct. We will start by explaining what a dashboard exactly is. Second, we will research the different types of dashboards known in literature. Third, we will research what different parts a dashboard can contain. Fourth, we will look at the design of a dashboard. Lastly, we will look into programs in which we can make a dashboard.

2.8.1 Definition of a dashboard

There are two types of dashboards, one in vehicles and digital dashboards (Groger et al., 2013). We will be looking into digital dashboards. In literature, we can find two definitions for digital dashboards. The first is a visualisation of key performance indictors (KPIs), and the other is a front end for monitoring, analysing, and optimizing business activities (Groger et al., 2013). Dashboards are visual displays that feature the most important information needed to achieve specific goals captures on a single screen (Smith, 2013). It also states that effective dashboards should be designed as monitoring tools that are understood at a glance. Sarikaya et al., (2019) and (Few, 2007) describe a dashboard as a predominantly visual information display that people use to rapidly monitor current conditions that require a timely response to fulfil a specific role. According to Few (2007), a dashboard is a visual display of the most important information needed to achieve one or more objectives, consolidated and arranged on a single screen so the information can be monitored at a glance. This also states that it is important to make a distinction between dashboards which are used for monitoring what is going on and displays that combine several charts on a screen for the purpose of analysis.

2.8.2 Types of dashboards

There is not only one specific type of dashboard. In literature, we can find dashboards which add value to different objectives. According to Few (2006) and Eckerson (2006), you can divide the dashboards based on their role:

- Strategic dashboards
- Analytical dashboards
- Operational dashboards.

Dashboards that are of strategic nature provide a quick overview that decision-makers need to monitor the health and opportunities of the business. These dashboards focus on high-level measures of performance.

Dashboards with analytical purses are typically used by data analysts, policy makers, evaluators, and researchers. They should be interactive and allow users to drill down into the details of the data. Furthermore, it should support explorations and examination (Smith, 2013). Dashboards with an analytical focus require a greater context. These dashboards should support interactions with the data, such as drilling down into the underlying details, to enable the exploration needed to make sense of it that is, not just to see what is going on, but also to examine the causes.

Dashboards with an operational purpose have a dynamic and immediate nature. When monitoring operations, it is important to maintain awareness of activities and events that are constantly changing and might require attention and response at a moment's notice (Smith, 2013). The display media on these dashboards must be very simple. The meaning of the situation and the appropriate responses must be extremely clear and simple (Smith, 2013).

2.8.3 Parts of a dashboard

A dashboard consists of several parts. Before designing a dashboard, it is important to be aware of which parts you need to include in the dashboard. In this section, we explain what literature tells us about which parts should be included in a dashboard.

A dashboard should consist of three layers (Eckerson, 2006b):

- Graphical, abstracted data to monitor key performance metrics
- Summarised dimensional data to analyse the root cause of the problems
- Detailed operational data that identifies what actions to take to resolve a problem

Correspondently, the purpose of these layers is monitoring, analysing, and action.

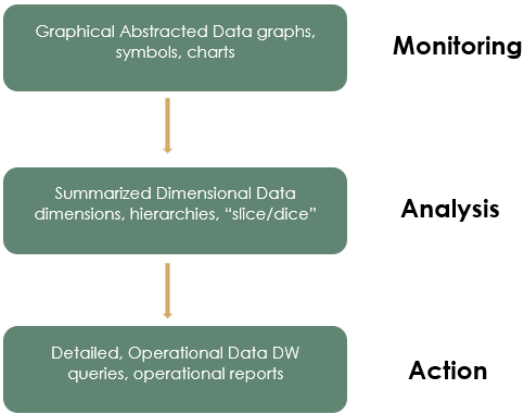


Figure 13: Three layers in dashboards, adapted from (Eckerson, 2006b)

A dashboard can be broken down into several components: data, technologies, users, organisation, features, and graphs and metrics (Cahyadi & Prananto, 2015).

There are five phases in dashboard development: selecting the key metrics, populating the dashboard with data, establishing relationships between the dashboard items, forecasting and scenarios, and connecting to financial consequences (Pauwels et al., 2009).

In literature we can find several sources describing which parts should be included in dashboard design:

- Data (Cahyadi & Prananto, 2015), (Bugwandeen & Ungerer, 2019)
- Technology (Cahyadi & Prananto, 2015), (Bugwandeen & Ungerer, 2019)
- Features (Cahyadi & Prananto, 2015)
- Data analysis (Cahyadi & Prananto, 2015), (Bugwandeen & Ungerer, 2019)
- Metrics (Cahyadi & Prananto, 2015), (Pauwels et al., 2009), (Bugwandeen & Ungerer, 2019)
- Relationships between dashboard items (Pauwels et al., 2009)

- Forecasting and scenarios (Pauwels et al., 2009)
- Connecting to financial consequences (Pauwels et al., 2009)
- Visual effects (Bugwandeen & Ungerer, 2019)
- Dashboard functionality (Cahyadi & Prananto, 2015), (Bugwandeen & Ungerer, 2019)

Below we will discuss the following components: data, metrics, data analysis, and dashboard design.

Data

Dashboards are data-driven decision support tools (Wilbanks & Langford, 2014). Therefore, we need data to be able to get any content in a dashboard. The question then is where to get our data from and how to capture the data. Performance measurement systems are information systems that transform performance data into assessments of organisational and individual performance (Aalst et al., 2012). (Aalst et al., 2012) also states that sometimes a dashboard can be seen as a performance management system consisting of performance measures and a supporting infrastructure. These supporting infrastructures can vary from very simplistic manual methods of recording data to sophisticated information systems.

The data used in the dashboard needs to be of good quality. Using high-quality data in analysing is mandatory when you want to offer valuable insights (Cai & Zhu, 2015). In general assessing data quality follows three steps:

1. **State reconstruction:** collecting contextual information.
2. **Assessment/measurement:** measures the quality of the data collections along relevant dimensions (explained in more detail in Section 2.7).
3. **Improvement:** selection of the steps, strategies, and techniques for reaching new data quality targets.

There are two types of improvement techniques: data-driven and process-driven (Batini et al., 2009). Data-driven strategies improve the quality of the data by directly modifying the value of data. Process-driven strategies improve quality by redesigning the processes that create or modify data.

There are different types of data. In almost all cases a dashboard needs quantitative data (Few, 2006). This type of data is used to monitor the critical information needed to do a job.

(Few, 2006) explains some options to diversify displaying data:

- **Variations in timing:** displaying measures in a variety of timeframes can give additional information.
- **Comparison:** comparing a measure to one or more related measures can give new insights and more context.
- **Evaluation:** in some cases, it can be useful to clearly evaluate a certain piece of data. This data can be evaluated quickly. Examples to do this are using colours to represent the positiveness of a value.
- **Non-quantitative dashboard data:** most data used in dashboards are KPIs or of quantitative origin. In some cases, it is beneficial to use non-quantitative data.

Metrics

A metric can keep stakeholders informed of the status of a project (Kerzner, 2017). Furthermore, it might be quite difficult to manage a project effectively without good metrics. A part of a project manager's role

is to understand what critical metrics need to be identified and managed to get a full view of a current situation. For a dashboard, this means choosing the right metrics to serve the purpose of the dashboard. Some organisations prefer to use key performance indicators (KPIs) to define metrics (Eckerson, 2006a).

A KPI is a metric that embeds performance targets so organisations can chart progress toward goals (Eckerson, 2006b). Rasmussen et al., (2009) and Kerzner, (2017) explain that the KPIs in a dashboard need to be "SMART" defined. This means the KPI needs to be specific, measurable, achievable, result-oriented, and time-bound. KPIs can have interdependencies (Kerzner, 2017). Meaning, that a change in a certain KPI results in changes in other KPIs. Kerzner, (2017)also explains there are criteria for KPIs, KPIs should be: predictive, actionable, relevant, and automated.

Categories of metrics (Kerzner, 2017):

- Financial metrics
- Success-based metrics
- Project-based metrics
- Project management process metrics

Literature describes several techniques for developing effective metrics. These are listed below:

- **Get buy-in:** make sure the people whose performance is being measured understand, accept and endorse the metrics (Eckerson, 2006b)
- **Simplify:** to avoid cluttering, display only a handful of matrics on a single screen (Eckerson, 2006b)
- **Empower:** make sure the workers have the license to make decisions that will improve the performance based on the metrics (Eckerson, 2006b)
- **Avoid perfectionism:** develop the metric to a point where you are 80 percent confident that it will have the desired effect (Eckerson, 2006b)
- **Monitor and revise:** to ensure the effectiveness of the metrics, the usage of the metrics needs to be monitored on a continuous basis (Eckerson, 2006b), (Kerzner, 2017)
- **Incentive:** attaching incentives to metrics prematurely is a recipe for disaster (Eckerson, 2006b)
- **Involve technic people:** these people can evaluate the existence and condition of data needed to populate proposed metrics (Eckerson, 2006b)
- **Make sure the metrics are based on what is needed instead of what is wanted** (Kerzner, 2017)
- **Make sure the metrics are worth collecting** (Kerzner, 2017)
- **Make sure that what is collected is used** (Kerzner, 2017)
- **Make sure the metrics are informative** (Kerzner, 2017)

Kerzner (2017) explains some requirements for good metrics:

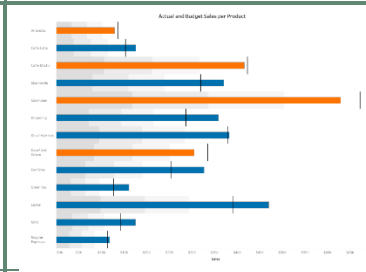
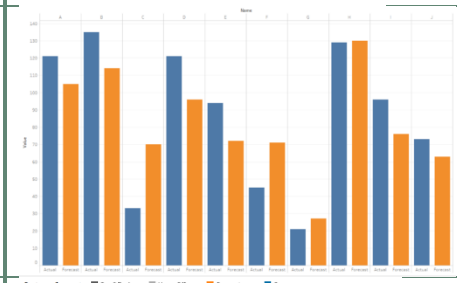
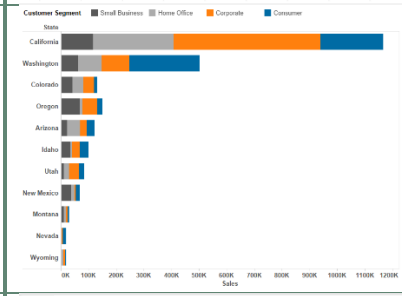
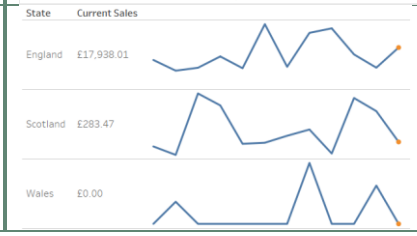
- Have a need or purpose
- Focus towards a target
- Be able to be measured with reasonable accuracy
- Reflect on the true status of the project
- Reporting structure
- Provide useful information
- Support proactive management
- Assist in assessing the likelihood of success or failure

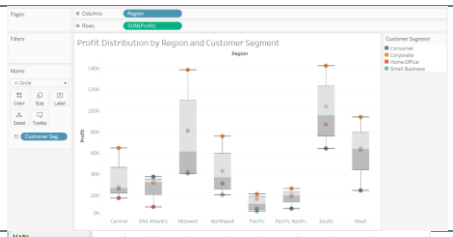
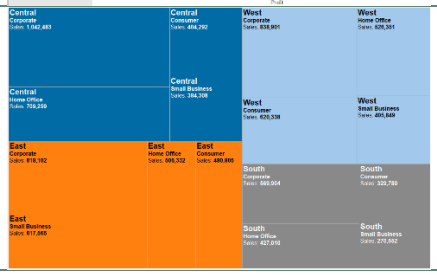
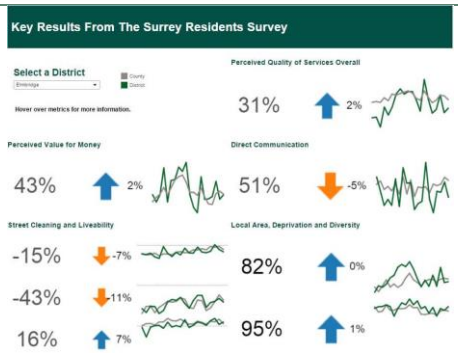
- Be accepted by the stakeholders as a tool for informed decision making

Data analysis

As dashboards are visual representations of data, they often make use of graphics. There are various media-displays which can be used to visualize data. Choosing inappropriate display media is one of the most common design mistakes made (Few, 2006). The best medium for displaying data depends on the nature of the information, the nature of the audience, and the needs and preferences of the audience.

Below we describe the different types of media displays as explained by (Few, 2006).

	Media display	Example	Description
Graphs	Bullet graph		Displays key measures, along with comparative measures and qualitative ranges to instantly declare what the state of the measure is.
	Bar graph		Displays multiple instances across different categories
	Stacked bar chart		Displays multiple instances of a hole and its parts.
	Line graph		Displays patterns in data.
	Sparklines		Displays the bare-bones and space-efficient time-series context for measures.

	Box plots		Displays the distribution of value sets across the entire range, from smallest to largest, with useful measures in between.
	Scatter plots		Displays whether or not, in what directions, and to what degree two paired sets of quantitative values are correlated.
	Treemaps		Display large sets of hierarchically or categorically structured data in the most space-efficient way possible.
Icons	Alert icons		To draw attention to information on a dashboard.
	Up/down icons		Provide a simple message that a measure has gone up or down.
	On/off icons		Serve as flags to identify some items as different from others.
-	Text		Information encoded as text.
	Images		Displays photos, illustrations, or diagrams.

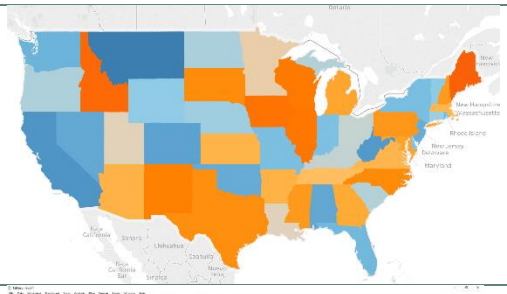
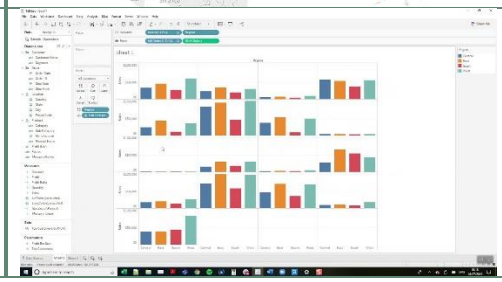
	Drawing objects		To arrange and connect pieces of information in relation to one another.
Organizers	Tables		Arrange data into columns and rows
	Spatial maps		To associate data both categorical and quantitative with physical space.
	Small multiples		Arranges graphs tabular, consisting of a single row or column of related graphs.

Figure 14: Types of media displays

2.8.4 Dashboard design

A dashboard is a visual display of the most important information needed to achieve one or more objectives (Few, 2006). Dashboards can be designed in endless ways, but there are some things to keep in mind when designing a dashboard. In this section, we discuss the literature regarding dashboard design.

There are two usage scenarios for a dashboard: push and pull (Janes & Sillitti, 2013). In the pull scenario, the user wants to get a specific piece of information. In this case, important considerations are:

- The dashboard should help the user to understand the context of the data
- The dashboard should help the user understand the meaning of the data

In the push scenario, the dashboard has to be designed so that important information is pushed to the used. In this case, the following considerations are important:

- The user should be able to see the dashboard without any effort
- The user should not need to interact with visualisations
- Arrange the data to minimize the time needed to consult the dashboard
- Guid ethe attention of the user to important information
- Consider aesthetic factors

The power of a dashboard hugely improves when you add the following two ways of interaction with data: Global filters and brushing (Few, 2007). Global filters enable the user to remove unwanted data from the dashboard. Brushing extends the ability to see connections in the data by highlighting specific sections.

