Chapter 6
Qualitative Process Analysis

Quality is free, but only to those who are willing to pay heavily for it.
Tom DeMarco (1940–)

Analyzing business processes is both an art and a science. In this respect, qualitative analysis is the artistic side of process analysis. Like fine arts, such as painting, there is not a single way of producing a good process analysis, but rather a range of principles and techniques that tell us which practices typically lead to a "good" process analysis.

In this chapter, we introduce a selected set of principles and techniques for qualitative process analysis. First, we present two techniques aimed at identifying unnecessary steps of the process (value-added analysis) and sources of waste (waste analysis). Next, we present techniques to identify and document issues in a process from multiple perspectives and to analyze the root causes of these issues.

6.1 Value-Added Analysis

Value-added analysis is a technique to identify unnecessary steps in a process in view of eliminating them. In this context, a *step* may be a task in the process or part of a task. It is often the case that one task involves several steps. For example, a task "Check invoice" may involve the following steps:

1. Retrieve the PO that corresponds to the invoice.
2. Check that the amounts in the invoice and those in the PO coincide.
3. Check that the products or services referenced in the PO have been delivered.
4. Check that the supplier's name and banking details in the invoice coincide with those recorded in the supplier management system.

In some cases, steps within a task are documented in the form of checklists. The checklists tell the process participants what things need to be in place before a task is considered to be complete. If detailed checklists are available, the process analyst

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can use them to decompose tasks into steps. Unfortunately, such checklists are not always available. In many cases, process participants have an implicit understanding of the steps in a task because they perform the task day in and day out. But this implicit understanding is not documented anywhere. In the absence of such documentation, the process analyst needs to decompose each task into steps by means of observation and interviewing.

Having decomposed the process into steps, a second prerequisite for value-added analysis is to identify who is the customer of the process and what are the positive outcomes that the customer seeks from the process. These outcomes are said to add value to the customer, in the sense that fulfilling these outcomes is in the interest or for the benefit of the customers.

Having decomposed the process into steps and having identified the positive outcomes of a process, we can then analyze each step in terms of the value it adds. Steps that directly contribute to positive outcomes are called *Value Adding* (VA) steps. For example, consider a process for repairing a washing machine or other appliance. The steps where the technician diagnoses the problem with the machine are value adding, as they directly contribute to the outcome the customer wishes to see, which is that the machine is repaired. Also, the steps related to repairing the machine are value adding.

Some steps do not directly add value to the customer but they are necessary for the business. Consider again the example of a process for repairing a washing machine. Imagine that this process includes a step "Record defect" in which the technician enters data into an information system about the washing machine and an explanation of the defect found in it. This step per se is not value adding for the customer. The customer wishes the machine to be fixed and does not get value by the fact that the defect in their machine was recorded in an information system. However, recording defects and their resolution helps the company to build up a knowledge base of typical defects and their resolution, which is valuable when new technicians are recruited. Also, such data allows the company to detect frequent defects and to report such defects to the manufacturer or distributor of the washing machine. Steps such as "Record defect" are termed *Business Value Adding* (BVA) steps. BVA steps are those that the customer is neither willing to pay for, nor gains satisfaction from (so they are not value adding), but they are necessary or useful to the company where the process is performed.

Steps that are neither VA nor BVA are called *Non-Value Adding* (NVA).

In summary, value-added analysis consists in breaking down each task in a process into steps, such as a preparation step, an execution step, and a handoff step. We then classify each step into one of three categories, namely:

- Value Adding (VA): This is a step that produces value or satisfaction to the customer. When determining whether or not a step is VA, it may help to ask the following questions: Would the customer be willing to pay for this step? Does the customer value this step enough to keep conducting business with us? And conversely, if we remove this step, would the customer perceive that the outcome of the process is less valuable?

- Business Value Adding (BVA): The step is necessary or useful for the business to run smoothly, to collect revenue, or it is required due to the regulatory environment of the business. When determining whether or not a step is BVA, it may help to ask the following questions: Is this step required in order to collect revenue, to improve or grow the business? Would the business (potentially) suffer in the long term if this step were removed? Does it reduce risk of business losses? Is this step required in order to comply with regulatory requirements?
- Non-Value Adding (NVA): The step does not fall into any of the other two categories.

Example 6.1 We consider the equipment rental process described in Example 1.1 (page 3). The customer of this process is the site engineer who submits an equipment rental request. From the perspective of the site engineer, the positive outcome of the process is that the required piece of equipment is available in the construction site when needed. Let us analyze the fragment of this process described in Figure 1.6, which we reproduce as Figure 6.1 for convenience. To identify the relevant steps, we walk through this model task by task, and we classify each step into VA, BVA, and NVA.

- The first task in the process model is the one where the engineer lodges the request. From the description in Example 1.1, we observe there are three steps in this task:

  1. Site engineer fills in the request.
  2. Site engineer sends the request to the clerk via email (handoff step).
  3. Clerk opens and reads the request (handoff step).

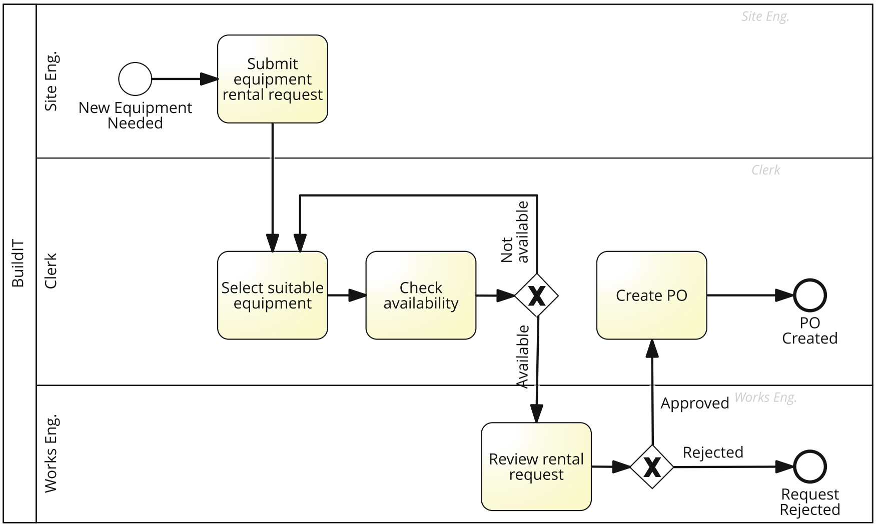

Fig. 6.1 Process model for the initial fragment of the equipment rental process

Arguably, filling the request is VA insofar as the site engineer cannot expect the equipment to be rented if they do not ask for it. In one way or another, the site engineer has to request the equipment in order to obtain it. On the other hand, the site engineer does not get value out of sending the request to the clerk by email nor does get value out of the clerk having to open and read the request. More generally, steps associated to handoffs between process participants, such as sending and receiving internal messages, are NVA.

- The second task is the one where the clerk selects a suitable equipment from the supplier's catalog. We can treat this task as a single step. This step is VA insofar as it contributes to identifying a suitable equipment to fulfill the needs of the site engineer.
- In the third task, the clerk calls the supplier to check the availability of the selected equipment. This "call supplier" step is value adding insofar as it contributes to identifying a suitable and available equipment. If the equipment is available, the clerk recommends that this equipment be rented. To this end, the clerk adds the details of the recommended equipment and supplier to the rental request form and forwards the form to the works engineer for approval. Thus we have two more steps: (i) adding the details to the rental request and (ii) forwarding the rental request to the works engineer. The first of these steps is BVA since it helps the company to keep track of the equipment they rent and the suppliers they rent from. Maintaining this information is valuable when it comes to negotiating or re-negotiating bulk agreements with suppliers. On the other hand, the handoff between the clerk and the works engineer (i.e. the "forwarding" step) is not value adding.
- Next, the works engineer examines the rental request in view of approving it or rejecting it. We can treat this examination as one step. This step is a *control step*, that is, a step where a process participant or a software application checks that something has been done correctly. In this case, this control step helps the company to ensure that equipment is only rented when it is needed and that the expenditure for equipment rental in a given construction project stays within the project's budget. Control steps are generally BVA.
- If the works engineer has an issue with the rental request, the works engineer communicates it to the clerk or the site engineer. This communication is another step and it is BVA since it contributes to identifying and avoiding misunderstandings within the company. If approved, the request is sent back to the clerk; this is a handoff step and it is thus NVA.
- Finally, assuming the request is approved, the clerk creates and sends the PO. Here we can identify two more steps: creating the PO and sending the PO to the corresponding supplier. Creating the PO is BVA. It is necessary in order to ensure that the rental request cost is correctly accounted for and eventually paid for. Sending the PO is value adding: It is this act that makes the supplier know when the equipment has to be delivered on a given date. If the supplier did not get this information, the equipment would not be delivered. Note however that what is value adding is the fact that the supplier is explicitly requested by the

Table 6.1 Classification of steps in the equipment rental process

Step	Performer	Classification
Fill request	Site engineer	VA
Send request to clerk	Site engineer	NVA
Open and read request	Clerk	NVA
Select suitable equipment	Clerk	VA
Check equipment availability	Clerk	VA
Record recommended equipment & supplier	Clerk	BVA
Forward request to works engineer	Clerk	NVA
Open and examine request	Works engineer	BVA
Communicate issues	Works engineer	BVA
Forward request back to clerk	Works engineer	NVA
Create PO	Clerk	BVA
Send PO to supplier	Clerk	VA

construction company to deliver the equipment on a given date. The fact that this request is made by sending a PO is secondary in terms of adding value to the site engineer.

The identified steps and their classification are summarized in Table 6.1.