There are several conditions described in literature which need to be kept in mind when designing a dashboard. These are listed below:

- Dashboard content:

    - the content of a dashboard should consist of the KPIs relating to the strategy of this organisation (Bugwandeen & Ungerer, 2019), (Eckerson, 2006a). Do not overwhelm users with too many things to monitor at one time.
    - It is important to provide enough context to the data (Few, 2006), (Eckerson, 2006a). The amount of context required depends on the viewer. Provide the properties or information of a metric when clicking on the metric.
    - Content should be in line with the information the users need (Eckerson, 2006a). Dynamically generate screens that are generically geared to every individual's role and responsibilities.
- Dashboard data analysis:
    - The dashboard should have drill-down capabilities to understand the root cause of deviations (Bugwandeen & Ungerer, 2019), (Eckerson, 2006a). Make sure that users do not get lost when using the drill-down functions.
    - Another point of attention is to accurately encode the quantitative data. Doing this wrong can give wrong information (Few, 2006).
    - Make the analysis guided (Eckerson, 2006a). Guide the users through the process of analysing.
    - Support further analysis (Eckerson, 2006a). Enable the user to use the data for "what-if" analysis.
- Dashboard visual effects:
    - The dashboard should consist of a single screen and simplicity is key (Bugwandeen & Ungerer, 2019), (Few, 2006), (Eckerson, 2006a). Too many details slow the viewer down.
    - It is also important to choose the most suiting measure. Choosing a misfit can make the dashboard more complicated than needed (Few, 2006).
    - A common mistake is choosing the wrong display media (Few, 2006). Sometimes this is caused by the designer wanting more variety in figures.
    - Data should be highlighted in a way such that the most important data should catch the attention of the viewer immediately (Few, 2006), (Eckerson, 2006a). For example, highlight exceptions.
    - Get rid of useless decoration (Few, 2006), (Eckerson, 2006a).
    - Metrics should visually express performance state, performance direction, and/or performance progress (Eckerson, 2006a).
    - A dashboard should have between 3 and 7 metrics (Eckerson, 2006a).
    - Organise the information to support its meaning and use (Few, 2006), (Eckerson, 2006a). The top left quadrant and the centre get the most attention, next is the upper right and lower left quadrants, and lastly the bottom right quadrant. Group elements that are related.
        - Organise groups according to business functions, entities, and use
        - Co-locate items that belong to the same group
        - Delineate groups using the least visible means
        - Support meaningful comparisons
        - Discourage meaningless comparisons
    - Maintain consistency for quick and accurate interpretation (Few, 2006).

    - Make the viewing experience aesthetically pleasing (Few, 2006). It is important to understand how we perceive colour. You can use hue, lightness, saturation, and intensity.
        - Choose colours appropriately.
        - Choose high-resolution clarity
        - Choose the right text
- Dashboard platforms:
    - The most important factors when choosing a platform are that the platform is serving the requirements, is user-friendly, is accurate, and can perform good analyses (Bugwandeen & Ungerer, 2019).
    - Make sure the users can access the dashboard via alternative interfaces (Eckerson, 2006a).
- Dashboard functionality:
    - A certain degree of customisation should be possible, but the format must remain standard (Bugwandeen & Ungerer, 2019), (Eckerson, 2006a).
    - Test design for usability (Few, 2006).

Many dashboards contain the following mistakes (Eckerson, 2006b):

- **Too flat:** they offer limited capability for drilling down and interacting with the underlying data
- **Too manual:** they require a lot of expertise and time to modify or change
- **Too isolated:** they may meet immediate business needs, but undermine the organisation's ability to obtain a single, consistent view of information across units
- **Too inaccurate:** when a dashboard merges information from multiple sources inaccurately
- **Too cool:** when dashboards use visually attractive displays that are perceptually ineffective

2.8.5 Main takeaway: Designing a dashboard

The purpose of dashboards is to feature the most important data needed for the corresponding situation. The quality is dependent on how well the dashboard suits the purposes of what the dashboard is meant for. We found three types of dashboards: a strategic dashboard, an analytical dashboard, and an operational dashboard. A typical dashboard consists of several parts, these are data, metrics, data analysis, technology, features, relationships, scenarios, visual effects, and functionalities. After deciding what to include there is another important factor, dashboard design. The most important design rules for a dashboard are having the right display for a certain metric, arranging the data well in the dashboard, keeping the number of media displays in mind, do not use many non-informative displays, do not use too many colours.

3. Finding the solution

Now we have retrieved the background information we need, we can start looking into using this in the situation of Techspread. The goal of this chapter is to define a solution for the problem Techspread is experiencing. We want to develop a tool which visualises the validated outcomes of changes. Below you can find an overview of the structure of this report. Here you can see what we will do in this chapter and what it will be used for.

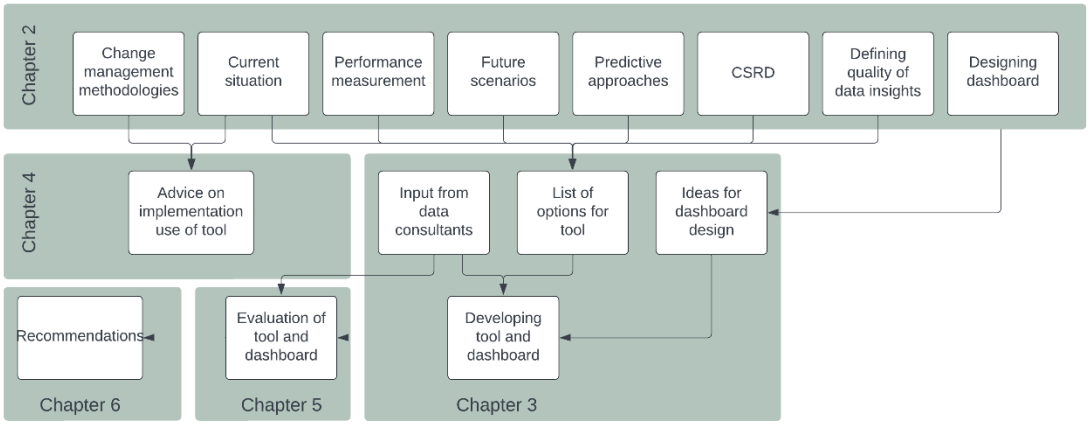


Figure 15: Report construction overview

We will answer the following questions in this chapter:

9. How can we best define the scenarios in a tool that validates outcomes of changes?
10. Which variables should be used in the tool?
11. What conditions should be met by the tool?
12. How can you build a tool that validates outcomes of changes regarding data insights of processes in an organisation?

To answer the first three questions, we planned an input session with the data consultants at Techspread. A presentation was prepared which was used to get input on defining scenarios, selecting variables, setting conditions for the model, and determining what the tool should give as output. We used the findings from literature to prepare this session.
The tool consists of two parts: Excel sheet to gather data and dashboard to visualise this data. In this chapter we start with the general decisions for the tool in Section 3.1. Then we look into more specifically into the Excel sheets in Section 3.2. Lastly, we look into the dashboard in Section 3.3.

3.1 The tool

In this section we will define several matters for the tool. We start by setting the conditions, next we define the scenarios we will use in the tool. Thirdly, we will look into selecting the variables we will be gathered data for. Lastly we look at the output of the tool.

3.1.1 Conditions for the tool

Together with Techspread, we drafted some conditions for the model. These conditions represent what Techspread values and what they think is important to see in a model.

- The tool should be adjustable, so it can be better used for all the different organisations they have as clients. With this we mean that as not every company values the same things equally, it is important that the tool makes it possible to reflect this.
- The tool needs to be well-defined, we do not want any uncertainties in context.
- The tool should be easy and efficient to use.
- We need to be able to compare situations to earlier moments. In this case, it would enable Techspread to compare different moments in time with each other and track progress.
- After a while, the tool should be usable for comparisons between other organisations.
- Representable for the customer so the customer will be able to use results in their reports.

We will take these conditions into account in the process of creating the tool and we will evaluate the tool based on these conditions.

3.1.2 Defining scenarios

During a input session, we discussed how we should define the scenarios in our model. We found out it will be way more valuable to use scenarios in a different way then found in literature. It is valuable for an organisation to see the results of multiple changes regarding data insights combined instead of only the results of creating one insight separately. Therefore, we decided to use scenarios to display the combined results of implementing different changes. We will have three scenarios: “individual”, “datamodel”, and “data doelgroep”.

In the scenario “individual”, the results of creating a single insight will be displayed. Results from each insight will be shown separately. In the scenario “datamodel” insights are grouped based on to which datamodel they relate. This scenario will consist of several groups which all represent a certain data model. For each data model, it is shown what the result is when this group of data insights is created. An example of a data model could be a dashboard. In the scenario “data doelgroep” insights are grouped per department of the organisation. For each group, it is shown what the results will be when all insights valuable to that department are created.

The groups in the scenarios “datamodel” and “data doelgroep” are created by the data consultants at Techspread. The expected results for these scenarios are estimated by the data consultants.

3.1.3 Selection of variables

In Section 2.2 we researched what variables are useful in measuring performance in businesses. We have set up a list of possible variables which could be useful for Techspread based on literature. During the input session, we went over this list and determined what variables would be useful. After this, we brainstormed about using other variables. As explained in Section 2.1.3 we need different variables for two types of changes. We discussed this during the input session. We will discuss them separately in this section.

Selecting variables from literature

From literature, we found a list of possible variables. To keep the input session efficient, we left out the variables which seemed not of use in the case of Techspread and added some that did seem useful. During the input session, we went over this list. Additions were also made. With the help of literature and our own experience, we noted for each variable an explanation, benefits, and drawbacks. In the last column, we have written what the conclusion is with regards to the use of the variable.

Variable	Explanation	Benefits	Drawbacks	Conclusion
Employee satisfaction	To measure how happy employees feel in their position	Techspread suggests changes in working processes, this factor can be of importance	Mostly based on opinion and no monetary values	Useful.
Time	To show how much time it takes to complete a certain task	Many small changes can easily be expressed in time saved	Some factors cannot be expressed in time saved	Useful.
Costs	To show how much costs are saved because of a certain change	Many changes can easily be expressed in changes in costs	Some factors cannot be expressed in costs saved	Useful.
Return on assets	Compares the profit to the total assets invested	Shows the impact a change has on profitability compared to the assets invested in the organisation, own equity and investors' equity	This value will barely show a difference when you look at a smaller change	Could be useful, focus on assets.
Economic Value Added	To measure the final value gained: Net operating profit – (cost of having capital * current capital)		Focuses on what impact the cost of having capital has on the profit. Doesn't consider many factors. A change in this value is mostly dependent on capital-related factors. Does not have much to do with the benefit of change.	Could be useful with a slightly altered definition.
Indirect costs	To measure costs which are not directly related to a certain production process. They are not variable costs which can be assigned to producing a product	Many processes bring along indirect costs. The changes Techspread makes are in all processes throughout organisations, saving indirect costs would be quite useful	Could also be valuable to just look at all costs saved, not only the indirect costs.	Could be useful, but then cost in general.
Overall Equipment Effectiveness	Shows to what extent each piece of equipment is operated to its full potential	It is quite clear where we still have room for improvement.		Could be useful, but then use of assets.
Product quality	To measure how the quality of the product is perceived		The changes Techspread suggests do not have much to do with the quality of products	Not suited.
Customer satisfaction	To measure how customers feel about an organisation, product, service, etc	Customer opinion has a big influence on the successfulness of an organisation	Techspread does not have much to do with how customers perceive an organisation	Not suited.
Error sensitivity	To measure the chances of making			Not suited.

	mistakes in a certain process			
Capability development	Measures how people in an organisation are developing in what they do for the organisation			Not suited.
Profit margin	Measures the sales of selling a certain product minus all costs made for producing that product	A clear view of what the impact of a change is on the profit	Leaves out the overall costs. Product-specific costs might decrease, while overall costs increase. Does not make sense in the case of Techspread as they look at small processes, not necessarily related to producing a product.	Not suited.
Return on equity	To compare the profit to the total equity	Shows the impact a change has on the profitability of an organisation taking into account their equity	This value improves if equity gets lower and profit stays the same, while with long-term investments this is not the case. Smaller changes in specific processes do not have much influence on the equity	Not suited.

Table 4: Economic variables discussed

The variables discussed above are mostly useful when talking about changes in processes. For the changes concerning data models, we used a different approach. To find useful variables for these, we talked about what reasons there are for making these models. The main goal was to create valuable data insights or improve the already existing data insights.

In Section 2.7 we performed a systematic literature review on defining the quality of data insights. We looked per dimension whether we thought this would be useful to include in the model. This can be found in the table below. Some dimensions are not useful because measuring these would be undoable, or it has not enough added value compared to the effort.

Dimension	Definition	Conclusion
Accessibility	extent to which data is available	Useful
Appropriate amount of data	extent to which the volume of data is appropriate	Useful
Completeness	extent to which data is not missing and is of sufficient breadth and depth	Useful
Concise representation	extent to which data is well represented	Useful
Consistent representation	extent to which data is presented in the same format	Useful
Ease of manipulation	extent to which data is easy to manipulate	Useful

Free-of-Error	extent to which the data is correct and reliable	Useful
Interpretability	extent to which data is clear to interpret	Useful
Objectivity	extent to which data is unbiased, unprejudiced, and impartial	Useful
Relevancy	extent to which data is applicable and helpful for the task at hand	Useful
Security	extent to which access to data is restricted appropriately	Useful
Timeliness	extent to which the data is sufficiently up-to-date	Useful
Understandability	extent to which the data is easily comprehended	Useful
Accuracy	extent to which the data is coherent with the actual situation	Useful
Validity	coherence of the data in relation to a defined domain	Useful
Uniqueness	whether there are duplicates in the records	Useful
Clarity	extent to which it is easy to understand the data	Useful
Availability	extent to which it is easy to access the data	Useful
Volatility	extent to which data remains valid over time	Useful
Ease of operation	extent to which data is easy to use	Useful
Derivation integrity	percentage of correct calculations of derived data according to the derivation formula of calculation definition	Not useful, measuring this would be too extensive
Maintainability	extent to which data is missing	Not useful, overlapping with free-of-error
Speed	server and network response time	Not useful, is not influenced by Techspread
Currency	difference between the time in which data are stored in the system and the time in which data are updated in the real world	Not useful
Consistency	extent to which the data is in line with itself, or does it contradict itself?	Not useful, too extensive to measure
Traceability	extent to which it is possible where the data come from	Not useful
Value-Added	extent to which data is beneficial and provides advantages from its use	Not useful, is already represented by the other pillars
Reputation	extent to which data is highly regarded in terms of its course or content	Not useful, extensive to measure

Believability	extent to which data is regarded as true	Not useful, measuring opinions of users is extensive

Table 5: Decision data quality dimensions

Together with Techspread we decided to work with "pillars". The pillars represent a certain category, which will defined with variables. Some of these variables will be rating variables, which need an explanation of the grading scale.

Variables for changes in processes

With the help of literature and input from the data consultants at Techspread, we were able to determine what variables would be important and convenient to see back in the tool. We did this by thinking of five pillars. As we want to minimize subjectivity in assigning values to these pillars, we used multiple variables to help get an objective value. As changes influence multiple processes, we will depict the changes in the pillars and variables for each process separately. The pillars and the corresponding variables are summarized below. After the summary, an explanation of the variable is given, together with an explanation of why we chose this variable.

1. Time needed
    a. The current time needed to execute tasks in a certain process
    b. The time needed to execute tasks in a certain process after implementing the change
2. Wage costs needed
    a. Time saved in each wage scale
    b. Wage per hour for each wage scale
3. Assets in use
    a. Improvement in asset A
    b. Improvement in asset B
    c. Improvement in asset C
4. Social score
    a. Pollution
        i. Improvement in chosen pollution types
    b. Waste
        i. Hazardous waste
        ii. Recyclable waste
        iii. Other waste
    c. Material input
        i. Reused/recycled material input
        ii. Other material input
    d. Energy
        i. Renewable
        ii. Other
    e. Water
        i. Recycled water consumption
        ii. Other water consumption
    f. Employee satisfaction
5. Tracking progress

The data on needed time will be collected in hours and the final value will also be shown in hours. Data on the needed wage costs will be collected in euros and the final value will also be shown in euros. The improvement in use of assets will be measured in percentage and the final value for asset use is the average improvement in percentage. The social score is calculated in a more complicated way. Users are asked to rate the importance of each social segment. Then the percentage improvement is determined for each of the social segments. Then the weighted average of the improvement is calculated which will be the final value for the social score.

Variables for changes with regard to insights

The variables needed for the insights given by data models differ from the variables for processes. Below we summarized what pillars and complementing variables will be used for formulating the value of data insights. We need to keep in mind that the results of new insights will only actually be there when the use of this insight is implemented in a process. Implementing the use of a data model in a process is a change to the process and therefore, the results of that will also be treated as a change to a process. In this section, we will look at the results of data insights.

1. Time needed
    a. The current time needed to execute tasks in a certain process
    b. The time needed to execute tasks in a certain process after implementing the change
2. Quality of data insight
    a. Accessibility
    b. Appropriate amount of data
    c. Completeness
    d. Concise representation
    e. Consistent representation
    f. Ease of manipulation
    g. Free-of-Error
    h. Interpretability
    i. Objectivity
    j. Relevancy
    k. Security
    l. Timeliness
    m. Understandability
    n. Accuracy
    o. Validity
    p. Uniqueness
    q. Clarity
    r. Availability
    s. Volatility
    t. Ease of operation
3. Tracking progress

The data for time needed will be collected in the same way as for the changes in processes. The final values for the quality of the data insights will be determined in a more complicated way. First the users is asked to rate the presence of each dimension on a scale of zero to five. Zero meaning not present at all, five meaning no improvement left. Then they have to fill out the expected levels after implementing the

change. The user is also asked to express their how much they value each dimension. With this information we calculate a weighted total. The final value for quality of data insights will be a weighted total of the rating of all dimensions.

3.1.4 The output of the tool

The main question the tool should answer is the following: “What are the results of changes or groups of changes?”

The output of the tool will be a sheet in which all data is gathered and visualisations of the results of a specific change or a group of changes. This will be done for the changes in processes and the three scenarios. The output will be visualised in several dashboards which are explained in Section 3.3. With this, we will keep in mind the conditions we have set in Section 3.1.1.

3.2 The Excel sheets

In this section, we will look into the Excel part of the tool in more detail. We will start by explaining the sheets and their use, after which we will look into the information flow.

3.2.1 The Excel sheets explained

In this section, we will explain the Excel part of the tool and its use. For Techspread we have written a handbook which can help when using the tool. This handbook also explains how the tool exactly works, which might come in handy when wanting to alter the tool or when wanting to understand where a certain value comes from.

After defining the scenarios, variables, output, and conditions we were able to start building the tool. In Excel, we used several sheets where Techspread together with their customer can put information which will be later used in the dashboard. We will go over each sheet and explain its purpose. At the end of this section, we show how the data flows through the tool in Figure 17.

Initial input

This sheet is shown in Figure 16. In this sheet, we want to collect some information about the current situation of the organisation and their values. When you click the button “click here to start”, there will be a form which asks for the number of wage scales, assets, and pollutions to include. Based on these answers the tables in the sheet are altered so the right information can be filled out.

The first block is for giving information about the wage scales. In the second block we ask to select the most important assets for the organisations and which percentage of these assets are currently in use.

In the third block, we ask to select types of pollution to include, in what these should be measured and the initial level. The next block asks to provide the for each social segment and what their initial level is.

Then we ask to divide 6 points over the 6 segments of the social score based on importance. This means that if every segment is as important to the company, every segment would get one point. If some segment is more important to them, it should get more points. These values are used in calculating the social score. The more points assigned to a segment, the more it counts in the calculation of the social score.

The last block asks to divide 20 points over all dimensions regarding data quality. The purpose is the same as mentioned above. With these dimensions, the quality of data insights will be determined. Below a table is shown with each dimension and an explanation of what this dimension means.

When all needed information is filled out in this sheet you can click the corresponding button. This button will give the right structure to the next sheets.

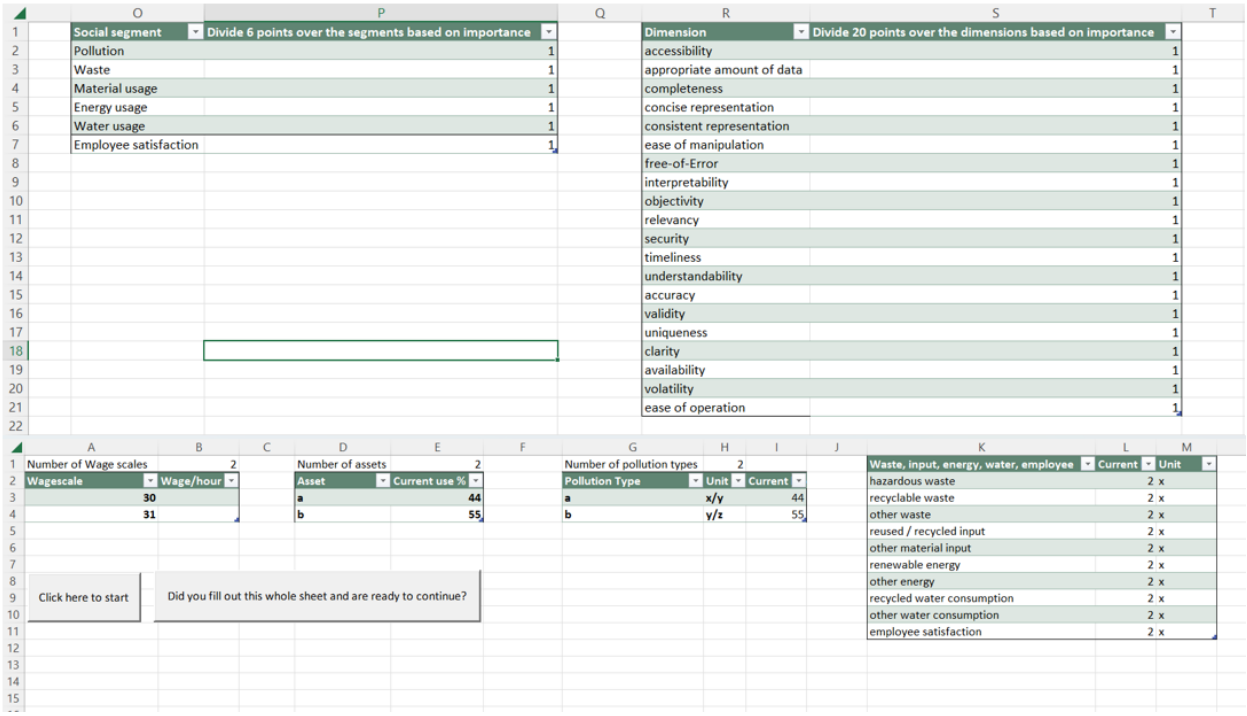


Figure 16: Initial input sheet

Dashboard processes

In this sheet, all changes in processes and the needed corresponding values can be filled out. In the first two columns, we ask for some general information: the name of the change and the code of the change.

The next columns represent the pillar time and costs. We ask for each wage scale to fill out how many hours this task initially takes each month, how much this costs and how many hours it is expected to be after implementing the change. When the change is actually implemented the user can enter the actual final time and costs needed. After these columns, there are some columns which contain the total values. These can be automatically calculated when clicking the button after filling out this sheet.

The next columns represent the pillar change in assets. Here the initial percentage in use and the expected percentage in use after implementing the change can be filled out. Again, after actually implementing the final percentage in use can be added. After this, you find the columns for the total. These will be filled out after clicking the button.

The next columns represent the pillar for the social score. We ask again to fill out the initial level and the expected final level. Later the realised level can be added. If the button is pressed, the columns left open for the totals will be filled out.

You can find a button to add the progress of a new week. This button adds a column with the week number in which you can add what changes are done, which are in progress and for which the implementation has not yet started.

Compare scenario individual, compare scenario datamodel, compare scenario datadoelgroep

In these sheets, all changes which have an influence on the insights in the data of an organisation need to be filled out. In the first three columns, the general information has to be filled out: the name of the insight, the code of the insight, and the codes of related changes.

The next columns are for information on time and wage. These work the same as mentioned before. If these are filled out you can click the first button to calculate the total values for time and wage.

In the next columns, we will look at the improved quality of the insight. In the columns, the user can fill out the initial and expected final level of the dimension. These grades need to be between zero and five. Zero means that the dimension was totally not present, and five meaning there is nothing to improve regarding that dimension.

Chosen scenario

When a certain scenario is chosen for implementation the information about this scenario can be filled out in this sheet. The idea is the same as mentioned before, but now it only needs to be done for the scenario which will be implemented. Another difference is that this sheet does ask for the final values realised after implementation.

Progress chosen scenario

The goal of this sheet is to track the progress of the chosen scenario during implementation. By clicking the first button you can add a row for a certain week. In this row, you can fill out the values for this certain week. This information will be used to track and show progress.

3.2.2 Information flow tool

Here we show an image of how the data flows through the tool. You can see how the input is used and what it will result in. Keep in mind that in the end the information will be used for the visualisations in the dashboard.

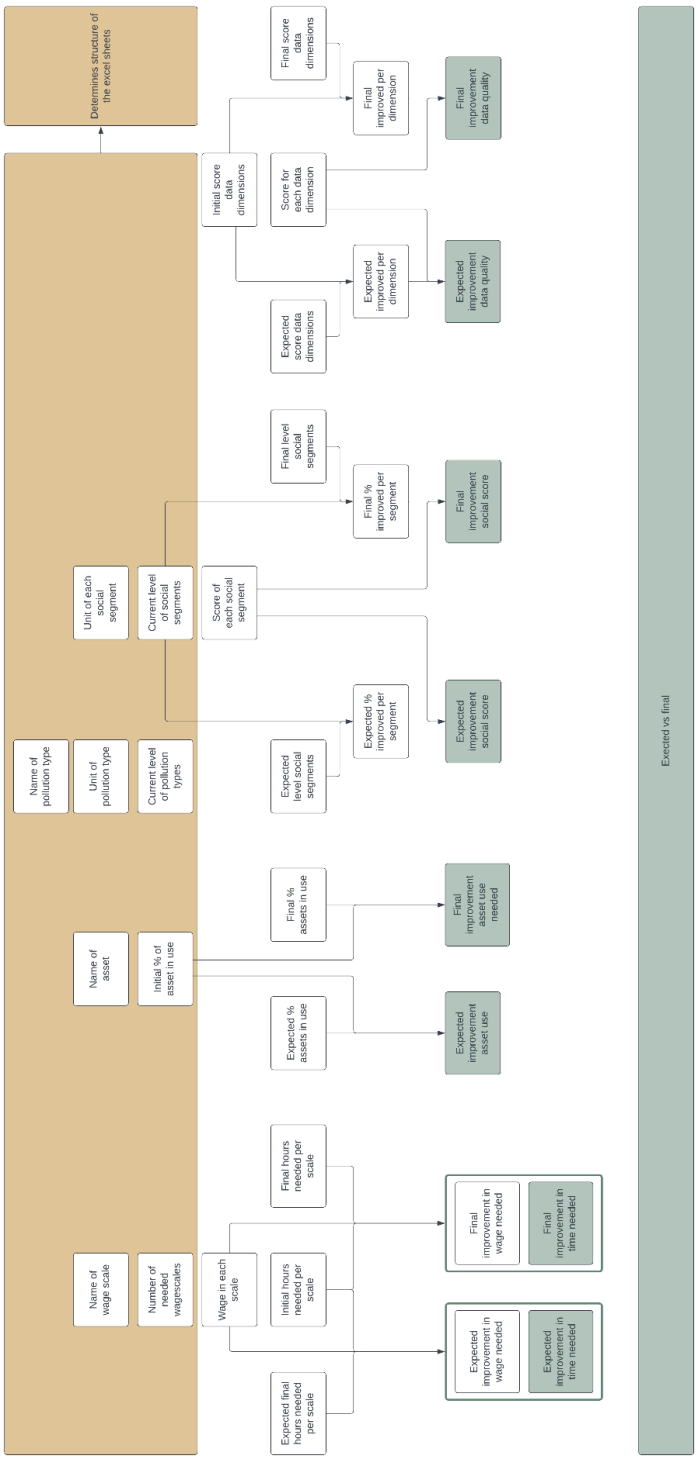


Figure 17: Information flow in tool

3.3 The dashboard

In this section, we will discuss the dashboards we will make to visualise all data. We start by explaining the different dashboards in Section 3.3.1. Then we will be selecting the metrics for each dashboard in Section 3.3.2. In Section **Error! Reference source not found.** we will talk about the information in each dashboard. Lastly, we will explain each dashboard with the help of screenshots in Section 0.

3.3.1 Variation in dashboards

As Techspread needs dashboards for different purposes we first have to decide for which purposes we want a dashboard. As we want to show different measures for changes regarding processes than we want to show for changes regarding data, we will make different dashboards for the two. Furthermore, for both types of changes, we will need a dashboard to reflect on the expectations. We also decided to make a difference between a dashboard used to compare scenarios and a dashboard that shows the progress of the chosen scenario. To summarize, we will have the following dashboards:

1. Dashboard for processes: Shows the progress of implementing changes regarding processes.
2. Dashboard reflecting on processes: Shows the difference between the expected outcomes and the final outcomes of the changes in processes.
3. Dashboard for comparing scenarios: Can be used to select which scenario to implement.
4. Dashboard for the chosen scenario: Shows the progress of implementation of the chosen scenario.
5. Dashboard for reflection on the scenario: Shows the difference between the expected outcomes and the final outcomes of the chosen scenario.

3.3.2 Selecting metrics

In this section, we will select the metrics we would like to display in our dashboard. We will make use of the literature search in Section 2.8. Furthermore, we will use the information in our tool explained in Section 3.1 and our own ideas.

<u>Dashboard for processes</u>

It is useful to have an overview of what the expected results are from the suggested changes. Besides, during the implementation of the changes, it is nice to see the progress and the improvements. As not all data is interesting to them, we will show them a summary. For the changes regarding processes, this will consist of:

- The changes in time needed
- The changes in wages needed
- The changes in the use of assets
- The changes in the social score
- Tracking of progress

<u>Dashboard for reflecting on processes</u>

After implementing changes, it is important to reflect on the final result. Before implementing the changes, certain estimations were made on the expected results. Now, the final results of the changes are known. Techspread can learn a lot from comparing the expected results and the final results. For this dashboard the following metrics will be used:

- Final vs expected final time improvement
- Final vs expected final use of assets improvement
- Final vs expected final improvement in social score

Dashboard for comparing scenarios

When choosing a certain scenario to implement it is valuable to have a dashboard in which you can compare the outcomes of the different scenarios. In this dashboard, we will use the following metrics.

- The changes in time needed
- The changes in the level of data quality

Dashboard for the chosen scenario

During the implementation of a scenario, it is nice to see what the progress is and what is still left to do. Also after implementing the scenario it can be interesting to see what the progress was over the weeks. We will use the following metrics in this dashboard:

- The progress of time needed
- The progress of the data quality level
- Progress over the weeks

Dashboard for reflection on the scenario

Again, it is important to be able to reflect on your work. Therefore, we also need a dashboard which can compare the expected outcomes and the final outcomes of implementing a scenario. In this dashboard we will use the following metrics:

- Final vs expected final time improvement
- Final vs expected final level of data quality improvement

3.3.3 Dashboards information and design

We have decided on the metrics, now we need to make them measurable. In this section, we will formulate KPIs that measure the factor and select a media display to visualise each KPI. Decisions regarding the media displays will mainly be based on the interpretation of the literature search in Section 2.8, the data we decided to include in the tool is explained in Section 3.1. Lastly, we will look at the design rules which are important for the dashboards.

Dashboards information

Dashboard for processes

Metric	KPI	Display media
The changes in time needed	Expected time improvement in percentage	Bar chart
	Initial hours needed per month	Bullet graph
	Expected final hours needed per month	
	Initial hours needed per month per scale	Bullet graphs

	Expected final hours needed per month per scale	
	Expected time improvement in percentage	Table
	Expected time improvement in percentage per scale	
The changes in wage needed	Initial wage needed per month	Bullet graph
	Expected final wage needed per month	
	Expected wage improvement in percentage	Table
	Expected wage improvement in percentage per scale	
The changes in use of assets	Improvement of percentage of assets in use	Bar chart
	Initial total use of assets in percentage	Bar chart with reference line
	Expected final total use of assets in percentage	
	Initial use per asset in percentage per asset	Bar chart with reference line
	Expected final use in percentage per asset	
The social score	Social scores	Bullet graph
	Initial level per social segment	Bar chart with reference line
	Expected final level per social segment	
	Rating of importance of social segments	Pie chart
Tracking of progress	Percentage of changes in progress	Stacked bar chart
	Percentage of changes implemented	

Table 6: Parts in dashboard for processes

Dashboard for reflecting on processes

Metric	KPI	Display media
Final vs expected final time improvement	Expected final time improvement	Bar chart
	Final time improvement	
	Difference in percentage	Table
Final vs expected final use of assets improvement	Expected final use of asset improvement	Bar chart
	Final use of asset improvement	
	Difference in percentage	Table
Final vs expected final social scores	Expected final social score	Bar chart
	Final social score	

	Difference in percentage	Table

Table 7: Parts in dashboard for reflecting on processes

Dashboard for comparing scenarios

Metric	KPI	Display media
The changes in time needed	Time improvement in percentage	Bar chart
	Initial total hours needed per month	Bullet graph
	Expected final total hours needed per month	
	Total time improvement in percentage	Table
	Initial hours needed per month per scale	Bullet graph
	Expected final hours needed per month per scale	
	Time improvement per scale in percentage	Table
The changes in level of data quality	Data quality level improvement in percentage	Bar chart
	Rating of importance of dimensions	Pie chart
	Improvement in data quality score per dimension	Bar chart

Table 8: Parts in dashboard for comparing scenarios

Dashboard for chosen scenario

Metric	KPI	Display media
The progress of time needed	Total hours of time needed per month over the weeks	Line graph
	Hours needed per month per scale over the weeks	Line graph
	Expected final total hours needed	Reference line in line graph
	Expected final hours needed per scale	Reference line in line graph
The progress of the data quality level	Total data quality level over the weeks	Line graph
	Expected final total level of data quality	Reference line in line graph
	Progress over the weeks per dimension	Line graph
Progress over the weeks	Percentage of changes in progress per week	Stacked bar chart
	Percentage of changes implemented per week	

Table 9: Parts in dashboard for chosen scenario

Dashboard for reflection on scenario

Metric	KPI	Display media
Final vs expected final time improvement	Expected final total time improvement	Bar chart
	Final total time improvement	
	Expected final time improvement per scale	Bar chart
	Final time improvement per scale	
	Difference in final and expected final improvement of total time needed in percentage	Table
Final vs expected final level of data quality improvement	Expected final total level of data quality	Bar chart
	Final total level of data quality	
	Expected final level of data quality per dimension	Bar chart
	Final level of data quality per dimension	
	Difference in final and expected final improvement in total data quality level in percentage	Table

Table 10: Parts in dashboard for reflection on scenario

Design rules

We found in literature that not every part of the dashboard gets similar attention. Furthermore, there are some other rules for arranging dashboards. Therefore, we will have to decide where to place which KPI.