□

One may wonder whether creating the PO is a VA step or a BVA step. Arguably, in order for the equipment to be available, the supplier needs to have an assurance that the equipment rental fee will be paid. So one could say that the creation of the PO contributes to the rental of the equipment since the PO serves to assure the supplier that the payment for the rental equipment will be made. However, as mentioned above, what adds value to the site engineer is the fact that the supplier is notified that the equipment should be delivered at the required date. Whether this notification is done by means of a PO or by means of a simple electronic message sent to the supplier is irrelevant, so long as the equipment is delivered. Thus, producing a formal document (a formal PO) is arguably not value adding. It is rather a mechanism to ensure that the construction company's financial processes run smoothly and to avoid disputes with suppliers, e.g., avoiding the situation where a supplier delivers a piece of equipment that is not needed and then asks for payment of the rental fee. More generally, we will take the convention that documentation and control steps imposed by accounting or legal requirements are BVA.

Exercise 6.1 Consider the process for university admission described in Exercise 1.1 (page 5) and modeled in Figure 5.4 (page 197). What steps can you extract from this process? Classify these steps into VA, BVA, and NVA.

Having identified and classified the steps of the process as discussed above, one can then proceed to determining how to minimize or eliminate NVA steps. Some NVA steps can be eliminated by means of automation. This is the case of handoffs for example, which can be eliminated by putting in place an information system that allows all stakeholders to know what they need to do in order to move forward the rental requests. When the site engineer submits a rental request via this information system, the request would automatically appear in the to-do list of the clerk. Similarly, when the clerk records the recommended supplier and equipment, the works engineer would be notified and directed to the request. This form of automation makes these NVA steps transparent to the performers of the steps. The topic of process automation will be discussed in further detail in Chapter 10.

A more radical approach to eliminate NVA steps in this example is to eliminate the clerk altogether from the process. This means moving some of the work to the site engineer so that there are less handoffs in the process. Of course, the consequences of this change in terms of added workload to the site engineer need to be carefully considered. Yet another approach to eliminate NVA (and BVA) steps would be to eliminate the need for approval of rental requests in cases where the estimated cost is below a certain threshold. Again, this option should be weighted against the possible consequences of having less control steps in place. In particular, if the site engineers were given full discretion to rent equipment at their own will, there would need to be a mechanism in place to make them accountable in case they rent unnecessary equipment or they rent equipment for excessively and unnecessarily long periods.

While elimination of NVA steps is generally considered a desirable goal, elimination of BVA steps should be considered as a trade-off given that BVA steps play a role in the business. Prior to eliminating BVA steps, one should first map BVA steps to business goals and business requirements, such as regulations that the company must comply to and risks that the company seeks to minimize. Given a mapping between BVA steps on the one hand and business goals and requirements on the other, the question then becomes the following: What is the minimum amount of work required in order to perform the process to the satisfaction of the customer, while fulfilling the goals and requirements associated to the BVA steps in the process? The answer to this question is a starting point for process redesign (see Chapter 8).

6.2 Waste Analysis

Waste analysis can be seen as the reverse of value added analysis. In value added analysis we look at the process from a positive angle. We try to identify value adding steps, and then we classify the remaining steps into business-value adding and non-value adding. Waste analysis takes the negative angle. It tries to find waste everywhere in the process. Some of these wastes can be traced down to specific steps in the process, but others, as we will see, are hidden in between steps or sometimes throughout the process.

Waste analysis is one of the key techniques of the *Toyota Production System* (TPS) developed by Taiichi Ohno and colleagues in the 1970s. This technique has been integrated in various management paradigms such as Lean management [115]. Ohno used to describe the TPS as follows: What we are doing, all the time, is to look at a timeline from the moment a customer puts an order to the point that the cash for that order is collected. And looking at the timeline, we are trying to reduce the *muda*. Muda is a Japanese term for waste. Ohno and his colleagues came up with a classification of waste into seven types, which we group into three higher-level categories to make them easier to remember:

- *Move*: Wastes that are related to movement. This category includes two types of waste: *transportation* and *motion*.
- *Hold*: Wastes arising from holding something. Again, this category includes two types of waste: *inventory* and *waiting*.
- *Overdo*: Wastes arising from doing more than is necessary in order to deliver value to the customer or the business. This category encompasses three types of waste: *defects*, *overprocessing*, and *overproduction*.

6.2.1 Move

The first and perhaps most pervasive source of waste is *transportation*. In a manufacturing process, transportation means moving materials from one location to another one, such as from a warehouse to a production facility. In a business process, physical transportation occurs, for example, when documents are sent from one process participant to another—often signaling a handoff of work between participants—or when physical documents are exchanged with an external party. In modern business processes, physical document exchanges have been largely replaced with electronic exchanges. For example, purchase orders, shipment notifications, delivery receipts and invoices are often exchanged via *Electronic Data Interchange* (EDI) channels. Meanwhile, internal handoffs between process participants are generally automated by means of Process-Aware Information Systems, as we will discuss in Chapter 9. But despite the replacement of physical document flows with electronic ones, which we have witnessed in the past decades, transportation remains nonetheless a source of waste. Indeed, every time that a handoff occurs between participants, this handoff entails some delay, as the participant who needs to take the relay is likely to be busy with other work when the handoff occurs.

A process model with lanes and pools can help us to identify transportation waste. Typically, there is transportation waste wherever a sequence flow goes from one lane to another in a pool. Such a sequence flow represents a handoff. In a similar vein, if the process model has multiple pools, every message flow is a potential transportation waste.

Example 6.2 Let us consider the equipment rental process model introduced in Example 1.1 (page 3). The fragment of the process from the creation of the rental request up to its approval is shown in Figure 6.2. The figure highlights four transportation wastes. The first three come from handoffs between process

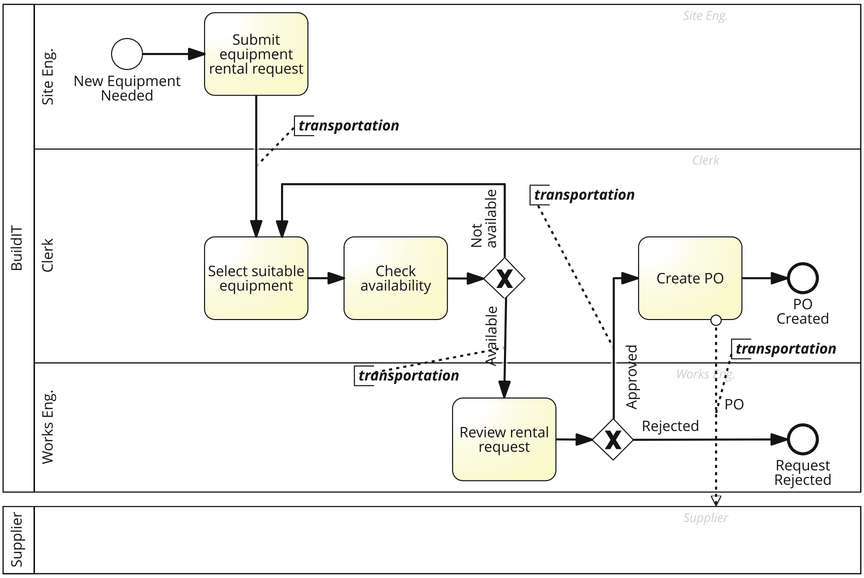

Fig. 6.2 Fragment of the equipment rental process from creation of rental request up to creation of the PO

participants: (i) from the site engineer to the clerk; (ii) from the clerk to the works engineer; and (iii) from the works engineer back to clerk. The fourth transportation waste occurs when the clerk sends the purchase order to the supplier.

Later in the process, we can note two other transportation events: the delivery of the equipment to the construction site and its subsequent removal at the end of the renting period. One might argue that these two transportation events are value adding, since the delivery of the equipment is precisely what the site engineer seeks. Still, the rental company would strive to minimize this transportation, for example, by optimizing the placement of equipment so that it is close to the construction sites where it is likely to be used.

A final transportation waste occurs when the supplier submits the invoice. □

This example shows that not all transportation waste in a process can be eliminated. In particular, the transportation of equipment cannot be fully eliminated. But we can strive to reduce it or we can strive to reduce its cost. For example, to reduce the cost of physical transportation of goods, we can batch together several deliveries. Similarly, transportation of physical documents can in some cases be replaced by electronic exchanges. In other situations, it may be possible to reduce the number of handoffs, so as to reduce the waiting times and context switches that these exchanges create.

The second type of waste related to movement is *motion*. Motion refers to process participants moving from one place to another during the execution of a process. Motion is common in a manufacturing process where workers move pieces from one place to another in the production line. In the field of business processes, motion wastes are less common than in manufacturing process, but they are nonetheless present.

Consider, for example, a vehicle inspection process where customers have their vehicles inspected in order to assess their roadworthiness and their compliance with respect to gas emission requirements. In this process, vehicles have to go through different inspection bases in order to undergo different tests. Oftentimes, process participants have to move equipment or tools from one inspection base to another to perform certain tests. This is a motion waste.

Another form of motion waste—which can be found in digitized processes—arises when a process participant has to switch from one application to another during the performance of a task. For example, when doing a vehicle inspection booking for a new customer, the receptionist may need to record the customer details in one application, and then schedule the inspection in another application. The movement between these two applications is motion waste. A set of techniques and tools known under the name of Robotic Process Automation (RPA) [15] aim at reducing this type of motion waste. RPA will be further discussed in Chapter 9.

6.2.2 Hold

We can also generate waste by having materials, work items, or resources on hold. The first type of hold waste is called *inventory*. In manufacturing processes, inventory waste arises whenever we hold more inventory than what is strictly necessary at a given point in time in order to maintain the production lines working. In the field of business processes, inventory waste usually does not take the form of physical inventory. Instead, inventory waste shows up in the form of *Work-In-Process* (WIP). WIP is the number of cases that have started and have not yet completed.

For example, in the vehicle inspection process mentioned above, it may happen that a vehicle does not pass the inspection the first time due to a minor issue (e.g., worn tyres). In this case, the customers is asked to correct the issue at their preferred garage and to come back for a second inspection. At any point in time, it may be that dozens of vehicles are in a state between their first inspection and their second inspection. Those vehicles contribute to high levels of WIP and hence they constitute inventory waste. One may ask why do we consider these pending inspections a form of waste? The reason is that these pending inspections are *unrealized value*. The customers only get value out of this process once their vehicle has passed the inspection. Ideally, we would like cases to arrive and leave as fast as possible, so as to generate as much value as possible.