The top left corner should contain the most important information. The lower right corner is the least important information. Also, it is important to keep the related KPIs close to each other. The data should be arranged in a way that minimizes the time needed to understand the dashboard.

For the reflection dashboard, we decided to use one page on which all information can be found. For the other dashboard, we decided to make one overview page for the main 'pillars' and by clicking on these the user will be led to a more detailed page showing more information. As all pillars are equally important, we treat them equally in the dashboards.

In literature, we also found several other recommendations regarding the design of a dashboard. In Section 2.8.3 these are listed. We will state the ones most important for this situation. The dashboard should consist of a single screen with fitting measures and display media. A dashboard should not contain unnecessary decoration and should contain between three and seven metrics. By maintaining consistency throughout the dashboard, the interpretation will become easier and more accurate. Below we show one of the dashboards. As can be seen, we have kept these rules in mind when designing the dashboard. We are using the colours orange and green throughout the whole dashboard and providing a clear explanation of what they mean. This helps make the dashboard easy to understand.

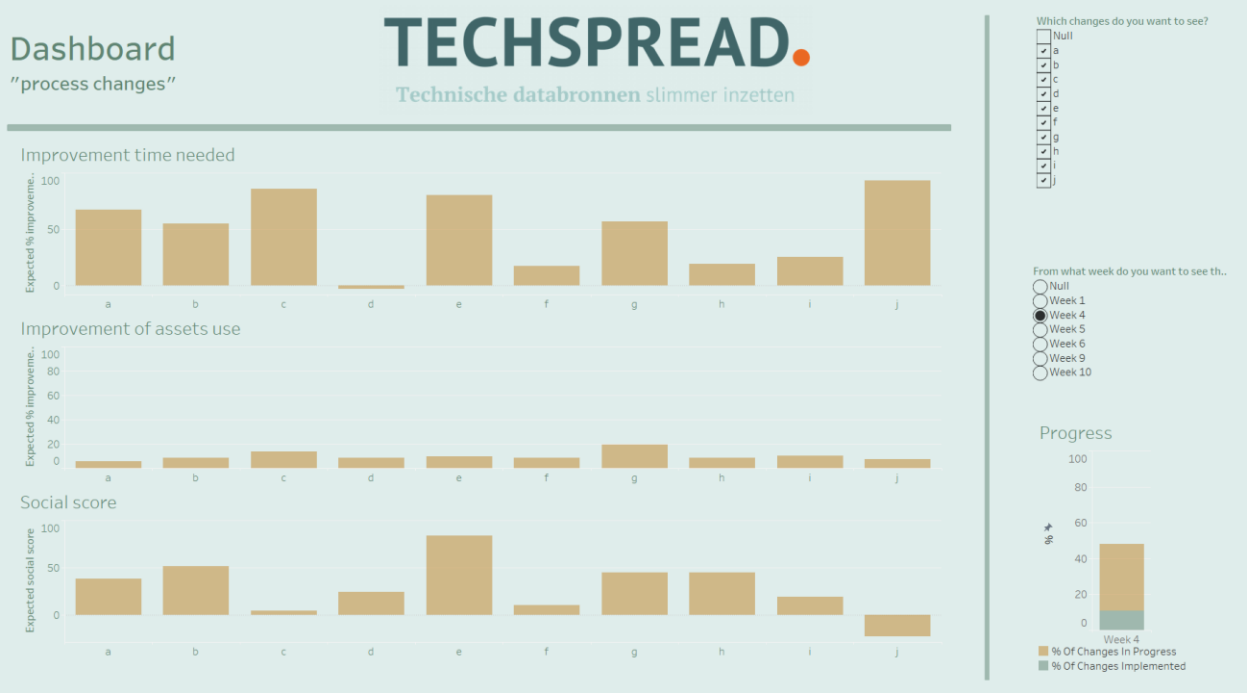


Figure 18: Example dashboard

3.3.4 Dashboard explained

In this section, we will look at the dashboards in more detail. We will discuss what the media displays shown in the pictures mean, how they represent the KPIs, and what value they add to the user. The data used in the dashboard is random.

Dashboard for processes

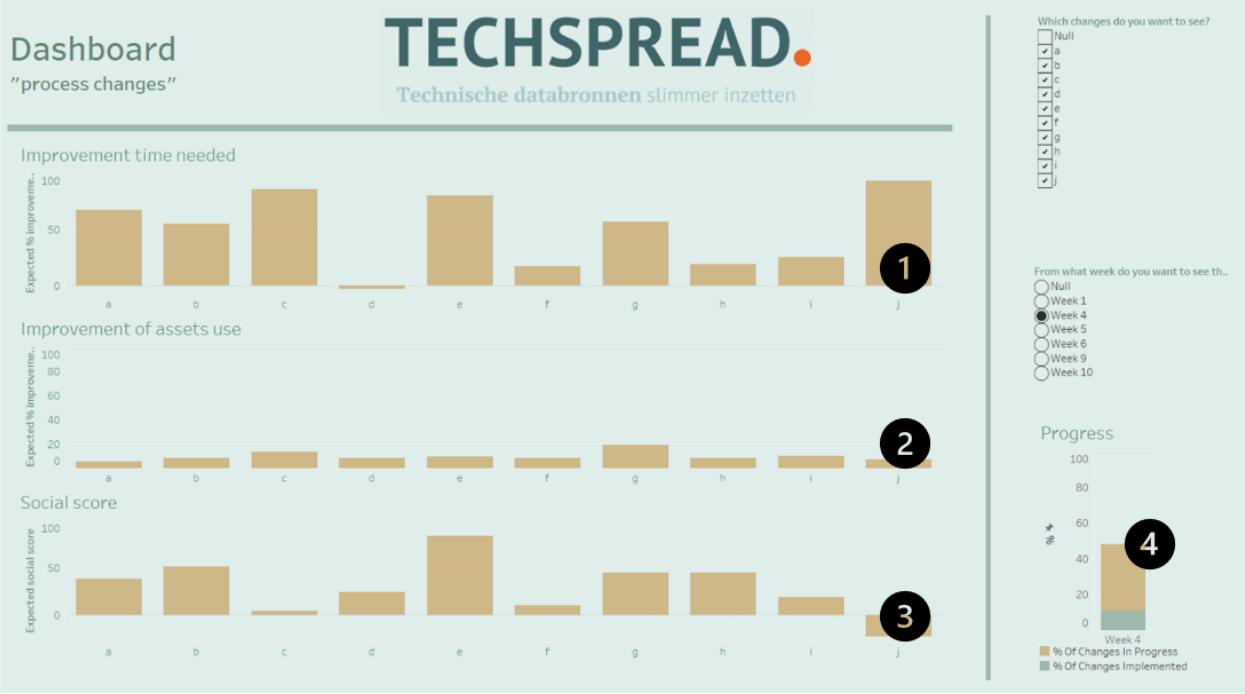


Figure 19: Dashboard "process changes"

This dashboard shows an overview of the possible changes and the expected results of these changes. Besides, it shows the progress of implementing these changes. The goal of this dashboard is to give an overview in comparing the possible changes in the processes. With the filter, they can decide which changes to show.

1. Improvement in time needed per month: In this chart, users can see the expected percentage of improvement in time needed depending on the changes. In this chart, they can compare the expected improvement in time per change.
2. Improvement in percentage of assets in use: In this chart, users can see the improvement in the percentage of assets used. Therefore, they can compare the possible changes on basis of the improvement of asset use.
3. Improvement in social score: In this chart, users can see the social score as a result of implementing certain changes. With this figure, they can compare the social scores of each change.
4. Tracking progress: This figure shows the progress over the weeks. By choosing the current week in the filter, you can see which percentage of the possible changes are implemented and which are in progress. This part of the dashboard is useful during the implementation phase to see how the project is progressing.

Processes – time in more detail

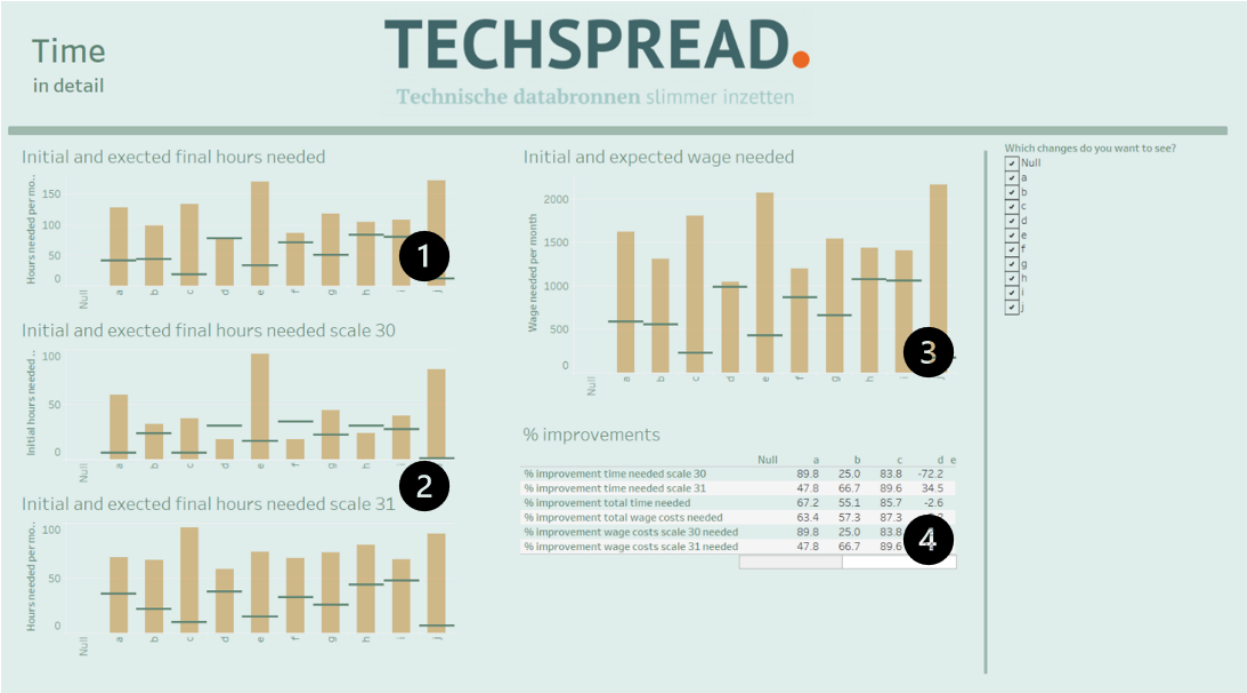


Figure 20: Dashboard "Time in detail"

This dashboard shows more details regarding the changes in time needed. Besides, it shows the change in wages needed which is directly dependent on the change in hours. The goal of this dashboard is to enable the user to compare the changes in more detail with regard to the time needed.

1. Initial and expected total hours needed: This chart shows the initial hours needed and the expected hours needed. This enables the user to compare the level of hours needed per change.
2. Initial and expected time needed per scale: This figure shows the initial time needed and the expected time needed per scale. In these figures, you can compare the changes based on changes in time needed in more detail. This is useful when a company values changes in a certain scale more than others.
3. Initial and expected wage needed: This figure shows the initial wage needed and the expected wage needed after implementing the change. Both are shown in euros. This figure can be used to compare changes based on wage levels.
4. Percentage of improvement: This table shows the expected improvements in time needed and wage needed in percentage. This enables the user to easily compare exact numbers to one another.

Processes – assets in more detail

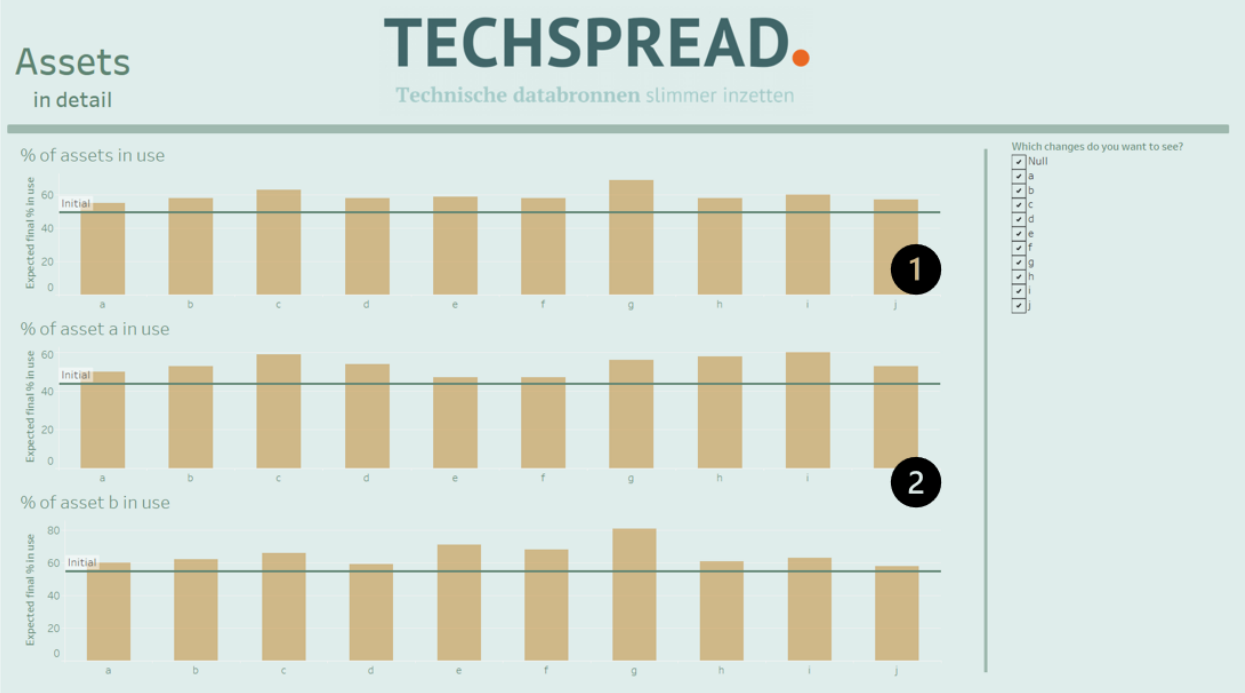


Figure 21: Dashboard "Assets in detail"

This dashboard shows more details regarding the changes in the use of assets. This is done by showing the figures explained below. The goal of the dashboard is to compare the possible changes in more detail with regard to the impact they have on the use of assets.

1. Percentage total assets: This figure shows the initial and expected final percentage of total assets used. Users can see for each change wat levels are expected.
2. Use of assets per asset type: This figure shows the initial percentage of assets in use and the expected final percentage of assets in use after implementing the change. This figure is useful when the user wants to see specifically which assets are changing instead of only the total.