Another type of waste falling under the hold category is *waiting*. In manufacturing processes, waiting waste occurs, for example, when unfinished products come out from one production line and they need to wait for the workers in the next production line to become available in order to proceed. In the case of a business process, waiting waste occurs when a task waits for a process participant to become available. Waiting waste can also occur in the opposite direction: Instead of the task waiting for a resource, we might have a resource waiting for a task. This sub-type of waiting waste is called *idleness*.

Let us consider again the vehicle inspection process. At some point in time, it might be that there is a technician at an inspection base waiting for the next car, because the next car is still being inspected at the previous base. This is an example of idleness.

On the other hand, consider the case of a travel request that has undergone one approval, but needs to undergo a second one. This second approval is a task. If the participant responsible for the second approval is not available when the first approval is completed, the request is put on hold. The time that the request spends on hold is waiting waste.

Transportation waste often implies waiting waste. For example, the three flows going across lanes in Figure 6.2 induce waiting waste because process participants who receive the rental request will often not be available when the request is handed off to them.

6.2.3 Overdo

The third category of waste are those related to overdoing. The first type of overdo waste is called *defect* waste. Defect waste refers to all work performed in order to correct, repair, or compensate for a defect in a process. Defect waste encompasses *rework*, meaning situations where we have to perform again a task that we have previously executed in the same case, because of a defect the first time the task was performed. In a travel requisition process, an example of a defect waste is when a travel requisition request is sent back by the approver to the requestor for revision because some data was missing.

Another type of waste in this category is called *overprocessing*. Overprocessing refers to work that is performed unnecessarily given the outcome of a process instance. It includes unnecessary perfectionism, but it also includes tasks that are performed and later found not to be necessary.

Coming back to the vehicle inspection process, let us assume that the technicians take a lot of time to measure the vehicle emissions with a higher degree of accuracy. This perfectionism is waste. If in addition we find out later that the said vehicles for which the emissions were measured so accurately, end up not fulfilling the emissions levels by a big margin, then all this accuracy was unnecessary.

Consider now the example of the travel approval and assume that about 10% of the requests are rejected trivially after several tasks have been completed, because there is not enough budget for the travel. These unnecessary task executions could be avoided by doing a budget check earlier in the process, so as to avoid wasting the time of the approvers. This example illustrates that simple verification steps at the start of a process can help to minimize overprocessing. This approach to minimize overprocessing will be further discussed in Chapter 8.

The final type of waste, namely *overproduction*, is closely related to overprocessing. While overprocessing occurs when a task is executed and later found to be unnecessary, overproduction occurs when we execute an entire process instance that does not add value upon completion.

Consider a quote-to-cash process in which the quote-to-order sub-process produces many quotes that are later rejected by the customer. In other words, the customer obtains a quote but does not submit a subsequent purchase order. The rejected quotes are overproduction waste. We should strive to minimize this waste by not attracting requests for quote that will not lead to an order, or by trying to convert every possible request for quote we get into an order, because the fulfilled order is what adds value to the organization.

Another typical example of overproduction occurs when a process instance is canceled by its initiator (the customer). For example, consider a travel approval process in which some travel requests are created just in case the trip is needed (without certainty). If it turns out that the travel is not needed, the travel request is canceled. These canceled instances create non-value adding work for the process participants. Ideally, we would like to minimize this waste and only have to handle the necessary requests.

Similarly, travel requests that are rejected for reasons that could have been foreseen prior to the process instance being created constitute overproduction waste. For example, a travel request that is rejected due to lack of budget, in a way that could have been detected upfront, is an overproduction waste.

This latter example illustrates that the boundary between overproduction and overprocessing is sometimes subtle. The key difference is that overprocessing occurs when it is necessary to start the process instance in order to discover that the instance cannot be fulfilled, whereas overproduction occurs in two cases:

- When the instance ends up in a positive outcome, but it turns out that the instance was not needed.
- When the instance ends up in a negative outcome that could have been foreseen prior to the instance being created.

Example 6.3 Consider the fragment of the equipment rental process captured in Figure 6.2 (page 220). After performing the task "Check availability", it may happen that the selected equipment is not available. In this case, the clerk needs to go back and select an alternative equipment. In other words, there is a rework loop. This rework is a defect waste.

Once the clerk has found a suitable and available equipment item, the works engineer might reject the request because the job for which the equipment is required can be done using an equipment item available at a nearby construction site. In other words, the creation of the rental request could have been avoided if the site engineer was able to check which other equipment items are available at nearby sites. The latter is an example of overproduction waste. □

Exercise 6.2 Identify wastes in the university admission process of Exercise 1.1 (page 5) and classify them according to the seven types of waste. Consider the following additional information.

Each year, the university receives in total 3,000 online applications. There are 10 study programs. Each study program has 30 study places. The top-5 applicants in each study program are offered scholarships in addition to a study place. Applicants initially ranked in positions 6 to 30 in their study program are offered a study place but without a scholarship. After the committee has examined the applications, each application is either: (i) accepted with a scholarship, (ii) accepted without scholarship, (iii) admissible but not accepted unless a study place is freed up by a higher-ranked applicant, or (iv) rejected due to low scores or plagiarism.

Successful applicants must accept or decline the offer at most two weeks after notification. If an applicant declines the offer, his or her study place is allocated to the next admissible non-admitted applicant in the ranking of his or her study program. If an applicant with an allocated scholarship rejects his or her study place, the scholarship is allocated to the next applicant in the corresponding ranking who does not yet have an allocated scholarship.

Applications are rejected or discarded for the following reasons:

- 20% of applications are rejected initially due to deficiencies in the online application form (e.g., missing documents). In half of the cases, the applicant manages to fix the identified issues and the application passes the administrative check after the second try.
- 10% of applications are rejected because the hard copy is not received on time.
- 3% rejected due to a negative advice from the academic recognition agency.
- 2% rejected due to invalid English language test.
- 5% rejected due to plagiarized motivation letter.
- 5% rejected due to poorly written motivation letters.
- 15% rejected due to low GPA.
- 20% of applicants are offered a place but decline it. In 60% of these cases, the applicant declines because he or she expected to get a scholarship, but his or her score was insufficient. In another 30% of cases, applicants decline because they had already accepted an offer elsewhere. The rest of cases where applicants decline an offer are due to personal reasons.
- 20% of applicants are declared admissible but do not receive an offer due to lack of study places.

The admissions office handles circa 10,000 emails from applicants concerning the application process, including questions about the application form, the required documents, the eligibility conditions, the application status, etc.

6.3 Stakeholder Analysis and Issue Documentation

When analyzing a business process, it is worth keeping in mind that "even a good process can be made better" [61]. Experience shows that any non-trivial business process, no matter how much improvement it has undergone, suffers from a number of issues. There are always errors, misunderstandings, incidents, unnecessary steps and other waste when a business process is performed on a day-to-day basis.

Part of the job of a process analyst is to identify and to document the *issues* that affect the performance of a process. To this end, an analyst will typically gather data from multiple sources and will interview several stakeholders, chiefly the process participants but also the process owner and managers of organizational units involved in the process. Each stakeholder has a different view on the process and will naturally have a tendency to raise issues from his or her own perspective. The same issue may be perceived differently by two stakeholders. For example, an executive manager or a process owner will typically see issues in terms of performance objectives not being met or in terms of constraints imposed for example by external pressures (e.g., regulatory or compliance issues). Meanwhile, process participants might complain about insufficient resources, hectic timelines as well as errors or exceptions perceived to be caused by other process participants or by customers.

Below, we introduce three complementary techniques to collect, document and analyze issues in a process:

1. Stakeholder analysis, which allows us to collect issues from complementary perspectives.
2. Issue register, which allows us to document issues in a structured manner.
3. Pareto analysis and PICK charts, which allow us to select a subset of issues for further analysis and redesign.

6.3.1 Stakeholder Analysis

Stakeholder analysis is a widely used technique in the field of project management. This analysis is generally undertaken at the start of a project in order to understand who has an interest in the project and could therefore contribute to, affect, or be affected by the project's execution, and how.

In the field of BPM, stakeholder analysis is commonly used to gather information about issues that affect the performance of the process from different perspectives. In this context, there are typically five categories of stakeholders:

- The customer(s) of the process.
- The process participants.
- The external parties (e.g., suppliers, sub-contractors) involved in the process.
- The process owner and the operational managers who supervise the process participants.
- The sponsor of the process improvement effort and other executive managers who have a stake in the performance of the process.

Each of these categories of stakeholders bring their own viewpoint and are likely to perceive different issues in the process. The customers are likely to be concerned with issues such as slow cycle time, defects, lack of transparency, or lack of traceability (i.e., inability to observe the current status of the process).

Process participants might be rather concerned about high resource utilization, as this means that they have to work under stress. They might also be concerned about defects, though not necessarily the same defects as the customer since the process participants see the process from the inside. Specifically, process participants are likely to see defects arising from handoffs in the process, whereas customers do not necessarily see these defects if they are internally fixed. More generally, process participants are usually able to provide insights regarding wastes in the process, not only defects, but also transportation, movement and waiting waste (arising from handoffs), as well as overprocessing.

External parties can have a variety of concerns, depending on their role in the process. Suppliers and sub-contractors (which are a common type of external party) are generally concerned about having a steady or growing stream of work from the process, being able to plan their work ahead, and being able to meet contractual requirements. In other words, they are concerned about predictability, and they might see opportunities to improve the interactions between their own process and the processes with which they are integrated.

The process owner and the operational managers are likely to be concerned with the performance measures of the process, be it high cycle times or high processing times. Indeed, processing times are directly related to labor costs and hence they affect the efficiency of the process. A process owner might also be concerned about common defects in the process, as well as overproduction. The process owner and other managers are generally also concerned about compliance with internal policy and external regulations.

The sponsor and other high-level managers are generally concerned with the strategic alignment of the process and the contribution of the process to the key performance measures of the organization. They might also be concerned about the ability of the process to adapt to evolving customer expectations, external competition, and changing market conditions. Sponsors and high-level managers might also raise opportunities (as opposed to issues), for example opportunities to attract additional customers, to expand into a new market segment, or to cross-sell or up-sell products or services to existing customers.

When a process improvement effort starts, the sponsor and the process owner will generally put forward a set of objectives and targets to be achieved by the improvement effort. They may also put forward one or more hypotheses regarding the main bottlenecks and issues in the process. The analyst takes this initial set of objectives, targets, and perceived issues as a starting point. The analyst then identifies and conducts interviews with stakeholders in each of the above categories in order to collect additional perceived issues. By cross-checking the perceived issues raised during these interviews, and by validating them via additional data collection, the analyst identifies a set of validated issues from the perspective of each category of stakeholder. These validated issues are the input to construct an issue register as discussed below.

Example 6.4 Consider the equipment rental process discussed in previous examples. The owner of this process is BuildIT's purchasing manager. The purchasing manager is concerned by the growing volume of equipment rental expenses. In the past year, these expenses have grown by 12% whereas the overall volume of construction activity (measured by revenue) has grown by only 8%. The purchasing manager launches an improvement effort to bring down the rental expenses by 5%. This objective is in line with overall target set by the CFO of 5% of company-wide cost reductions.

An analyst is asked to review the rental process. The analyst identifies the following stakeholders:

- Customer: the site engineers.
- Process participants: the clerks, the works engineers and the accounts payable team at the financial department (who handle the invoice).
- Process owner and operational managers: purchasing manager, construction project managers, accounts payable team lead.
- Upper management: the CFO, acting as the business sponsor as part of the broader mandate for cost reduction.
- External party: the equipment rental suppliers.

After interviewing the process owner, the analyst notes two perceived issues in the process:

- Equipment is often hired for longer than needed, leading to inventory waste.
- Penalties are often being paid to the suppliers due to: (i) equipment being returned upon receipt because it was not suitable for the job; and (ii) late invoice payments. In both cases, these penalties arise from wastes of type defect.

The above observations illustrate that oftentimes, issues raised during the stakeholder analysis (particularly issues raised by the process owner and the process participants) are associated with wastes. Hence, the output of waste analysis can be helpful when engaging in a stakeholder analysis.

The analyst decides to start by gathering data from the site engineer, the clerk and the works engineer, given their central role in the process. He proceeds with interviews in order to derive deeper qualitative insights. The interviews are partly driven by the waste analysis—in particular transportation, waiting, and defects, as well as the inventory waste raised by the process owner.

After interviewing three site engineers, the analyst retains that the main concern of the site engineers is the delay between the moment they create an equipment rental and the moment the corresponding equipment arrives. The analyst determines that this delay is of 3.5 working days on average (sometimes three, sometimes 4 days, rarely less or more). The site engineer also confirmed that sometimes they have to reject equipment when they receive it because the equipment is not suitable for the job—even though they claim that in their requests, they clearly indicate what type of equipment is needed and for what purpose.

On the other hand, the clerks' main concerns are:

- Lack of clarity in the requirements they receive from the site engineers, which somehow contradicts the viewpoint of the latter.
- Inaccurate and incomplete equipment descriptions in the catalogs of the site engineer vendors.
- Slow turnaround times when asking the works engineers to approve the rental requests.

The works engineers echo the concerns of the purchasing managers that site engineers are sometimes retaining the rented equipment for longer than strictly needed (inventory waste). They are aware that sometimes the delivered equipment does not match the requirements of the site engineers and is hence returned, but they do not perceive that this is a major issue.

The accounts payable team claims that they are aware of the fact that penalties are being paid for late invoice payments. However, they claim that it is not their fault. In 98% of cases, invoices are being paid at most three working days after their internal approval. The accounts payable department claims that it is not possible to do faster, and that in any case, the penalties of late invoices would still occur even if they could reduce the payment time from 3 days to 2 days.

The analyst also interviewed two suppliers, who echoed the fact that sometimes the delivered equipment was rejected by the site engineer, and that invoices took too long to be paid. The suppliers additionally perceived that there is a lack of integration between their systems and the ones used internally at BuildIT. A supplier commented that this lack of integration could be one of the reasons why mistakes were being made along the way.

The analyst retains that the issues raised by the process owner are being echoed in several ways by other stakeholders. The analyst also takes note of the slow cycles times reported by the site engineer, and the misunderstandings and data quality issues raised by the clerk. □

Exercise 6.3 Let us consider again the university admission process for international students described in Exercise 1.1 (page 5). The owner of this process is the Head of the Admissions Office, who reports to the university's Deputy Vice-Chancellor for Student Affairs. The Head of Admissions Office is simultaneously concerned about the cost of running the admissions process, but equally as much by the fact that the university is losing talented admission candidates to competing universities.

Regarding the costs, the process owner reports that each instance of the admission process generates € 100 in labor cost, including the time spent by the admissions office as well as the time spent by the academic committees responsible for assessing and ranking the applications. The admissions office additionally pays a fee of € 30 to an external agency to verify the validity and equivalence of each submitted diploma, plus € 20 per submitted application to the provider of the online application system that students use to submit and track their applications. The university's marketing office additionally spends € 100 in marketing per application. The university charges to the applicant a non-reimbursable application fee of € 100 per application. As discussed in Exercise 6.2 (page 224), out of 3,000 applications only 300 applicants end up joining a study program. The remaining students drop out during the process for the reasons enumerated in Exercise 6.2.

Regarding the loss of candidates during the admission process, the process owner is particularly concerned about the relatively high number of applicants who receive an admission offer but do not accept it. Specifically, 30% of applicants who receive an offer reject it as mentioned in Exercise 6.2 (page 224) and 30% of those who reject the offer do so in favor of a competing university.

You are tasked with doing an analysis of the above process in order to come up with a list of issues. Given the description of the process in Exercise 1.1 (page 5) and the information given above, prepare a plan including:

- The list of stakeholders you would interview (justify your choice).
- For each stakeholder, discuss what types of issues you would expect him or her to raise (hypothesized issues) and what questions you could ask to each stakeholder in order to determine if these hypothesized issues indeed exist, and if so, what is their impact.

6.3.2 Issue Register

Stakeholder analysis allows us to identify issues in a business process from multiple perspectives. The next natural step is to organize and document these issues and to assess their impact both quantitatively, for example in terms of time or financial loss, as well as qualitatively in terms of perceived nuisance to the customer or perceived risks that the issue entails. This is the role of the *issue register*. Concretely, an issue register is a listing that provides a detailed analysis of each issue and its impact in the form of a table with a pre-defined set of fields. The following fields are typically described for each issue:

- *Name of the issue*. This name should be kept short, typically 2–5 words, and should be understandable by all stakeholders in the process.
- *Description*. A short description of the issue (e.g., 1–3 sentences) focused on the issue itself as opposed to its consequences or impact, which are described separately.
- *Priority*. A number (1, 2, 3, ...) stating how important this issue is relative to other issues. Note that multiple issues can have the same priority number.
- *Data and assumptions*. Any data used or assumptions made in the estimation of the impact of the issue, such as for example number of times a given negative outcome occurs, or estimated loss per occurrence of a negative outcome. In the early phases of the development of the issue register, the numbers in this column will be mainly assumptions or ballpark estimates. Over time, these assumptions and rough estimates will be replaced with more reliable numbers derived from actual data about the execution of the process.
- *Qualitative impact*. A description of the impact of the issue in qualitative terms, such as impact of the issue on customer satisfaction, employee satisfaction, long-term supplier relationships, company's reputation, or other intangible impact that is difficult to quantify.
- *Quantitative impact*. An estimate of the impact of the issue in quantitative terms, such as time loss, revenue loss, or avoidable costs. This field in the issue register provides a link between qualitative and quantitative analysis techniques.

Quantitative analysis techniques, such as those to be presented in the next chapter, allow us to obtain refined estimates of the quantitative impact of an issue.

Other fields may be added to an issue register. For example, in view of process redesign, it may be useful to include an attribute *possible resolution* that describes possible mechanisms for addressing the issue.

Example 6.5 We consider again the equipment rental process described in Example 1.1 (page 3) and the stakeholder analysis summarized in Example 6.4. As a result of the stakeholder analysis, the analyst concluded that the issues raised by the process owner were echoed by the customer (site engineer) and the other process participants. The analyst also found three other perceived issues: one raised by the site engineer (delays in the rental process) and two by the clerk (unclear site engineer requirements and inaccurate or incomplete catalog data). The analyst decided not to include these perceived issues in the initial issue register, because they appeared to be possible causes of the issues raised by the process owner, rather than top-level issues on their own. Accordingly, the analyst proceeded to analyze the issues raised by the process owner by gathering additional data about their frequency and the impact of each occurrence of those issues.

Based on the collected data, the analyst prepared the issue register in Table 6.2.[1]

□

Question Issue or factor?

An issue register may contain a mixture of issues that have a direct impact business performance as well as other issues that are causal or contributing factors of issues that then impact on business performance. In other words, the issue register contains both *issues* and *factors*. For example, when preparing the issue register of the equipment rental process, one could be tempted to include entries such as the following ones:

- Clerk misunderstood the site engineer's requirements for an equipment.
- Clerk did not select the correct equipment from the supplier's catalog due to inattention.
- Clerk indicated an incorrect delivery date in the PO.
- Supplier did not deliver the equipment that had been ordered.
- Delivered equipment is faulty or is not ready-for-use.
- Supplier delivered the equipment to the wrong construction site or at the wrong time.
- The equipment arrived five working days after the site engineer had requested it, but the site engineer needed the equipment earlier.

All of the above issues are possible causal or contributing factors of a top-level issue, namely "Equipment is rejected by the site engineer". The fact that the site

[1] In this issue register we do not use one column per field, but rather one row per field. This is a pragmatic choice to better fit the issue register within the width of the page.