Processes – social score in more detail

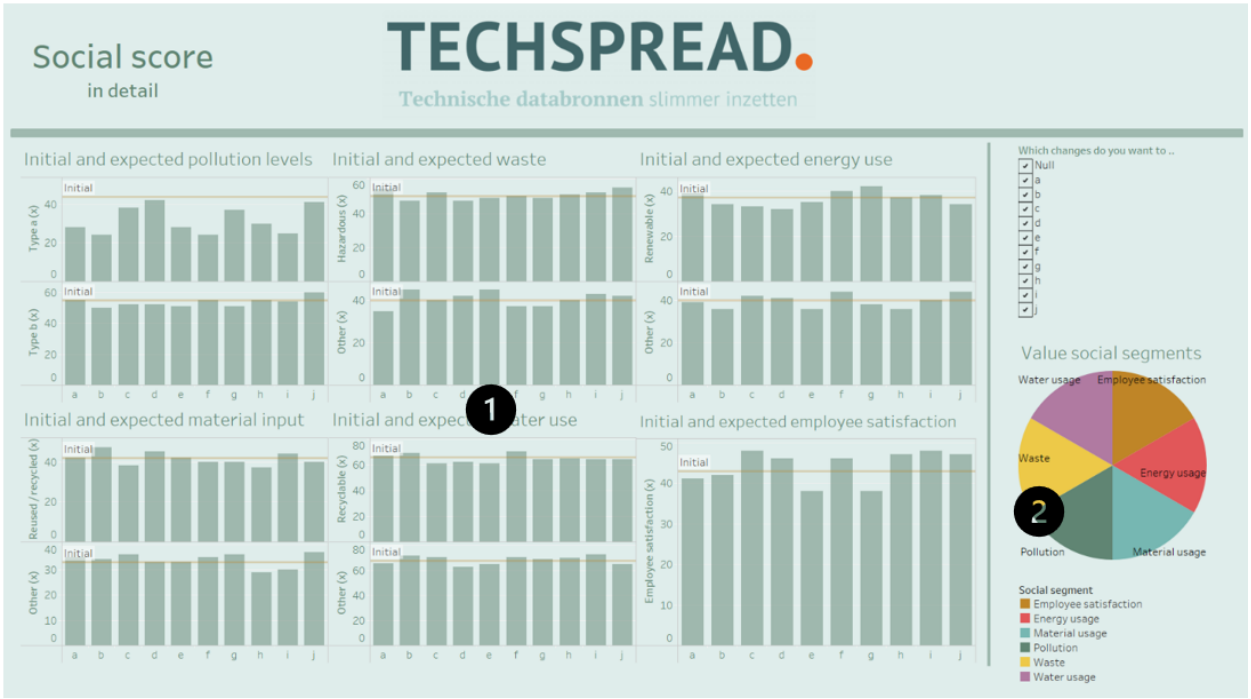


Figure 22: Dashboard "Social score in detail"

This dashboard shows more details regarding the changes in social score. The goal of this dashboard is to enable the user to compare the possible changes in more detail with regard to their impact on the social score.

1. Changes in level per segment: These figures show the initial level and the expected final level of each segment of the social score for each change. This is useful when the user is interested to see how individual segments will change instead of only the total social value.
2. Rating of importance social segments: This figure shows what priority is given to which segment of the social score. At the beginning of starting to work with a new company Techspread will ask the organisation about what segments they find more important and based on this, a value is given to each segment.

Dashboard for reflecting on processes

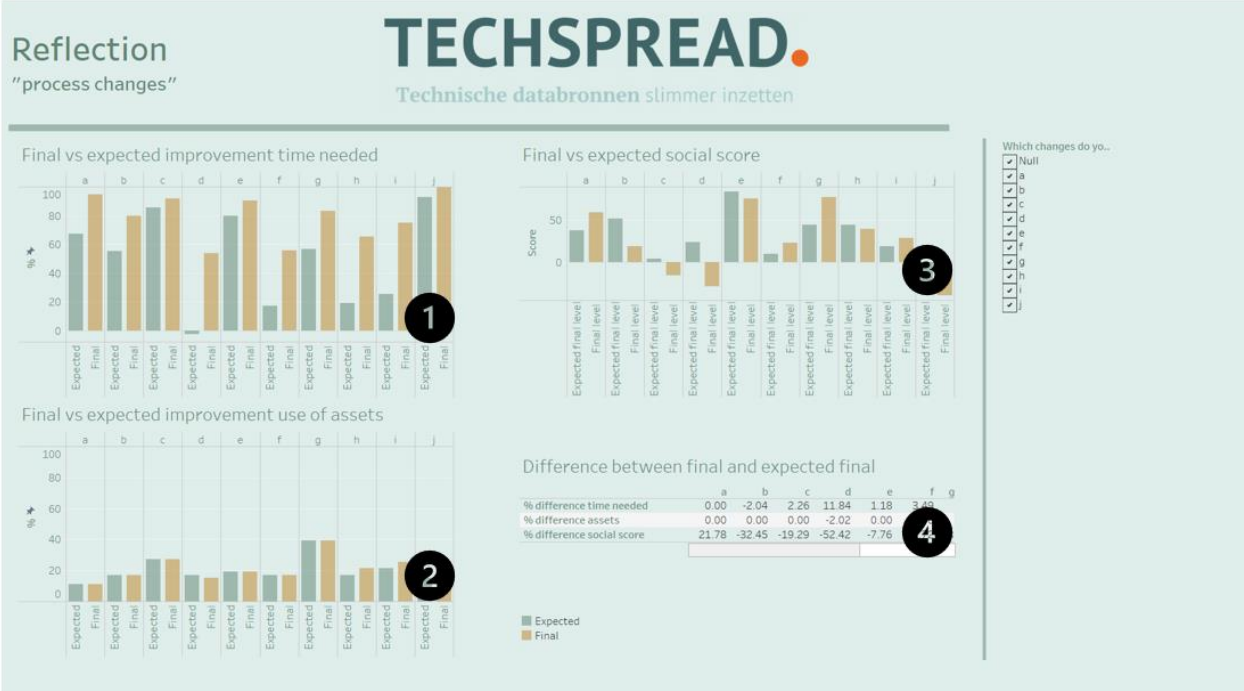


Figure 23: Dashboard "Reflection process changes"

This dashboard can be used after implementing changes in processes. This dashboard compares the expected final result with the actual final result. The goal of this dashboard is to enable the user to reflect on their expectations. It shows how well the expectations were compared to the actual outcome.

1. Final vs expected final time improvement: This figure shows the expected final and real final time improvement. This is useful when the user wants to see how reality differs from the expectations.
2. Final vs expected final use of assets improvement: This figure shows the expected final and real final improvement in the use of assets.
3. Final vs expected final social score improvement: This figure shows the expected and final social score. With this figure, the user can compare the expectations with reality.
4. Differences between expected and final improvement: This table shows how much the expected final and real final differ from each other in percentage.

Dashboard for comparing scenarios

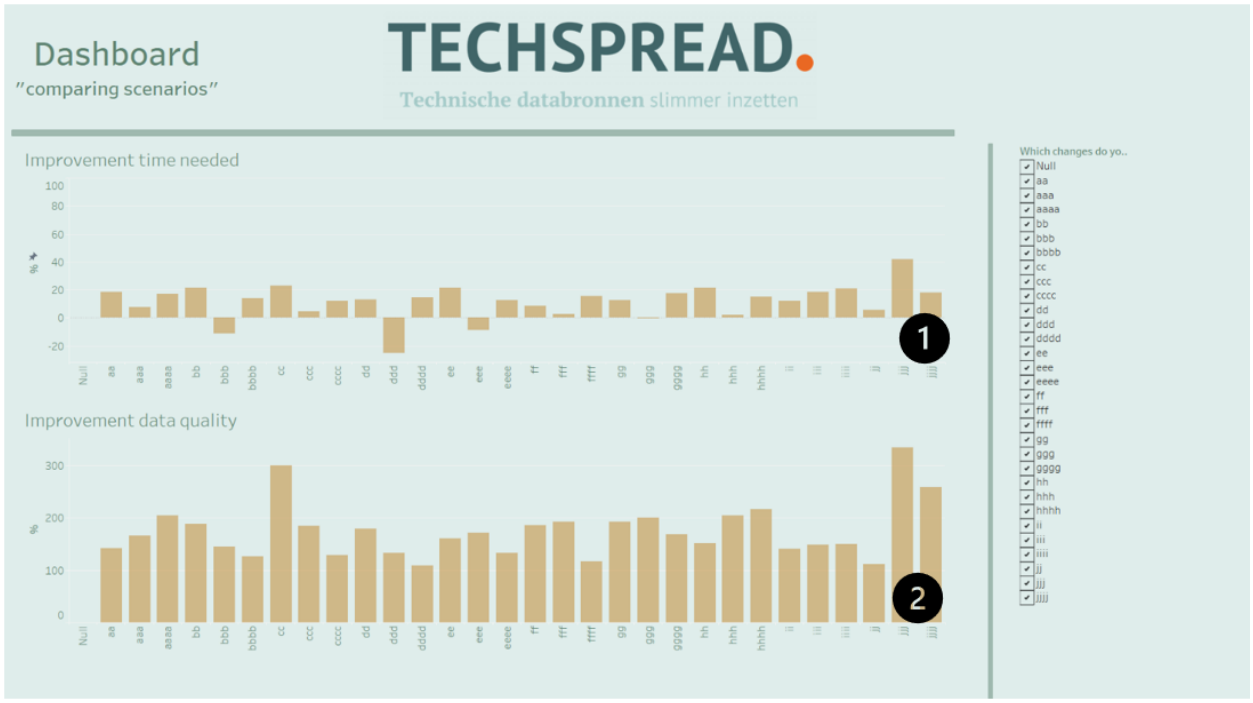


Figure 24: Dashboard "Comparing scenarios"

This dashboard can be used when deciding on which scenario to implement. It compares the possible scenarios based on the two pillars. The goal is to give the user an overview of what to compare the scenarios on.

1. Improvement in time needed: In this chart, users can see the improvement of time needed for each scenario in percentage. In this chart, they can compare the expected improvements and the difference in them between possible scenarios. They can decide to filter these with the filter shown on the right.
2. Improvement in total data quality: This figure shows the expected improvement in the total level of data quality in percentage. Users can compare the scenarios on how they affect the data quality.

Scenarios – time in more detail

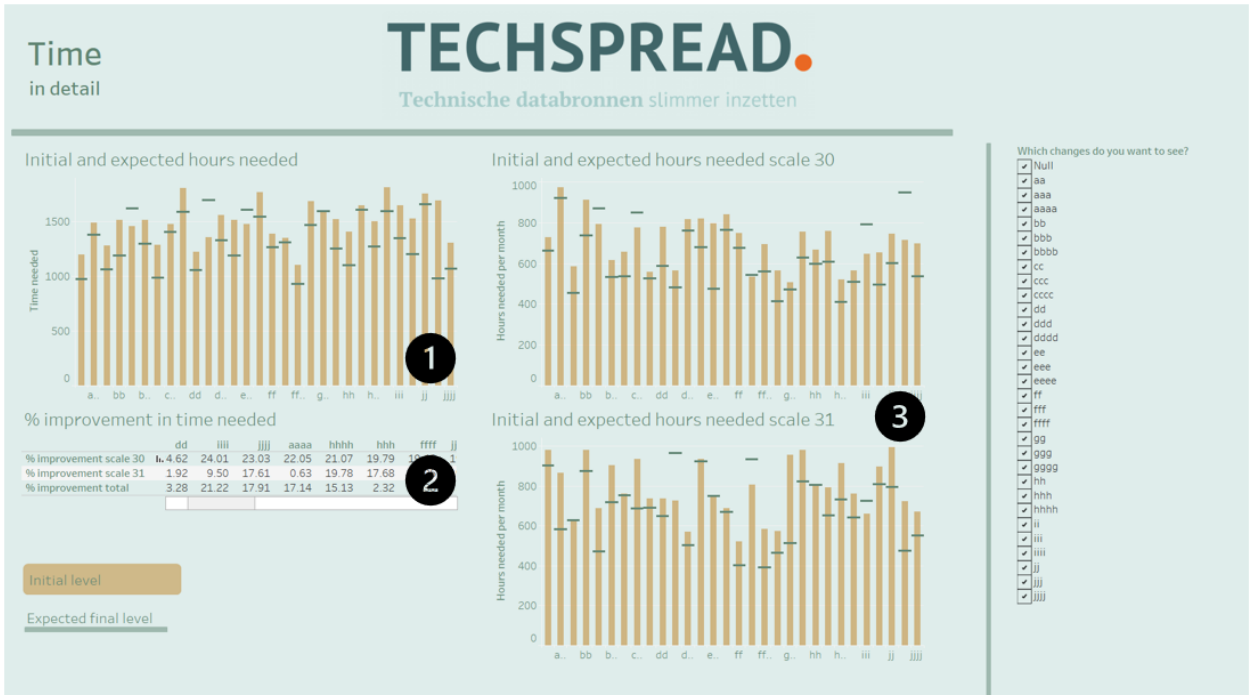


Figure 25: Dashboard "Time in detail"

This dashboard enables the user to compare the scenarios on changes in time needed in more detail. The goal is to enable the user to see how each scenario influences the time needed in total as well as in each wage scale.

1. Initial and expected total time needed: This figure shows the initial and expected final level of time needed for each scenario. Users can use this figure to compare the levels of time needed for each scenario.
2. Improvement in time needed: This table shows the time improvement in percentages. It is shown for the total and for all scales. This enables the user to easily compare exact numbers to each other.
3. Initial and expected time needed per month per scale: This figure shows the initial time needed and the expected time needed per scale. In these figures, you can compare the scenarios based on changes in time needed in more detail. This is useful when a company values changes in a certain scale more than others.

Scenarios – data quality in more detail

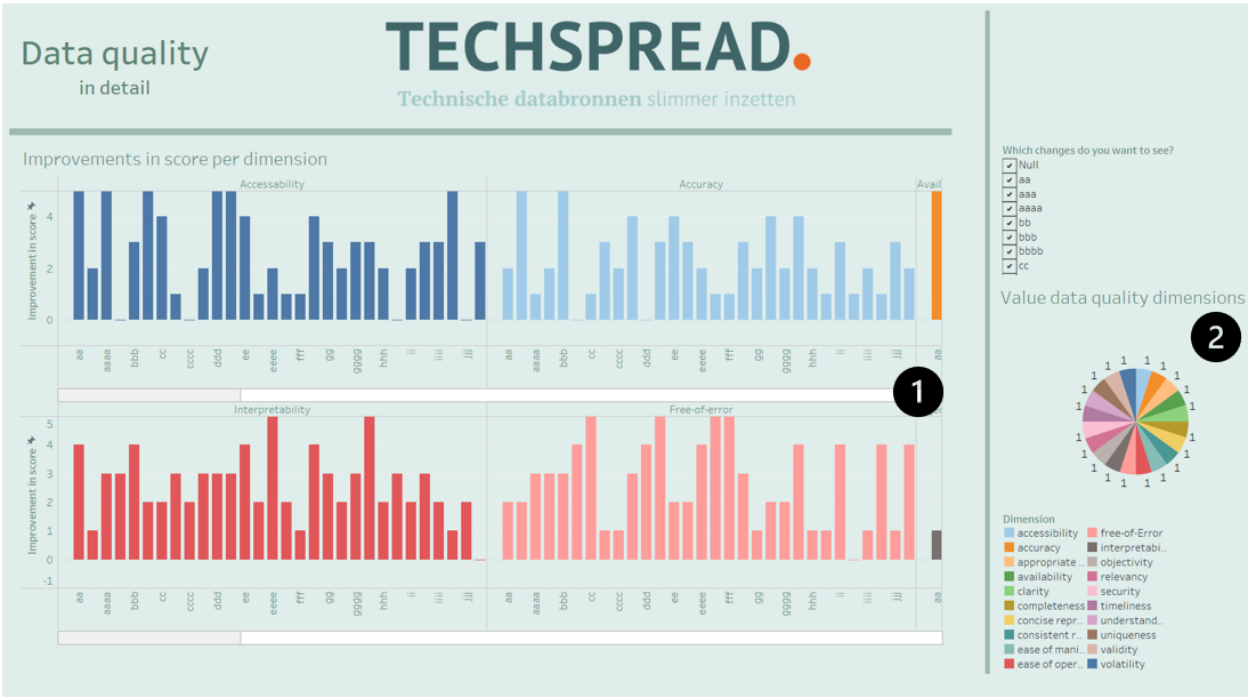


Figure 26: Dashboard "Data quality in detail"

This dashboard shows more detailed information on what effect the implementation of the scenarios has on the expected outcome of the level of data quality. The goal is to help the user in their decision of which scenario to choose with regard to the impact it has on the data quality.

1. Expected improvements per dimension: This figure shows the expected improvement per dimension for each scenario. This is useful when the user is interested in how individual dimensions are influenced by implementing certain scenarios.
2. Rating of importance dimensions: This figure shows what priority is given to which dimension in data quality. At the beginning of starting to work with a new company Techspread will ask the organisation about what dimensions they find more important and based on this, a value is given to each dimension.