Table 6.2 Issue register of equipment rental process

Issue 1: Equipment kept longer than needed
Priority: 1
Description: Site engineers keep the equipment longer than needed
Data and assumptions: BuildIT rents 3,000 pieces of equipment per year. In 10% of cases, site engineers keep the equipment 2 days longer than needed. On average, rented equipment costs € 100 per day
Qualitative impact: Not applicable
Quantitative impact: $0.1 \times 3,000 \times 2 \times 100$ = € 60,000 in additional rental expenses per year
Issue 2: Rejected equipment
Priority: 2
Description: Site engineers sometimes reject the delivered equipment due to non-conformance to their specifications
Data and assumptions: BuildIT rents 3,000 pieces of equipment per year. Each time an equipment is rejected due to a mistake on BuildIT's side, BuildIT is billed the cost of 1 day of rental, that is € 100. 5% of them are rejected due to an internal mistake within BuildIT (as opposed to a supplier mistake)
Qualitative impact: These events disrupt the construction schedules and create frustration and internal conflicts
Quantitative impact: $3,000 \times 0.05 \times 100$ = € 15,000 per year
Issue 3: Late payment fees
Priority: 3
Description: BuildIT pays late payment fees because invoices are not paid by the due date
Data and assumptions: BuildIT rents 3,000 pieces of equipment per year. Each equipment is rented on average for 4 days at a rate of € 100 per day. Each rental leads to one invoice. About 10% of invoices are paid late. On average, the penalty for late payment is 2% of the amount of the invoice
Qualitative impact: Suppliers are annoyed and later unwilling to negotiate more favorable terms for equipment rental
Quantitative impact: $0.1 \times 3,000 \times 4 \times 100 \times 0.02$ = € 2,400 per year

engineer rejects the equipment creates a direct impact for BuildIT, for example in terms of delays in the construction schedule. Meanwhile, the issues listed above have an indirect business impact, in the sense that they lead to the equipment being rejected and the needed equipment not being available on time, which in turn leads to delays in the construction schedule.

When an issue register contains a combination of issues and factors, it may be useful to add two fields to the register, namely "caused by" and "is cause of", that indicate for a given issue, which other issues in the register are related to it via a cause-effect relation. This way it becomes easier to identify which issues are related between them so that related issues can be analyzed together. Also, when an issue X is a factor of an issue Y, instead of analyzing the impact of both X and Y, we can analyze the impact of Y and in the qualitative and quantitative impact fields of X we can simply refer to the impact of Y. For example, in the impact field of issue "Clerk misunderstood the site engineer's requirements" we can simply refer to the impact of "Equipment is rejected by the site engineer".

Alternatively, we can adopt the convention of including in the issue register only top-level issues, meaning issues that have a direct business impact, and separately, we can use why-why diagrams and cause-effect diagrams to document the factors underpinning these top-level issues. This convention is followed in the rest of this chapter, meaning that the issue registers shown below only contain top-level issues rather than factors. The analysis and documentation of the causes of each issue is undertaken outside the issue register by means of root cause analysis techniques, which we will discuss later in this chapter. Hence, for each issue we put in an issue register, there is at least one stakeholder who is directly impacted by the issue, and hence we can do an impact analysis of each issue.

In the above example, the number of issues is small. In a large organization, a stakeholder analysis of a core process can lead to dozens of issues. Moreover, when we engage in a BPM program covering many processes, the number of issues across all processes can be in order of hundreds. In these cases, it pays off to use an *Issue Tracking system* to maintain the issue register. An issue tracking system is a collaboration tool that allows its users (among other things) to create, document, edit, and comment on issues, and to generate filtered and sorted lists of issues according to a range of criteria.

Exercise 6.4 We consider again the university admission process. As discussed in Exercise 6.3 (page 228), the process owner is concerned by the costs of the process and by the fact that good candidates are being lost to competing universities during the admission process. Concretely, we saw in Exercise 6.2 (page 224) that 30% of students who receive an offer reject it, and that out of those, 30% of them reject the offer because they received an offer from a competing university. The interviews as well as data from applicant surveys reveal that one of the issues faced by the university is that students have to wait too long to know the outcome of their application. It often happens that by the time a student is admitted, the student has decided to go to another university instead. Write an issue register to document this issue (only this issue). Take into account the data in Exercises 6.2 and 6.3.

6.3.3 Pareto Analysis and PICK Charts

The impact assessment conducted while building the issue register can serve as input for *Pareto analysis*. The aim of Pareto analysis is to identify which issues or which causal factors of an issue should be given priority. Pareto analysis rests on the principle that a small number of factors are responsible for the largest share of a given effect. In other words:

- A small subset of issues in the issue register are likely responsible for the largest share of impact.
- For a given issue, a small subset of factors behind this issue are likely responsible for the largest share of occurrences of this issue.

Sometimes this principle is also called the 80-20 principle, meaning that 20% of issues are responsible for 80% of the effect. One should keep in mind however that the specific proportions are only indicative. It may be for example that 30% of issues are responsible for 70% of the effect.

A typical approach to conduct Pareto analysis is as follows:

1. Define the effect to be analyzed and the measure via which this effect will be quantified. The measure might be for example:
   - Financial loss for the customer or for the business.
   - Time loss by the customer or by the process participants.
   - Number of occurrences of a negative outcome, such as number of unsatisfied customers due to errors made when handling their case.
2. Identify all relevant issues that contribute to the effect to be analyzed.
3. Quantify each issue according to the chosen measure. This step can be done on the basis of the issue register, in particular, the quantitative impact column of the register.
4. Sort the issues according to the chosen measure (from highest to lowest impact) and draw a so-called *Pareto chart*. A Pareto chart consists of two components:
   a. A bar chart where each bar corresponds to an issue and the height of the bar is proportional to the impact of the issue or factor.
   b. A curve that plots the cumulative percentage impact of the issues. For example, if the issue with the highest impact is responsible for 40% of the impact, this curve will have a point with a y-coordinate of 0.4 and an x-coordinate positioned so as to coincide with the first bar in the bar chart.

Example 6.6 Consider again the equipment rental process described in Example 1.1 (page 3) and the issue register in Example 6.5. All three issues in this register have in common that they are responsible for unnecessary rental expenditure, which is a form of financial loss. From the data in the impact column of the register, we can plot the Pareto chart in Figure 6.3.

This Pareto chart shows that issue "Slow rental approval" is responsible already for 78% of unnecessary rental expenditure. Given that in this example there are only three issues, one could have come to this conclusion without conducting Pareto analysis. In practice though, an issue register may contain dozens or hundreds of issues, making Pareto analysis a useful tool to summarize the data in the issue register and to focus the analysis and redesign efforts on the set of issues that would lead to the most visible impact. □

Exercise 6.5 Let us consider again the equipment rental process. This time we take the perspective of the site engineer, whose goal is to have the required equipment available on site when needed. From this perspective, the main issue is that in about 10% of cases, the requested equipment is not available on site the day when it is required. When this happens, the site engineer contacts the suppliers directly to resolve the issue, but still, resolving the issue may take several days. It is estimated that each such delay costs € 400 per day to BuildIT. By inspecting a random sample

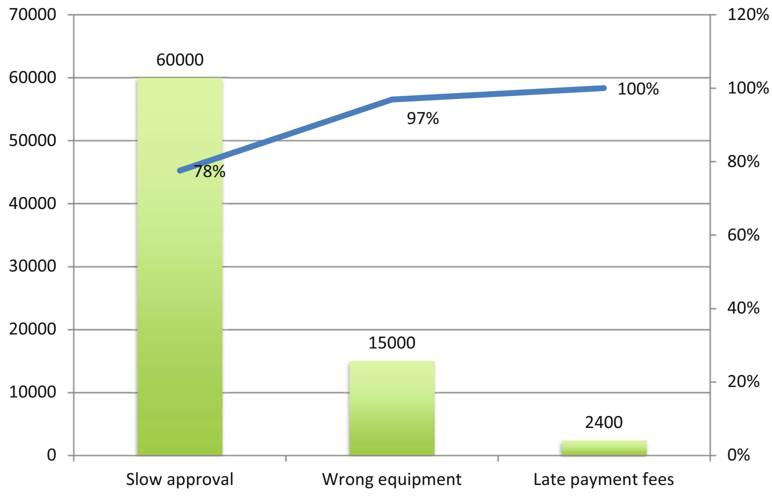

Fig. 6.3 Pareto chart for excessive equipment rental expenditure

of delayed equipment deliveries during a one-year period and investigating the cause of each occurrence, an analyst found that:

1. In total, five occurrences were due to the site engineer not having ordered the equipment with sufficient advance notice: The site engineers ordered the equipment the day before it was needed, when at least 2 days are needed. These cases cause delays of 1 day on average.
2. Nine occurrences were due to the fact that none of BuildIT's suppliers had the required type of equipment available on the requested day. These cases cause delays of 1 to 4 days (3 days on average).
3. 13 occurrences were due to the approval process taking too long (more than a day) due to mistakes or misunderstandings. For these cases, the delay was 1 day on average.
4. 27 occurrences were due to the equipment having been delivered on time, but the equipment was not suitable and the site engineer rejected it. These cases cause delays of 2 days on average.
5. Four occurrences were due to mistakes or delays attributable entirely to the supplier. These cases lead to delays of one day. However, in these cases, the supplier compensated BuildIT by providing the equipment 2 days for free (the remaining days are still charged). Recall that the average cost of an equipment rental per day is € 100.
6. For two occurrences, the analyst did not manage to determine the cause of the delay (the process participants could not recall the details). The delays in these cases where 2 days per occurrence.

The sample of analyzed occurrences represents around 20% of all occurrences of the issue during a one-year period.

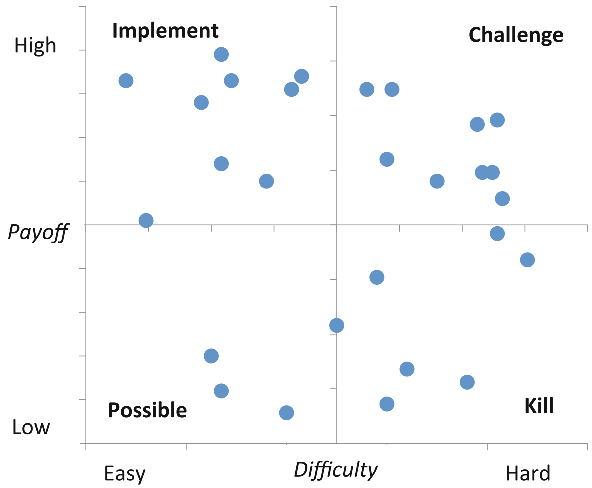

Fig. 6.4 PICK chart visualizing the payoff and difficulty of addressing each issue

Draw a Pareto chart corresponding to the above data.

It is worth highlighting that Pareto analysis focuses on a single dimension. In the example above, the dimension under analysis is the impact in monetary terms. In other words, we focus on the estimated payoff of addressing an issue. In addition to payoff, there is another dimension that should be taken into account when deciding which issues should be given higher priority, namely the level of difficulty of addressing an issue. This level of difficulty can be quantified by the investment required to change the process, such that the issue in question is addressed.

A type of chart that can be used as a complement to Pareto charts in order to take into account the difficulty dimension is the *PICK chart*. PICK is an acronym standing for Possible, Implement, Challenge, and Kil. These are the names of the four quadrants of a PICK chart (see Figure 6.4). In a PICK chart, each issue appears as a point. The horizontal coordinate of a point captures the difficulty of addressing the issue (or more specifically the difficulty of implementing a given improvement idea that addresses the issue). Meanwhile, the vertical coordinate of an issue captures its potential payoff. The horizontal axis (difficulty) is split into two sections (easy and hard) while the vertical axis (payoff) is split into low and high. These splits lead to four quadrants that allow analysts to classify issues according to the trade-off between payoff and difficulty:

- *Possible* (low payoff, easy to do): issues that can be addressed if there are sufficient resources to do so.
- *Implement* (high payoff, easy to do): issues that should definitely be implemented as a matter of priority.
- *Challenge* (high payoff, hard to do): issues that should be addressed but require significant amount of effort. In general one would pick one of these challenges and focus on it rather than addressing all or multiple challenges at once.

- *Kill* (low payoff, hard to do): issues that are probably not worth addressing or at least not to their full extent.

6.4 Root Cause Analysis

Root cause analysis is a family of techniques that helps analysts to identify and understand the root cause of issues or undesirable events. Root cause analysis is not confined to business process analysis. In fact, root cause analysis is commonly used in the context of accident or incident analysis as well as in manufacturing processes where it is used to understand the root cause of defects in a product. In the context of business process analysis, root cause analysis is helpful to identify and to understand the issues that prevent a process from having a better performance.

Root cause analysis encompasses a variety of techniques. In general, these methods include guidelines for interviewing and conducting workshops with relevant stakeholders, as well as techniques to organize and to document the ideas generated during these interviews or workshops. Below, we will discuss two of these techniques, namely *cause-and-effect diagrams* and *why-why diagrams*.

6.4.1 Cause-Effect Diagrams

Cause-effect diagrams depict the relationship between a given *negative effect* and its potential causes. In the context of process analysis, a negative effect is usually either a recurrent issue or an undesirable level of process performance. Potential causes can be divided into causal and contributing factors (hereby called *factors*) as explained in the box below.

CAUSAL VERSUS CONTRIBUTING FACTORS
Two broad types of causes are generally distinguished in the area of root cause analysis, namely *causal factors* and *contributing factors*. Causal factors are those factors that, if corrected, eliminated or avoided would prevent the issue from occurring in future. For example, in the context of an insurance claims handling process, errors in the estimation of damages lead to incorrect claim assessments. If the damage estimation errors were eliminated, a number of occurrences of the issue "Incorrect claim assessment" would definitely be prevented. Contributing factors are those that set the stage for, or that increase the chances of a given issue occurring. For example, consider the case where the user interface for lodging the insurance claims requires the claimant to enter a few dates (e.g., the date when the claim incident occurred), but the

(continued)

interface does not provide a calendar widget so that the user can easily select the date. This deficiency in the user interface may increase the chances that the user enters the wrong date. In other words, this deficiency contributes to the issue "Incorrect claim data entry".

While the distinction between causal and contributing factor is generally useful when investigating specific incidents (for example investigating the causes of a given road accident), the distinction is often not relevant or not sufficiently sharp in the context of business process analysis. Accordingly, in this chapter we will use the term *factor* to refer to causal and contributing factors collectively.

In a cause-effect diagram, factors are grouped into categories and possibly also sub-categories. These categories help to guide the search for potential causes. Concretely, when organizing a brainstorming session for root cause analysis, one way to structure the session is to first go around the table asking all participants to give their opinion on the potential causal or contributing factors of the issue at hand. These potential factors are listed in no particular order. Next, the potential factors are classified according to certain categories and the discussion continues in a more structured way using these categories as a framework. The outcome of this discussion is a list of potential (or hypothesized) factors. Each of these hypothesized factors should be validated subsequently by collecting data from the relevant information systems or by observing executions of the process during a period of time in order to determine if occurrences of the negative effect can indeed be traced back to occurrences of the potential factor.

A well-known categorization for cause-effect analysis are the so-called 6 M's, which are described below together with possible sub-categorizations.

1. **Machine** (technology)—factors pertaining to the technology used, like for example software failures, hardware failures, network failures, or system crashes that may occur in the information systems that support a business process. A useful sub-categorization of Machine factors is the following:

    a. Lack of functionality in application systems.
    b. Redundant storage of data across systems, leading for example to double data entry (same data entered twice in different systems) and data inconsistencies across systems.
    c. Low performance of IT of network systems, leading for example to low response times for customers and process participants.
    d. Poor user interface design, leading for example to erroneous customer or process participants not realizing that some data is missing or that some data is provided but not easily visible.
    e. Lack of integration between multiple systems within the enterprise or with external systems such as a supplier's information system or a customer's information system.

2. **Method** (process)—factors stemming from the way the process is defined or understood or in the way it is performed. An example of this is when a given process participant A thinks that another participant B will send an email to a customer, but participant B does not send it because it is not aware it has to send it. Possible sub-categories of Method factors include:

   a. Unclear, unsuitable, or inconsistent assignment of decision-making and processing responsibilities to process participants.
   b. Lack of empowerment of process participants, leading to process participants not being able to make necessary decisions without consulting several levels above in their organizational hierarchy. Conversely, excessive empowerment may lead to process participants having too much discretion and causing losses to the business through their actions.
   c. Lack of timely communication between process participants or between process participants and the customer.

3. **Material**—factors stemming from the raw materials, consumables, or data required as input by the tasks in the process, like for example incorrect data leading to a wrong decision being made during the execution of process. The distinction between raw materials, consumables, and data provides a possible sub-categorization of these factors.
4. **Man**—factors related to a wrong assessment or an incorrectly performed step, like for example a claims handler accepting a claim even though the data in the claim and the rules used for assessing the claim require that the claim be rejected. Possible sub-categories of Man factors include:

   a. Lack of training and clear instructions for process participants.
   b. Lack of incentive system to motivate process participants sufficiently.
   c. Expecting too much from process participants (e.g., overly hectic schedules).
   d. Inadequate recruitment of process participants.

5. **Measurement**—factors related to measurements or calculations made during the process. In the context of an insurance claim, an example of such a factor is one where the amount to be paid to the customer is miscalculated due to an inaccurate estimation of the damages being claimed.
6. **Milieu**—factors stemming from the environment in which the process is executed, like for example factors originating from the customer, suppliers, or other external actors. Here, the originating actor is a possible sub-categorization. Generally, Milieu factors are outside the control of the process participants, the process owner, and other company managers. For example, consider a process for handling insurance claims for car accidents. This process depends partly on data extracted from police reports (e.g., police reports produced when a major accident occurs). It may happen in this context that some errors during the claims handling process originate from inaccuracies or missing details in the police reports. These factors are to some extent outside the control of the insurance company. This example illustrates that milieu factors may need to be treated differently from other (internal) factors.

These categories are meant as a guideline for brainstorming during root cause analysis rather than gospel that should be followed to the letter. Other ways of categorizing factors may be equally useful. For example, one alternative categorization is known as the 4 P's (Policies, Procedures, People and Plant). Also, it is sometimes useful to classify factors according to the tasks in the process from where they originate (i.e., one category per major task in the process).

The above categories are useful not only as a guide for brainstorming during root cause analysis, but also as a basis for documenting the potential root causes in the form of a cause-effect diagram. Concretely, given a categorization of potential causes, such as the 6 M's above, a cause-effect diagram consists of a main horizontal line (the *trunk*) from which a number of branches stem (see Figure 6.5). At one end of the trunk is a box containing the negative effect that is being analyzed (in our case the *issue* being analyzed). The trunk has a number of main branches corresponding to the categories of factors (e.g., the 6 M's). The root causes are written in the sub-branches. Sometimes, it is relevant to distinguish between *primary factors*, meaning factors that have a direct impact on the issue at hand, from *secondary factors*, which are factors that have an impact on the primary factors. For example, in the context of an insurance claims handling process, an inaccurate estimation of the damages leads to a miscalculation of the amount to be paid for a given claim. This inaccurate estimation of the damages may itself stem from a lack of incentive from the repairer to accurately calculate the cost of repairs. Thus, "Inaccurate damage estimation" can be seen as a primary factor for "Liability miscalculation", while "Lack of incentive to calculate repair costs accurately" is a secondary factor behind the "Inaccurate damage estimation". The distinction between primary and secondary factors is a

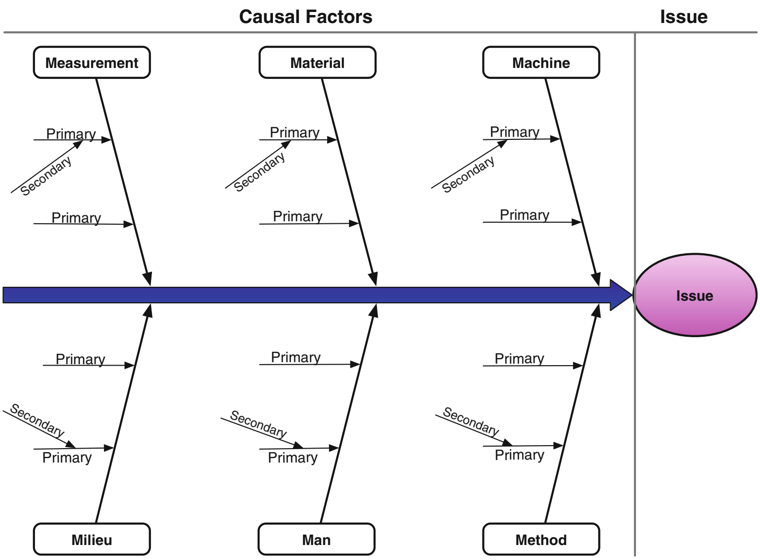

Fig. 6.5 Template of a cause-effect diagram based on the 6 M's

first step towards identifying chains of factors behind an issue. We will see later in this chapter that why-why diagrams allow us to dig deeper into such chains of factors.