Dashboard for chosen scenario

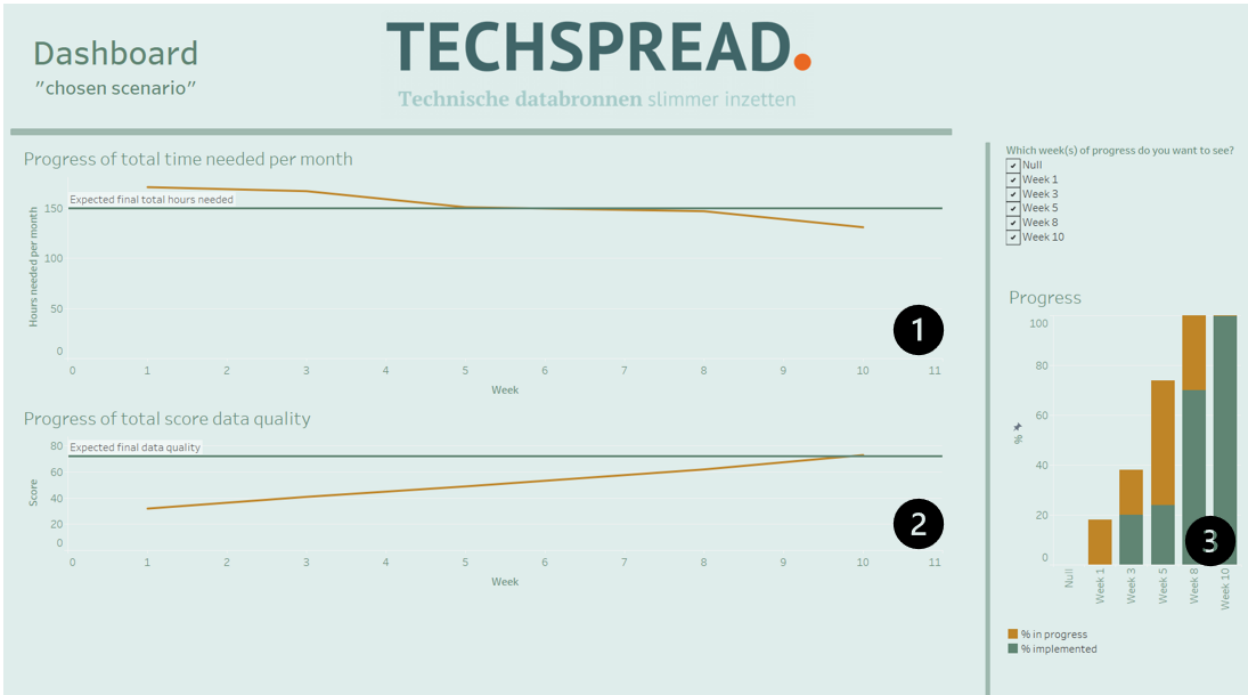


Figure 27: Dashboard "Chosen scenario"

This dashboard shows an overview of the progress of implementing the chosen scenario. This dashboard can be used after the implementation of a certain scenario has started. The goal is to show users where they are in the process of implementation and what the results are so far.

1. Progress of total time needed: This figure shows the progress of the total time needed per month. It shows how the total time needed has changed over the past weeks. Besides, it shows the expected final level, which shows how much still has to change.
2. Progress of total data quality level: This figure shows the progress of the total data quality level. It shows how this level has changed over the past weeks. Besides, it shows the expected final level, which shows how much still has to change.
3. Tracking progress: This figure shows the progress of implementing the scenario. The figure shows how many changes have been implemented and how many are still in progress. With this figure, users can see how much is still left to do and in which weeks most changes have been finished and started.

Chosen scenario – time in more detail

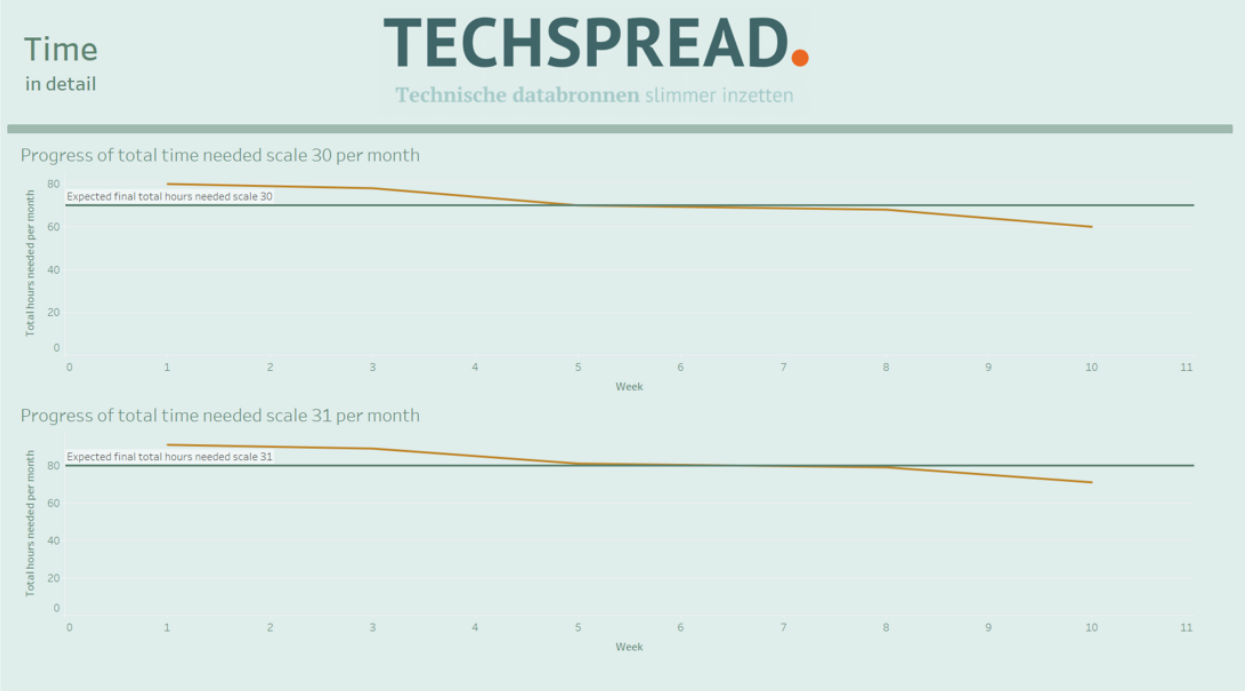


Figure 28: Dashboard "Time in detail"

This dashboard shows the progress regarding time changes in more detail for the chosen scenario. The goal is to show the progress in the needed time in more detail than in the main dashboard.

> Progress of time needed per scale: This figure shows how the level of time needed per scale has changed over the past weeks. Besides, it shows the expected final time needed. This is useful when the user is interested in seeing the changes in the individual scales.

Chosen scenario – data quality in more detail

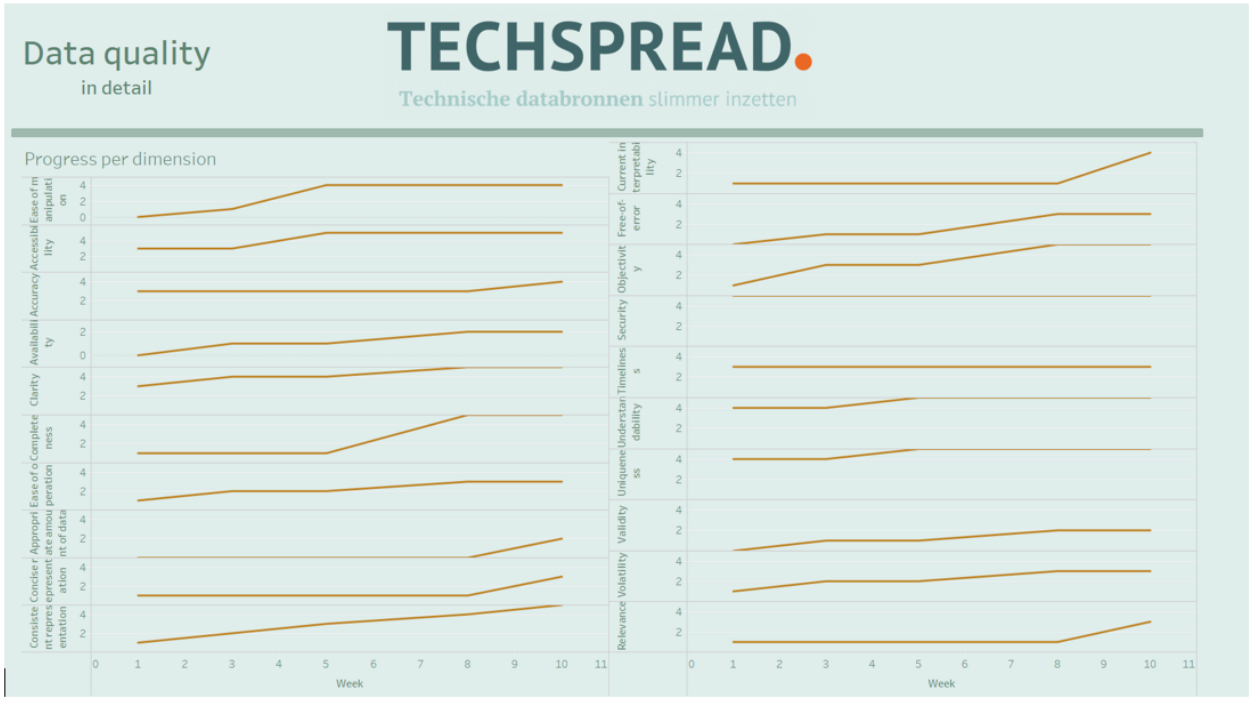


Figure 29: Dashboard "Data quality in detail"

This dashboard gives more insight into the change in the level of data quality over the weeks of implementation. The goal is to show more detailed progress with regard to separate data quality dimensions.

> Changes in score per dimension: This figure shows the progress of the level of each dimension of data quality. This is useful when the user in interested in a certain dimension or wants to distinguish between the total and individual changes in dimensions.

Dashboard for reflection on chosen scenario

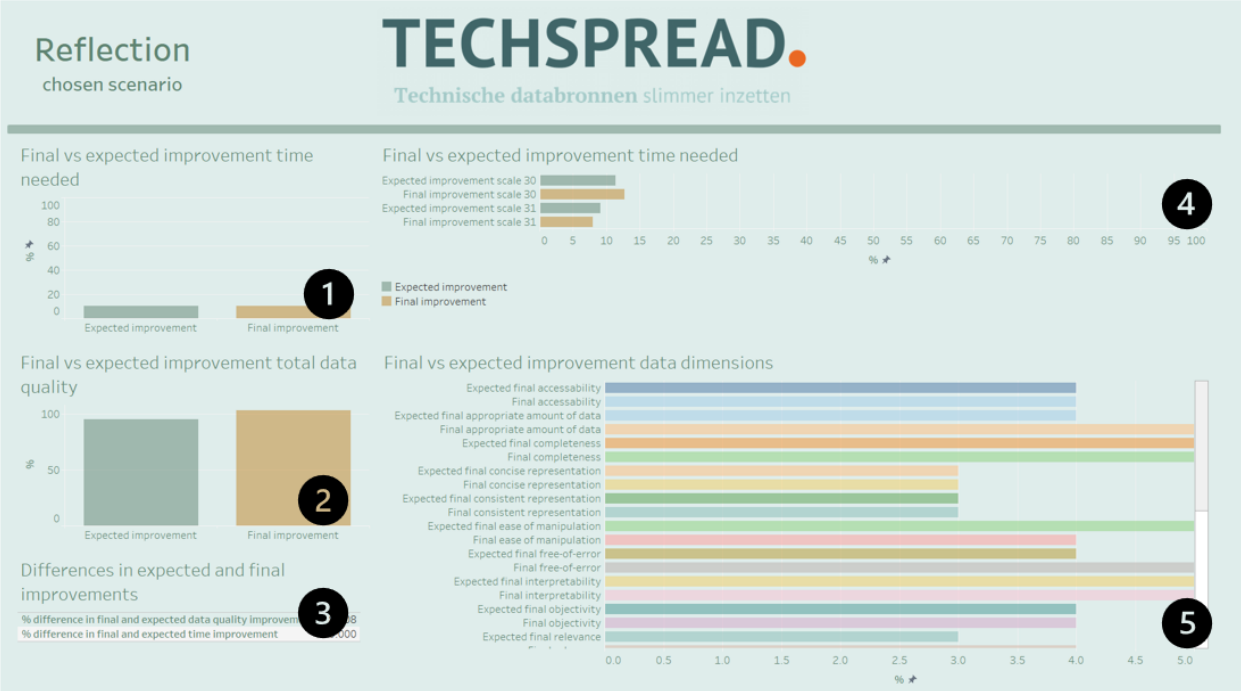


Figure 30: Dashboard "Reflection chosen scenario"

This dashboard can be used to reflect on the expectation Techspread had for implementing the chosen scenario. The goal is to show the difference between the expectations and the final outcomes. This can help Techspread in evaluating its expectations. Besides, it can be used to show the customer what was expected and what the final result is.

1. Final vs expected final improvement in time needed: This figure shows the expected final and the actual final improvement in both total hours needed and hours needed per scale. This enables the user to compare the expectations to reality for the total as well as the time per scale.
2. Final vs expected final improvement in total data quality level: This figure shows the expected final and the actual final improvement in the total level of data quality.
3. Final vs expected final: This table shows the difference between expected and real final in percentage for both time needed and data quality. This can be used to easy see how different the expectations from Techspread were from reality.
4. Final vs expected final time improvement per scale: This figure shows the expected final and actual final improvement in time needed per scale.
5. Final vs expected final improvement per data dimension: This figure shows what the improvements are per dimension.

3.4 Main takeaway: Finding the solution

The purpose of this chapter is to develop a complete tool. We started off by defining conditions together with Techspread. In Section 3.1.1 we explained the conditions in more detail. After this, we looked into defining the scenarios. The next step was to decide what data is needed as input for the tool. Depending on the type of change we defined different pillars to represent the data we would like to collect for that

change. We selected the following pillars: time needed, wage needed, use of assets, social score, and data quality. How we came to these pillars is further explained in Section 3.1.3.

The next step was to look into a way of visualising the collected data in a way that met the conditions mentioned. It was important to show the be able to compare the changes and scenarios, see the progress during the implementation phase, and that it looks professional. We found that we need several dashboards for different purposes, we chose to have five separate dashboards. For these, we selected KPIs and decided how to make these measurable. We looked into how we should visualize each KPI and how we should design the dashboard. At the end of this chapter, we have a tool which can be used to collect data and an interactive dashboard which can visualise the data collected.

4. Advice on implementation

In this chapter, we look into how we can implement the use of this tool and dashboard. The aim is to find an approach which Techspread can use for implementing this tool in their processes and guiding the changes that come with this. Below you can find an overview of the structure of this report. Here you can see what we will do in this chapter and what it will be used for.

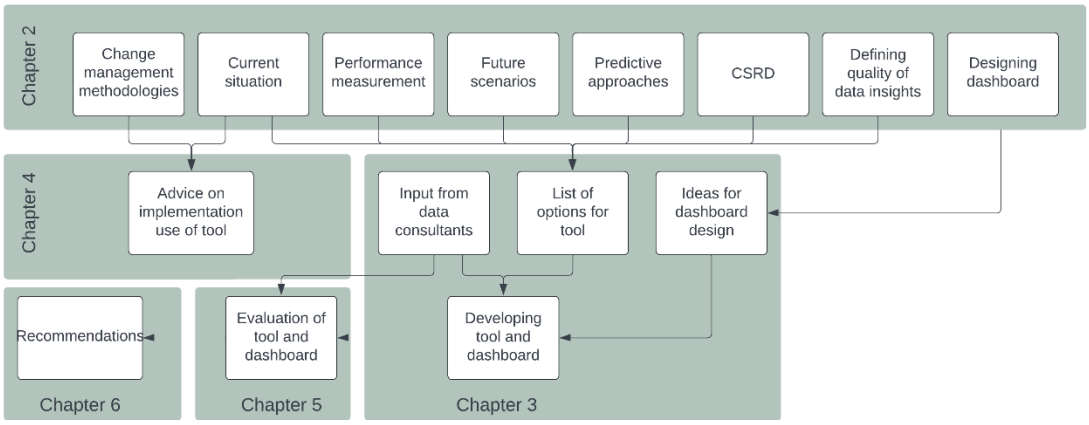


Figure 31: Report construction overview

The goal of this chapter is to answer the following question:

12. How can the use of a tool that validates outcomes of changes in a data strategy be incorporated in the business process?