Because of their visual appearance, cause-effect diagrams are also known as *Fishbone diagrams*. Another common name for such diagrams is *Ishikawa diagrams* in allusion to one of its proponents—Kaoru Ishikawa—one of the pioneers of the field of quality management.

Example 6.7 We consider again the equipment rental process described in Example 1.1 (page 3) and the issue register in Table 6.2 (page 231). One of the issues identified in the issue register is that sometimes, the delivered equipment is rejected by the site engineer. We can see three primary causes from the issue, which are summarized in the cause-effect diagram in Figure 6.6. The diagram also shows secondary causes underpinning each of the primary causes. Note that the factor "clerk selected equipment with incorrect specs" has been classified under the Material category because this factor stems from incorrect input data. A defect in input data used by a process falls under the Material category. □

Exercise 6.6 As discussed in Exercise 6.4 (page 232), one of the main issues of the university admission process is that students have to wait too long to know the outcome of their application. It often happens that by the time a student is admitted, the student has decided to go to another university instead. Analyze the possible causes of this issue using a cause-effect diagram.

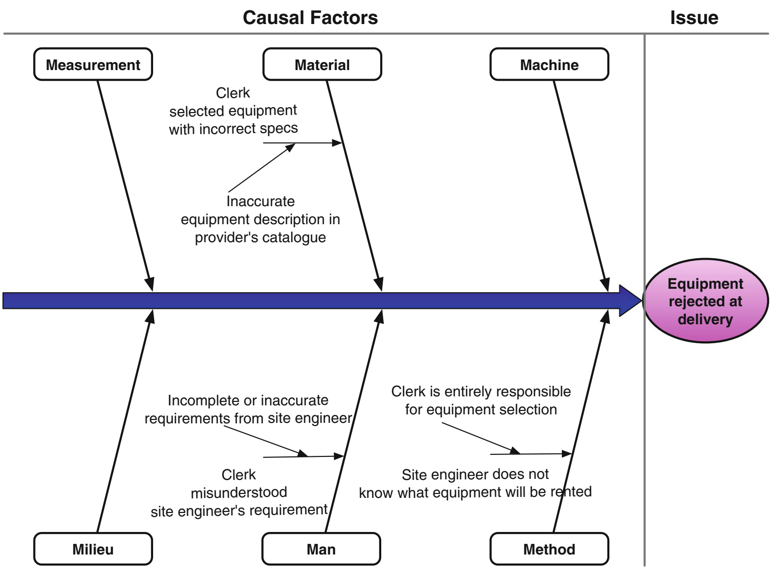

Fig. 6.6 Cause-effect diagram for issue "Equipment rejected at delivery"

6.4.2 Why-Why Diagrams

Why-why diagrams (also known as *tree diagrams*) constitute another technique to analyze the cause of negative effects, such as issues in a business process. The emphasis of root cause analysis is to capture the series of cause-to-effect relations that lead to a given effect. The basic idea is to recursively ask the question: Why has something happened? This question is asked multiple times until a factor that stakeholders perceive to be a *root cause* is found. A common belief in the field of quality management—known as the 5 Why's principle—has it that answering the "why" question five times recursively allows one to pin down the root causes of a given negative effect. Of course, this should not be treated as gospel, but as a guideline of how far one should go during root cause analysis.

Why-why diagrams are a technique for structuring brainstorming sessions (e.g., workshops) for root cause analysis. Such a session would start with an issue. The first step is to give a name to the issue that stakeholders agree on. Sometimes it is found that there is not one issue, but multiple issues, in which case they should be analyzed separately. Once the issue has been identified and a name has been agreed upon, this becomes the root of the tree. Then at each level the following questions are asked: "Why does this happen?" and "What are the main sub-issues that may lead to this issue?". Possible factors are then identified. Each of these factors is then analyzed using the same questions. When getting down in the tree (e.g., to levels 3 or 4) it is recommended to start focusing on factors that can be resolved, meaning that something can be done to change them. The leaves of the tree should correspond to factors that are fundamental in nature, meaning that they cannot be explained in terms of other factors. Ideally, these factors, called root causes, should be such that they can be eliminated or mitigated, but this is not necessarily the case. For example, in the context of an insurance claims handling process, a certain type of error in a police report may be due to lack of time and hectic schedules on the side of police agents involved in filling these reports. There is relatively little the insurance agency can do in this case to eliminate the error, other than raising the issue with the relevant authorities. Yet, the impact of this factor could be mitigated by putting in place checks to detect such errors as early as possible in the process.

A simple template for why-why diagrams is given in Figure 6.7. An alternative way of presenting the information in such diagrams is by means of nested bullet-point lists. In the rest of this chapter we will opt for this latter representation.

Example 6.8 We consider again the equipment rental process described in Example 1.1 (page 3) and the issue register in Table 6.2 (page 231).

Regarding the first issue, the analyst identified a dozen examples where equipment had been kept for more than 10 working days and reportedly not used during the whole rental period. The analyst found that in the majority of these cases, the equipment had been initially rented for a period of less than 10 days, but it was kept for longer by means of a deadline extension. By analyzing the data further, the analyst found that deadline extensions were quite common. It turned out that site engineers found it easy to get a deadline extension. They also knew that getting

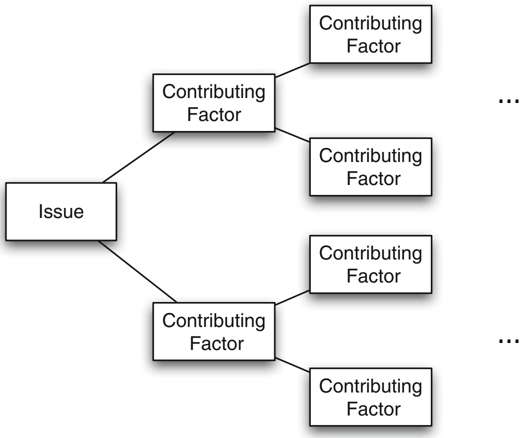

Fig. 6.7 Template of a why-why diagram

equipment rental requests approved took a couple of days or more, and the larger the cost and the longer the duration of the rental, the slower it was to get it approved. As a workaround, site engineers were renting equipment several days before the date when they actually needed it. Also, they were specifying short periods in their equipment rental requests in order to get them approved quicker. When the deadline for returning an equipment approached, they just called the supplier to keep the equipment for a longer period.

The analyst then had a closer look at the second issue (equipment being rejected). The initial interviews with the clerks had already provided some hints as to the causes of this issue. The clerks often misunderstood the site engineer's requirements for an equipment. They also found that the data in the suppliers' catalogs was inaccurate and incomplete. Further interviews with the site engineers also revealed that the site engineers often did not know what equipment had been ordered as a result of their rental request. Had they known it, they could have rectified the mistakes before the equipment reached the construction site.

Finally, the analyst took a closer look at the issue of penalties for late payment of invoices. Again, by taking some concrete examples and talking about them with the clerks, the analyst found that the issue partially came from the fact that clerks were having a hard time getting the site engineers to confirm that the data in the invoices are correct. Site engineers did not feel that verifying the invoices was a priority for them. The clerks also pointed out that there were often inconsistencies between the PO and the invoice. One of the causes for these inconsistencies was that, to avoid the hassle of taking back the equipment and exchanging it for another one, some of the suppliers had developed a workaround: Every time the supplier received a PO, the supplier contacted directly the site engineer to negotiate exactly which equipment should be delivered. As a result of this negotiation, very often the equipment that was actually delivered differed from the one specified in the PO.

Based on the above observations and others made during the interviews, the analyst wrote the following why-why diagrams (represented as nested bullet-point lists).

Issue 1 Site engineers sometimes reject delivered equipment, why?

- wrong equipment is delivered, why?
  - miscommunication between site engineer and clerk, why?
    - site engineer provides an incomplete or inaccurate description of what they want.
    - site engineer does not always see the supplier catalogs when making a request and does not communicate with the supplier, why?
      - site engineer generally does not have Internet connectivity.
    - site engineer does not check the choice of equipment made by the clerk.
  - equipment descriptions in supplier's catalog not accurate.

Issue 2 Site engineers keep equipment longer than needed via deadline extensions, why?

- site engineer fears that equipment will not be available later when needed, why?
  - time between request and delivery too long, why?
    - excessive time spent in finding a suitable equipment and approving the request, why?
      - time spent by clerk contacting possibly multiple suppliers sequentially;
      - time spent waiting for works engineer to check the requests;

Issue 3 BuildIT often has to pay late payment fees to suppliers, why?

- Time between invoice received by clerk and confirmation is too long, why?
  - clerk needs confirmation from site engineer, why?
    - clerk cannot assert when the equipment was delivered and picked up, why?
      - delivery and pick-up of equipment are not recorded in a shared information system;
      - site engineer can extend the equipment rental period without informing the clerk;
    - site engineer takes too long to confirm the invoice, why?
      - confirming invoices is not a priority for site engineer;

□

Exercise 6.7 Consider again the process for university admission described in Exercise 1.1 (page 5) and the issue described in Exercise 6.6 above. Analyze this issue using a why-why diagram.

6.5 Recap

In this chapter, we presented a selection of techniques for qualitative analysis of business processes. The first technique, namely value-added analysis, allows us to identify steps in the process that do not provide value to the customer or to the business. We then presented a complementary technique, which allows us to identify different types of waste. These two techniques allow us to identify potential inefficiencies in the process.