In Section 2.5 we gained insights into guiding the implementation of change in organisations. Below we will explain which approach we will use and how this approach can be executed. Due to the time restriction, we will not implement the use of the model, but instead, we will give an approach which can be used for implementation by Techspread in a later stage.

4.1 Selection of approach

To implement this change in Techspread we will use a shared method. This means that the employees are included in the process of change before the change is implemented (Waldersee & Griffiths, 2004). The goal of using this method is to build support for the change before implementing it, which results in a feeling of ownership, which in turn results in a commitment to make the change work. One of the most influencing factors for the successful implementation of change is the employees and their response to the change (Paulsen et al., 2004). We think this suits Techspread best because everyone is quite involved in the company and the ambience is open for input from everyone. There is not a strong sense of hierarchy. Therefore, having the employees on the same line about a change suits Techspread well.

For implementing the use of this tool and dashboard in Techspread we will mainly use the ADKAR approach. Furthermore, we will use two of the supporting factors of the Success Factor Model (Thomas Lauer, 2019). These supporting factors are that the organisation is open to change and that the project is well-organised. There are several reasons why using the ADKAR approach in this situation is beneficial. The model is suited for smaller changes (Nakigudde, 2019). Implementing this tool and dashboard can be seen as a small change. Furthermore, the tool and dashboard recognize that successful change is

depending on the people involved and not only on the process. ADKAR involves all people relevant to the change, which fits well with the company culture of Techspread.

4.2 Executing the approach

First, we will explain how each step of the ADKAR model would work for Techspread. Then we will explain the two factors of the success factor model which we think are important in this situation.

4.2.1 ADKAR

The ADKAR model consists of five. In this section, we will discuss how each step can be applied to Techspread.

Step 1: Awareness of the need to change

We want to get support from all stakeholders, therefore it is important that they are aware of the necessity for change. Although within Techspread most people are aware of the problem. We advise Techspread to still clearly state the problem to everyone who will have something to do with the tool or other processes which change when implementing the use of the tool. They can explain the current process and why they think there is room for improvement as mentioned in Chapter 1. People might already have input or ideas.

Step 2: Create a desire to support the change

It is beneficial when the stakeholders want to help with implementing the change. To receive this support the change and purpose should be clear to them. In the case of Techspread, this means that the data consultants should be convinced that using the tool is beneficial for their tasks. They should understand what the tool does and how this improves the current situation. We advise Techspread to do this by having an explanatory session with them. If people have doubts, these can be discussed and solved in such a session. This way, their concerns can be reduced.

Step 3: Create a wide understanding of how to change

Everyone involved in the change has to get an understanding of what has changed and adjust to new ways of doing things. To learn people new ways of doing things, training is necessary. For Techspread, this means making sure all stakeholders fully understand the tool and how to use it. This can be done by use of the provided handbook. Let people read the handbook and plan a practice session with them to make sure they ask the questions they got after reading the handbook. This way you can clear up the unclarities and everyone is confident in using the tool.

Step 4: Make sure stakeholders have the ability to demonstrate new skills and behaviours

When the change is implemented and people are now working differently, this should be evaluated. Now all data consultants are aware of how to use the tool, we can start with the actual implementation of the tool. When people start using the tool it is important to keep track of the change process. It is possible to complete this step by letting the users do a demo or test to show that they understand how to use the tool.

Step 5: Reinforcement to make the change stick

After implementing a change, it needs to be ensured that the changes have been adopted by everyone. It is important to see whether the change is fully implemented. Keep checking with people how they feel about using the model, and see what people think of the model. As they will have a new user experience

this can be used to improve the model. We advise keeping track of the suggestions and feedback and keep improving the tool. Also, after reflection, we advise sharing the results of using the tool with everyone.

4.2.2 Supporting factors

Besides using the ADKAR model, we also want to pay attention to two of the supporting factors from the success factor model.

Open to change

The first is making sure the organisation is open to change. This is important at the beginning, when you start with implementing the new model, but also throughout implementation. People should have the idea it is useful to give feedback as Techspread is open to changing the tool when necessary. Actively ask for feedback, think along on improvements, and communicate what is happening with the feedback. For Techspread this might not be the biggest issue as they are quite good at actively looking for more efficiency in their own organisation. We do advise organising input sessions on the use of the tool every once in a while, to search for improvements. In these sessions also mention what happened with the previous input.

Well-organised project

The second supporting factor is that the project should be well-organised. If you expect people to comply with a change it is important to organize this change well. We advise Techspread to make sure that the tool works and is checked before you let others try it out. Furthermore, communicate what the plan is regarding the use of the tool.

4.3 Main Takeaway: Implementation

People are the most important factor in successful change. Therefore, it is very important to make sure they are involved in the process. Communication plays an important role in this process. After research, we decided that using the ADKAR model together with some of the supporting factors from the success factor model would be suitable for the implementation process at Techspread.

5. Tool evaluation

The goal of this chapter is to find out whether the tool improves the current situation and solves the initial problem Techspread was experiencing. Below you can find an overview of the structure of this report. Here you can see what we will do in this chapter and what it will be used for.

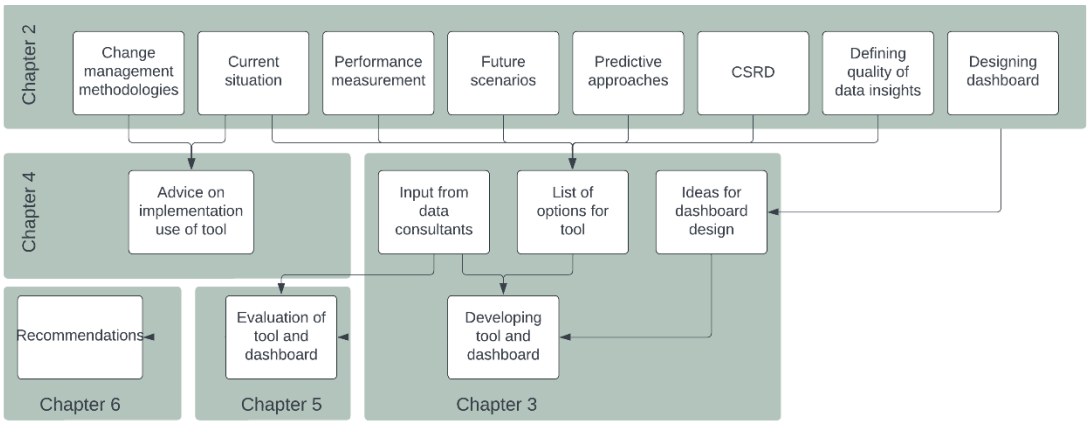


Figure 32: Report construction overview

The question we will be answering in this chapter is:

14. How well does the tool comply with the conditions?

We did this by asking Techspread for their opinion and feedback with regard to the tool. Earlier we discussed the conditions for the tool, in this chapter we will discuss how the delivered tool lives up to these conditions and whether there is room for possible improvements.

5.1 Evaluating the conditions for the tool

In this section, we will explain what we did to comply with every requirement. After this, we discuss the opinion of Techspread on the condition. For each condition, we will mention what we did to add to this condition, how Techspread evaluates the condition in the developed tool and what we think could still be improved.

1. *The tool should be adjustable, so it can be better used for all the different organisations they have as clients.*
   The tool is adjustable in various ways, most of which can be found in the first sheet, “initial input”. The following things are adjustable: the number of wage scales, the wage in each wage scale, their most important assets, their most important pollution types, all units, their value towards the social segments, and their value towards each data dimension.
   Techspread graded achieving this condition with four out of five points. The main comment on this condition is: “I think the tool has been designed with many options and therefore we can use it in various ways for different organisations.”
   We think this condition is well met. At the moment we cannot think of a way to improve performance regarding this condition.
2. *The tool needs to be very well-defined, we do not want any uncertainties in context.*
   When deciding on the variables for the model, we tried making everything as well-defined as possible. We defined the data quality by using 20 dimensions for which definitions are provided. The social

score is determined by looking at a weighted total of percentage improvements instead of asking for a score. The tool also asks for units which will be displayed in the corresponding columns. We also provided a handbook explaining how the tool works and what needs to be filled out everywhere.
Techspread graded achieving this condition with a score of four out of five. The main comment is: "The data storytelling fits the aim and target audience. Different people came to the same conclusion based on the same insights, even though it is about a complex matter. Therefore, the context of the data models is understood."
We think it is possible to improve the performance regarding this condition. At the moment we made the data quality level better defined by using 20 dimensions which together make up the data quality. While this is an improvement in making the level of data quality well-defined it leaves room for improvement. As we still ask the user to give a grade for each dimension, this is still subjective. Improvement is possible when thinking of a way to define the grading of the dimensions better and make this less subjective. The same goes for the grade in employee satisfaction.

3. *Easy and efficient to use.*
   Besides providing a handbook, we kept this condition in mind when designing the tool. We clearly explain what needs to be filled out and where and we tried making the tool intuitively to use.
   Techspread graded achieving this condition with a score of four out of five. The main comment is: "It is easy to use by a well thought out format the user can fill in."
   We think there are some ways of improving the ease and efficiency of using the tool. The Excel tool can be improved by making it easier to correct mistakes or to adapt the structure of the sheets at a later stage. For example, currently, if someone wants to add a new wage scale somewhere during the project, this can be quite a hassle. At the moment the structure in the Excel tool has to be determined in the beginning and adapting it along the way leaves room for improvement.
4. *We need to be able to compare situations to earlier moments.*
   The tool offers the option to add progress per week in the Excel file. This will then be visualised in the dashboard. This gives the easy option to compare between different moments in time.
   Techspread graded achieving this condition with a score of five out of five. The main comment is: "The way the data can be compared to different occasions and subjects makes is possible to compare easily."
   We think this condition is well met. At the moment we cannot think of a way to improve performance regarding this condition.
5. *After a while, the tool should be usable for comparisons between other organisations.*
   In the model, we ask for various data including the unit. This data can be gathered to calculate, for example, improvements in percentage, which can be used to compare between organisations.
   Techspread graded achieving this condition with a score of five out of five. The main comment is: "I think the way it is built is scalable, which for us, is really important. Also, we can build it up to create a benchmark in the future, which is a nice, unexpected advantage."
   We think there is improvement possible regarding this condition. As data will be gathered on the same variables it is possible to compare organisations based on this. The difficulty at the moment is that companies differ in various aspects. For example, size and efficiency. If we compare raw data, this will give a wrong idea as 10 hours per week in time improvement is nothing for a company with thousands of employees but is a lot for a company with the people. It is already an improvement to compare the data on improvement in percentages, but this still does not give a totally fair image. An organisation that already invested a lot in efficiency will achieve a smaller percentage improvement than an

organisation that never invested anything in efficiency. Therefore, we think it is possible to improve this condition by thinking of a way of presenting data which gives a more complete image when comparing organisations.

6. *Representable for the customer so the customer will be able to use results in their own reports.*
   The tool summarises the most important information and visualises this in a clear way. This makes the information should be understandable for the customers. The figures can be used in their own reports. Also, the changes regarding the Corporate Sustainability Reporting Directive can be used in official reporting of companies.
   Techspread graded achieving this condition with a score of five out of five. The main comment is: “The used colours, models, visuals, labels and overall data storytelling fits the way we would like to report overall. Therefore this outcome fits really well. Also, if needed, is it easy to change the way it is represented efficiently.”
   This condition might be better met when we add a way of customising the tool further. It might be possible to let the customer choose in what way to visualise the data. For example, it would be beneficial to be able to easily change the colours into the company colours for the tool.

5.2 Main takeaway: Evaluation

We reflected on the quality of the tool based on the conditions we have determined before starting to develop the tool. We discussed the evaluation of Techspread and discussed our suggestions. Techspread seems to be happy with the solution as shown by their final statement: “Overall the outcome is a well thought off solution to our problem, even better than we expected it to be since it is quite a complex data matter.” We discussed the following options to further improve the performance regarding the conditions:

- Make the tool better defined by finding a way to make the performance on each dimension of data quality and the employee satisfaction less subjective.
- Make the tool easier and more efficient in use by enabling the user to easily change the structure of the Excel sheets in a later stage of gathering data.
- Make the tool better at comparing between different organisations by thinking of a way of presenting data which gives a more complete image when comparing organisations.
- Make the tool more representable for customers by making the tool more customisable.

6. Conclusion & recommendations

In this chapter, we will conclude our research by giving conclusions and recommendations. In Section 6.1 we start with formulating conclusions to our research questions. In Section 6.2 we explain the restriction of this research. Section 6.3 wrote a discussion regarding this research. Lastly, we will explain our recommendations in Section 6.4.

6.1 Conclusion

In this section, we will conclude this research. We will first shortly repeat the initial problem the organisation was experiencing in Section 6.1.1. In Section 6.1.2 we answer all sub-questions. Then we answer the main question in Section 6.1.3.

6.1.1 Problem description

At the moment, Techspread does not validate the outcomes of the changes they suggest for the data strategy of their customers. Because of this, it is difficult for Techspread to show the customers what their service will deliver which makes it difficult for the customer to understand the added value.

To solve this problem, we formulated the following research question:

"How can we develop a tool that can validate the outcomes of changes in the data strategy of an organisation and how can the usage of the tool be incorporated in the business process?"

6.1.2 Answering sub-questions

In this section, we will summarise our findings for each of the sub-questions. More details on how we found these can be found in the corresponding chapters.

1. *What is the current process of presenting a business case at Techspread?*
    a. *What factors are currently considered when deciding on the optimal list of changes?*

Techspread performs a data inventory on which they base a list of possible changes. Together with the cusomer they decide on which changes to implement which gives them a final list of implementations. After this, they make a data roadmap, write their business case, draft a budget, and complete the data strategy. Besides the time needed to perform certain tasks, Techspread currently does not specifically collect any data on which they base the decision on which changes to implement.

2. *What are useful variables for measuring results of organisational changes?*

In literature, we found many possible measures for performance. Many of these are based on monetary values. The ones we used in our tool are time, costs, employee satisfaction, and an alteration of overall equipment effectiveness. The non-monetary values can be quite depending on the situation you are working with but are still important as not all changes can be expressed moneywise.

3. *How can you define possible scenarios usable for predictions?*

We found six ways of defining scenarios. The morphological, cross-impact analysis and both inductive approaches will need a large time investment without giving a result that weighs up to this. The four quadrants matrix and the Wilson matrix did seem to be useful at first, but after the input of Techspread this changed. After the input session with Techspread, we decided that we did not want to use any of

these approaches but use the scenarios to group changes in different ways. How we will use the scenarios in the tool is discussed in question 9.

4. *What approaches can be used to predict outcomes of changes in an organisation?*

We found three predictive approaches: Delphi, event simulation and using a scenario model. The one that seemed most interesting to Techspread is the scenario model. Delphi and event simulation are both quite time-consuming. For the Delphi method, Techspread would need a panel of experts, which might differ for each organisation, which makes this quite an extensive process. Furthermore, Techspread would be quite dependent on the opinions of others. The scenario model seems most in line with the fact that Techspread focuses on benefits from changes in an organisation. Later, we decided that these ways of predictive approaches are not of use to Techspread and the data will be filled out by their data consultants.

5. *What are useful theories about implementing change in working processes from organisations?*

We decided to base our advice to Techspread mainly on the ADKAR and Success Factor Model. ADKAR focuses on the individuals who are part of the process that will be changed. As implementing our tool would change the core of some working processes at Techspread there will be people that need to work with the model. Therefore, the most important factor is that they accept the change. We think using the supporting factors of the success factor model will enable a smoother process of implementing change.

6. *On what principles do companies need to report following the Corporate Sustainability Reporting Directive?*

What companies need to report on can be divided into four categories: cross-cutting standards, environment, social factors, and governance. We kept in mind that it should be doable for Techspread to find values for the current and new situations for these variables. Furthermore, it should be doable to set up measures related to the factors mentioned in the directive. We used the following variable in our tool: pollution, waste, material input, energy, water usage, and employee satisfaction.

7. *What are useful theories about determining the quality of data insights?*

We found that there are many dimensions which an organisation can select. Based on these, Techspread can determine the quality of their data. These do not need to be the same for each organisation. We left some dimensions out because they were already represented by other variables, they were too extensive to measure, or were overlapping with other dimensions. The dimensions we selected are: Accessibility, appropriate amount of data, completeness, concise representation, consistent representation, ease of manipulation, free-of-error, interpretability, objectivity, relevance, security, timeliness, understandability, accuracy, validity, uniqueness, clarity, availability, volatility, and ease of operation.

8. *What are useful theories about designing a dashboard?*

Dashboards are meant to provide visualisations to provide an easy-to-understand summary of the data needed in a certain situation. The design of a dashboard will depend on its purpose. There are several types of dashboards which all consist of several parts: data, metrics, data analysis, technology, features, relationships, scenarios, visual effects, and functionalities. The next step is to think about design, for which many rules are defined. Same goes for visualisations, there are many types of visualisations which should be used for visualising certain types of data. More information can be found in Section 2.8.

9. *How can we best define the scenarios in a tool that validates outcomes of changes?*

Together with Techspread we came up with a beneficial way of using scenarios. We will use three different scenarios: “individual”, “datamodel”, “datadoelgroep”. In this case, scenarios are used as different ways of grouping data insights to look at the combined results of them.

10. *Which variables should be used in the tool?*

The variables we will use in the tool are different per type of change. For changes in processes, the changes can be represented by four pillars: Time saved, wage costs saved, use of assets, and social values. The changes with regards to insights are represented by three pillars: Time saved, improvement in argumentation, and improved quality of insights.

11. *What conditions should be met by the tool?*

We came to the following conditions:

- The tool should be adjustable, so it can be better used for different organisations.
- The tool needs to be very well defined, we do not want any uncertainties on context.
- Easy and efficient in use.
- We need to be able to compare it to earlier moments.
- After a while the tool should be usable for comparisons between other organisations.
- Representable for the customer so the customer will be able to use results in their own reports.

12. *How can you build a tool that validates outcomes of changes regarding data insights of processes in an organisation?*

It was decided to build an Excel which can be used to collect data. The data to collect depends on the type of change. For changes regarding processes, they are the following: time needed, assets in use, social score. For changes regarding data insight, they are the following: time needed, data quality. Next, we constructed five dashboards to visualize this data. We created the following dashboards:

1. Dashboard for processes: Shows the progress of implementing changes regarding processes.
2. Dashboard reflecting on processes: Shows the difference between the expected outcomes and the final outcomes of the changes in processes.
3. Dashboard for comparing scenarios: Can be used to select which scenario to implement.
4. Dashboard for the chosen scenario: Shows the progress of implementation of the chosen scenario.
5. Dashboard for reflection on the scenario: Shows the difference between the expected outcomes and the final outcomes of the chosen scenario.

13. *How can the use of a tool that validates outcomes of changes in a data strategy be incorporated in the business process?*

As people are the most important factor in successful change, it is important to make sure they are involved in the process of change. Communication plays an important role. We advise Techspread to follow the steps in the ADKAR approach and make sure the supporting factors, being open to change and having a well-organised project, from the success factor model are present. We advise Techspread to first

discuss the need for change with all stakeholders. Next to that, we advise having an explanatory session to take create support regarding the use of the tool. Next, plan a practice session with people using the tool to make sure they can ask all questions they still have. Then, to make sure everyone understands how to use the tool, test them on their ability to use the model. After people started using the tool, we advise them to keep gathering feedback and communicate improvements made. Throughout the whole implementation we advise being open to feedback and suggestions to show openness to change. This can be done actively to organise input sessions. Lastly, make sure the project is well-organised, check that the tool works well before you let others use it and communicate the plan.

14. How well does the tool comply with the conditions?

After evaluating the tool, we can state that Techspread is quite satisfied with the tool and the way it meets the conditions we have set. There are some ways in which the tool can be improved:

- Make the tool better defined by finding a way to make the performance on each dimension of data quality and employee satisfaction less subjective.
- Make the tool easier and more efficient in use by enabling the user to easily change the structure of the Excel sheets in a later stage of gathering data.
- Make the tool better at comparing between different organisations by thinking of a way of presenting data which gives a more complete image when comparing organisations.
- Make the tool more representable for customers by making the tool more customisable.

6.1.3 Answering the main question

Now we have answered the sub-questions, we can answer the main research question:

"How can we develop a tool that can validate the outcomes of changes in the data strategy of an organisation and how can the tools use be incorporated in the business process?"

This question consists of multiple parts. The first one is: “How can we develop a tool that can validate the outcomes of changes in the data strategy of an organisation?” Subquestions 11 and 12 best summarize the answer to this question. The answer it to develop a tool that is adjustable, well-defined, easy and efficient to use, can compare between different moments in time, can compare between different organisations and is representable for the customer. In this research, we did this by defining several variables for which data needs to be gathered. Next to that, we developed an Excel tool in which this data can be gathered. Lastly, we designed five dashboards to visualize the collected data.

The second part of the question is: “How can the tools use be incorporated in the business process?” Sub-question 13 best summarizes the answer to this question. We advise Techspread to use the ADKAR method with two of the supporting factors of the success factor model, being open to change and having a well-organised project to implement the change.

6.2 Restrictions

In this section, we will discuss the restrictions of our research. First, we discuss reliability and validity. Then we will talk about the limitations.

6.2.1 Reliability & validity

In our research, interviews can jeopardize reliability. For example, when asking people at Techspread for input they might have been thinking about the current client they are working with. When we ask them

for input when they are working with another organisation, the input might be different. Therefore, we will clearly mention this, ask for input again at a later stage, and advise to keep reflecting on the tool when using it. Another factor is the interpretation of the researcher. This threat is minimized by checking during and after interviews and during the research in general whether I clearly understood the input.

During this research one of the biggest threats to internal validity is when we determined what variables to use in the model. When the variables are not representative, the tool would not make accurate visualisations. To minimize this threat, we checked with Techspread whether they agree to the variables.

Three factors that generally threaten external validity are the research population, time, and environment. The tool we made in this research might be usable for other organisations that have a similar purpose as Techspread. The variables in the tool are valuable for many organisations, but it only makes sense to use the tool if you are looking for the benefit from change.

In this research, the biggest threat to construct validity was when choosing the variables with which we defined the pillars. If the chosen variables do not fully represent the corresponding pillar, this might give a depicted image of the situation. To prevent this from happening, we researched this choice in multiple ways. We used interviews, literature search, and asked about it in the evaluation.

6.2.2 Limitations

A limitation of this research is that the tool was not tested in a real situation. If this would have been the case, we could have received more detailed feedback on how the tool works and where it needs adjusting. At the moment the tool has not been tested in a real-life situation.

This limitation is partly caused by the next limitation, which is time available. The goal is to finish the research in ten weeks. In this time, we cannot do endless research, therefore decisions have to be made regarding the scope of the research. An example of time restriction is that with more time we would have been able to put more time into evaluating the tool and adjusting the tool based on the received feedback.

As Techspread is rather small, only a little amount of people have given input on the tool. When more people would have looked critically at the tool, we might have been able to gather more ideas and feedback.

Another limitation is the way the data quality dimensions and employee satisfaction are measured. We currently ask the user to rate these levels, which leaves room for subjectivity. It would be more beneficial to have a fully defined way of measuring these levels.

6.3 Discussion

After finding and developing the solution, and performing an evaluation we found that the tool is a big improvement to the initial situation. The tool adds value in a few areas: communication the results of their service, gathering data, the learning process, and enabling the users to give feedback on the use of an actual tool. In the initial situation Techspread had no way of showing what their service would result in. This tool enables them to communicate their value more easily to their customers. The tool also adds value in the reflection process. Initially Techspread was not gathering a lot of data related to the suggested data strategy. As they were not gathering data, they also cannot easily see if the final result is in line what they initially expected, which keeps them from learning from their previous work. This tools gives them some support in their learning process. They can see how much the final results differ form their expectations, which can help them improve their later expectations. Lastly, the tool enables the users to

give specific feedback on the process. Even when the tool appear to be of low quality, it will be easier for the users to specifically mention where they think improvement is possible and in what way. This is of great value as we think this will enable an easier improvement of the process in general.

However, there is still room for improvement. We have to keep in mind that initially there was no tool at all, therefore we were not able to talk to people who have used a similar tool already and have feedback based on their user experience. Instead, this tool is the first version. Next to that, the tools use has not been implemented and reflected upon. Therefore, we don't have any user experience and feedback yet. We are aware of some possible improvements. The data quality dimensions and employee satisfaction level can be better defined, at the moment this leaves space for subjectivity as we ask for scoring these levels. Next to that, it could be more beneficial when the user is enabled to easily change the structure of the Excel sheets at a later stage of the data collection. Third, the tool leaves room for improvement when it comes to enabling the user to compare the data of different organisations. Lastly, it is possible to ass value to the tool by making it more customisable for the customers.

Even though the tool is a first version which has not been tested in real life, we do think it adds value. When developing a new solution from scratch, there will always be a first version on which people can continue building and improving.

6.4 Recommendations

As we have been working on this research for half a year, there are some ideas that have formed with regard to Techspread relating to this research. In this section, we will discuss the recommendations I have regarding the research itself and the recommendations regarding possible further research.

6.4.1 Research recommendations

Implementation of the tool

From the evaluation, we can conclude that the tool meets the conditions set. Therefore, it can be a logical choice for Techspread to implement the tools use in their processes. Our first recommendation would be to implement the tools use as described in Chapter 4.

Keep evaluating the tools variables

We recommend staying critical towards the variables and actively seeing whether they could be improved. It could be that when using the tool, organisations have suggestions on which variables they think would be valuable to have measured.

Improve user-friendliness of the tool

As the tool has not yet been used in real life it is important to see stay critical towards possible improvements in its use. Users might experience difficulties or might get ideas on how to improve the tool. It is important to keep improving the tool after implementing its use as this can increase the added value even further.

Keep evaluating the visualisations

When using the tool, it might be possible that organisations or users find that the right data is collected, but that it would be valuable to visualize it in a different way. We recommend actively evaluating this.

Learn from expected vs final

The tool gathers both the expected final result and the real final result. This shows how the expectations from Techspread differ from reality. We recommend trying to learn from the differences in these values and with that improve the following expectations.

6.4.2 Possible further research

Standardized data

By keeping track of the outcomes of certain implemented changes it can be possible to base future expectations on the old data. Besides learning from the actual outcome compared to the expectations it could be possible to let the tool predict the outcome of a certain change automatically.

Include implementation costs

Including the costs of implementing the change would give a more complete idea of the investment instead of only looking at the results. It could be interesting to research how to add this into the tool.

Further define the social score

Currently, the social score mostly looks at a decrease in certain numbers. This leaves room for improvement. If you differentiate between levels of improvement, the score could give a better image than it does now. For example, if you have both waste and recyclable waste, you could say that when the total level of waste stays the same but there is more recyclable waste, this is still a positive change. By finding a way of how this can be represented in the score, the quality of showing the social score can be improved.

Measuring data quality

Currently, the measurement of the data quality dimensions is done by asking the user to fill out scores. This leaves some room for subjectivity. It could be interesting to find a way of defining the data quality level which does not have any subjectivity.

How to compare better between different organisations

At the moment it is able to compare between different organisations as the same type of data is collected and the change in percentage is calculated. The difficulty currently is that companies differ in various aspects, for example, size and efficiency. If we compare raw data, this will give a wrong idea as a certain improvement should be interpreted differently for different organisations. It is possible to improve regarding this condition by thinking of a way of presenting data which gives a more complete image when comparing organisations.

Make the tool more customisable

The added value of the tool could be increased by finding ways to customise the tool further. For example, letting the user choose how to visualise the data or easily change the colours into the colours of the organisation for which it is used.

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8. Appendices

8.1 Systematic Literature Review

Definition of the knowledge problem / research question

We will perform this systematic literature review to answer the following question: "What approaches can be used to predict outcomes of changes in an organisation?"

Inclusion and exclusion criteria

The goal is to find existing models suitable to use for prediction of results of changes. These can be used when determining what model would be optimal to use for Techspread. "Predictive model" will be our first criterium. It will be important to use synonyms when we are not finding what we are looking for. Possible synonyms are stated in Table 11. We are searching for predictive model used in a specific setting. Terms specifying its use can also be useful in searching for literature. For example, the predictive model will be used to predict outcomes of organisational changes, therefore "organisational change" can also be a criterium. One example of such a model is a scenario model. We can also include this term in our search.

Databases

As we are searching for recent information with established scientific quality, we should be searching for scientific articles in an academic database (Eck, 2021). We will be using a multidisciplinary database to make sure that the quality is good. The databases that we will be using are Scopus and arXiv. ArXiv contains papers in the field of mathematics and mathematical finance which are in line with my research.

Search terms and used strategy

Below you can see a table which contains our key concepts, synonyms, broader terms, and narrower terms. This table will make the search for useful literature easier and more efficient.

Table 11: Search terms

Key concept	Synonyms	Broader terms	Narrower terms
"Predictive model"	"Prognostic model", "Forecast model"	"Result prediction",	"Simulation", "Change prediction model"
"Organisational changes"	"Future business insights"	"Future business outcomes", "business process reengineering"	"Predictive future", "Lean six sigma"
"Scenario model"	"Scenario analysis", "Predictive model"	"Future analysis", "Scenario-based planning"	"Predictive modelling", "Forecast model", "Predictive analytics"

Snowballing is a method used in literature search. When we have found a relevant source, we will use this one to find more useful sources.

Listing of results of search

Table 12: Search log

Date	Search query	Database	Hits	Limit / exclude	Comments
23/10/2022	TITLE ("predictive models" AND "change")	Scopus	**73**	-	Quite a good search, but need more about prediction in business

23/10/2022	TITLE ("predictive models" AND "business change")	Scopus	0	-	Too specific
23/10/2022	TITLE ("predictive models" AND "business")	Scopus	**3**	Limit: open access	Seem to get useful articles, might be good to search this terms broader
23/10/2022	TITLE-ABS-KEY ("predictive models" AND "business") AND (LIMIT-TO (OA , "all"))	Scopus	276	Limit: open access	Try to get more specific
23/10/2022	TITLE-ABS-KEY ("predictive model" AND "change" AND "business")	Scopus	**27**	Limit: open access	Some are good, some not in the right area
23/10/2022	TITLE-ABS-KEY ("predictive model") AND ("organisational change" OR "future business insights" OR "lean six sigma")	Scopus	**20**	Limit: open access	Applied in the right area, but not many articles that are really about the model
23/10/2022	TITLE ("forecasting" AND ("results" OR "outcomes")) AND ("organisational" AND "change")	Scopus	**2**	Limit: open access	Useful documents
16/09/2022	"Predictive model" AND "change" (searched in title)	arXiv	**2**		Useful documents found
16/09/2022	"Predictive model" AND "change" AND "business" (searched in abstract	arXiv	**7**		A few useful documents

Table 13: Number of results

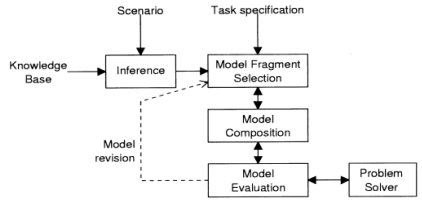
Total number of hits	134
Removing duplicates	-47
Selecting based on title	-58
Selecting based on abstract	-19
No access to full article	-19
Snowballing	+3
Added by further search	+2
Total selected	6

Conceptual matrix

Table 14: Conceptual matrix

Articles		Scenarios	Simulation	Delphi
1	Scenarios and scenario models	x		
2	On Compositional Modelling	x		
3	Qualitative forecasting methods in the business planning process	x	x	x
4	Modelling and analysis of business process reengineering strategies for improving emergency department efficiency		x	
5	Business process modelling using discrete-event simulation		x	
6	Delphi method			x

Table 15: Literature matrix

Title	Authors	Key findings
Scenarios and scenario models	J. Keppens	Compositional modeller takes 2 inputs and produces 1 output. 1st is a model that describe the real situation. 2nd is a description of what is going to happen, the task. This describes the criteria with which we can evaluate to what extend we can accept it. The output is a model which describes the scenario, the 1st input, in more detail. It is a model that contains conceptual participants and relations. The goal of a compositional modeller is to convert the scenario into a scenario model by means of task description.
On Compositional Modelling	J. Keppens & Q. Shen	More in depth explanation of the steps. Illustrated in a figure. 
Qualitative forecasting methods in the business planning process	N. Ravic,K. Njegic, M. Djekic	It explains the stages of creating scenarios and where you can use a scenario analysis for. It explains the basics of using the Delphi method.
Modelling and analysis of business process reengineering strategies for improving emergency department efficiency	S. Srinivas, R. P. Nazareth, M. S. Ullah	Describes the basics of discrete event simulation and what event simulation van be useful for. It explains the order and steps of how an event simulation is performed.
Business process modelling using discrete-event simulation	V. Hlupic, G. Vreede	Describes when it is beneficial to use event simulation and describes the process in steps.
Delphi method	M. M. Grime, G. Wright	Basic explanation of what the Delphi method is and when it is beneficial to use it.

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