Next, we presented a technique to collect issues from multiple perspectives, namely stakeholder analysis, as well as a template to document these issues in an issue register. The purpose of an issue register is to document issues in a semi-structured way and to analyze their impact on the business both from a qualitative and a quantitative angle. In particular, the issue register provides a starting point to build Pareto charts and PICK charts—two visualization techniques that provide a bird's-eye view of a set of issues. These charts help analysts to focus their attention on issues that offer the highest payoff (in the case of Pareto charts) or the best trade-off between payoff and difficulty (in the case of PICK charts).

Finally, we presented two techniques to uncover the causes behind a given issue, namely cause-effect analysis and why-why analysis. Whereas cause-effect analysis focuses on classifying the factors underpinning the occurrences of an issue, why-why analysis focuses on identifying the recursive cause-effect relations between these factors.

6.6 Solutions to Exercises

Solution 6.1

- VA: receive online application, evaluate academic admissibility, send notification to student
- BVA: check completeness, academic recognition agency check, English test check
- NVA: receive physical documents from students, forward documents to committee, notify students service of outcomes of academic admissibility.

Note. In this solution we treat the entire agency check as BVA. Part of this agency check consists in the admissions office sending the documents to the agency and the agency sending back the documents and their assessment to the admissions office. These two sub-steps could be treated as NVA. However, if we assume that the agency requires the documents to be sent by post to them, these sub-steps cannot be easily separated from the agency check itself. In other words, it would not be possible to eliminate these handoff steps without eliminating the entire agency check. Thus the entire agency check should arguably be treated as a single step.

Solution 6.2

Transportation. Right from the start of the process, we can spot transportation waste in the form of physical documents sent by the student to the admissions office, emails from the admission office to the student, and further documents sent by the applicant if the initial application is incomplete. The latter events can also be seen as defect waste. We also note that there is a handoff from the admissions office to the committee and back. These handoffs are transportation wastes too. Other transportation wastes come from the interactions between the admissions office and the external academic recognition agency.

Waiting. When the admissions office finds that an application is incomplete, an email is sent to the student asking for the missing information or documents. The fact that the application is put on hold until additional input is received from the candidate is waiting waste. Later in the process, the committee batches the applications and examines them every three months. This batching generates waiting waste. There may also be idleness waste during the period when the admissions office is waiting for the decisions of the academic committee, but without further information, it is not possible to assert that this idleness indeed occurs in practice (it may be that the office handles other work in the meantime).

Inventory. Given the committee meets every three months, we can hypothesize that at a given point in time, there are several hundred applications in a pending state. This constitutes inventory waste.

Defect. When an incomplete application is sent back to the applicant, the application needs to be checked again after the student resubmits a revised application. This second verification of completeness is rework, hence defect waste.

Overprocessing. Officers in the admissions office spend time verifying the authenticity of around 3,000 diplomas and language test results submitted by the applicants. In the end, however, only 5% of cases reveal any issues. Later on in the process, three quarters of the applications are passed on to the admission committees. The university ends up making a study place offer to only 20% of the applications that they receive. The fact that the document authenticity was verified for all the applications rejected by the committee is an example of overprocessing.

Overproduction. We can see two sources of overproduction waste: cases where an applicant rejects the admission offer he or she receives (20% of cases) and cases where the applicant is declared admissible but does not receive a study offer due to lack of places (20%).

Solution 6.3 The customer of the admissions process is the applicant. We distinguish between applicants who do not get an admission offer and those who get one.

Among those who get an admission offer, we distinguish between those who accept the admission offer and those who reject it. Additionally, we could distinguish those students who get an admission offer with scholarship from those who do not. Based on this classification, we may wish to interview at least one applicant whose application was rejected; one whose application who was accepted without scholarship and did not accept the offer; one whose application was accepted with scholarship and did not accept the offer; and one whose application was accepted without scholarship and accepted the offer. We could also interview one who was admitted with scholarship and accepted the offer but it is unclear if this would bring additional insights given the objectives of the process owner.

The main process participants are the admission officers and the admission committees (we assume there is one committee per curriculum). We should interview at least one representative from each of these two groups, and in the case of the admission committees, we should consider interviewing representatives of at least two committees.

There is one external party in the process (the academic recognition agency). However, given that their role in the process is punctual and given the objectives of the process owner, it does not seem that getting input from the academic recognition agency is necessary.

Given the description of the process, we hypothesize that the students are concerned by the complexity and slowness of the process, and hence we should be prepared to ask questions about the amount of effort that the process requires from them, and their perception about the response times in the process. They might also raise issues (defects) during the process, like for example wrong answers to their questions, and hence questions could be prepared to explore this possibility.

The admission officers have a large amount of applications to handle, so they might be concerned about excessive workload. But they could also be concerned about the amount of inquiries they get from students. There is a back-and-forth handoff with the admission committee in the process, and hence defects and waiting times associated to these handoffs. More generally, we could take each of the wastes identified in Solution 6.2 and prepare questions to shed light into the magnitude and impact of each waste.

The admission committee has to examine the applications from multiple perspectives and has to deal with discrepancies between different grading systems, as students come from different countries. They also have to assess the motivation letters and reference letters, which are free-form. One can expect them to raise issues about the complexity of tasks they perform. Questions could also be prepared to shed further light into the wastes identified in Solution 6.2, particularly with regard to handoffs.

Solution 6.4 In the following issue register, we only analyze the issue described in this chapter, namely that the admission process takes too long. In practice, the issue register would include multiple issues.

Issue 1: Students reject offer due to long waiting times

Priority: 1

Description: The time between online submission of an application to notification of acceptance takes too long, resulting in some students rejecting their admission offer.

Data and assumptions: Out of 3,000 applicants, 20% (i.e., 600) get an admission offer and reject it. Out of them 30% (i.e. 180) reject the offer because they accepted the admission offer elsewhere. In addition to these data, we assume that half of those who accept an admission offer elsewhere (i.e., 90 students) would have accepted our admission offer if we had made our offer earlier. According to the data in Exercise 6.3 (page 228), the assessment of each application costs € 100 per student to the university in time spent by the admissions office, plus € 50 of academic recognition agency fee and online application service fee. The university spends € 100 in marketing for each application it attracts, but this is covered by the € 100 application fee.

Qualitative impact: Students who would contribute to the institution positively are lost. Delays in the admission process affect the image of the university vis-à-vis future students, and generate additional effort to handle enquiries from students while they wait for the admission decisions.

Quantitative impact: 90 × € 150 = € 13,500 per admission round

In the above issue analysis, the effort required to deal with enquiries during the pre-admission period is listed in the qualitative impact field. If it were possible (with a reasonable amount of effort) to estimate how many such enquiries arrive and how much time they consume, it would be possible to turn this qualitative impact into a quantitative one.

Solution 6.5 First, we analyze the cost incurred by each type of occurrence (i.e., each causal factor) in the sample:

1. Last-minute request: 1 day delay (because normally 2 days advance notice are needed), thus € 400 cost × 5 = € 2,000.
2. Equipment out-of-stock: 3 days delay = € 1,200 × 9 = € 10,800.
3. Approval delay: 1 day delay = € 400 × 13 = € 5,200.
4. Rejected equipment: 2 days delay = € 800 × 27 = € 21,600. Note that in Example 6.5 we mentioned that when an equipment is rejected, a fee of € 100 (on average) has to be paid to the supplier for taking back the equipment. However, we do not include this fee here because we are interested in analyzing the costs stemming from equipment not being available on the required day, as opposed to other costs incurred by rejecting equipment.
5. Supplier mistake: 1 day delay = € 400 minus € 200 in rental cost saving = € 200 × 4 = € 800.
6. Undetermined: 2 days delay = € 800 × 2 = € 1,600.

Since the sample represents 20% of occurrences of the issue over a year, we multiply the above numbers by 5 in order to estimate the total yearly loss attributable to each causal factor. The resulting Pareto chart is given in Figure 6.8.

Solution 6.6 The cause-effect diagram corresponding to this exercise should include at least the name of the issue (e.g., "Student waiting time too long") and the following factors:

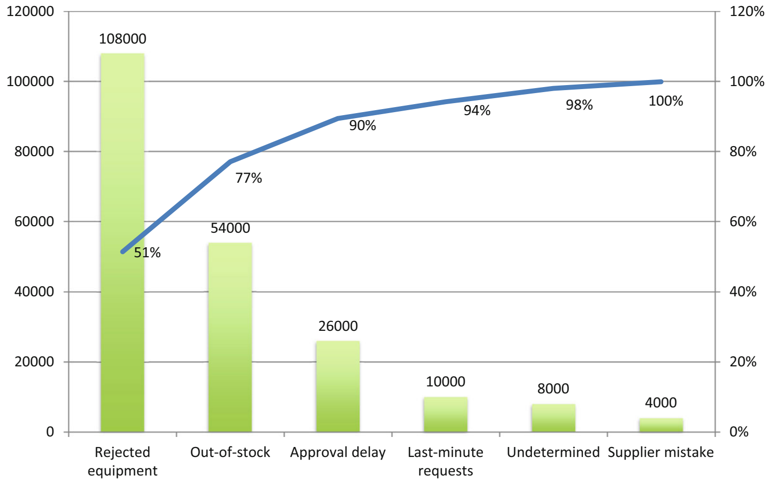

Fig. 6.8 Pareto chart of causal factors of issue "Equipment not available when needed"

- Process stalls due to agency check. This is a Method issue, since the issue stems from the fact that the process essentially stalls until a response is received from the agency. One could argue that to some extent this is a Milieu issue. But while the slowness of the agency check is a Milieu issue, the fact that the process stalls until a response is received from the agency is a Method issue.
- Agency check takes too long. This is a Milieu issue since the agency is a separate entity that imposes its own limitations.
- Academic committee assessment takes too long. This is a Method issue since the process imposes that the academic committee only assesses applications at certain times (when it meets), rather than when applications are ready to be evaluated.
- Physical documents take too long to be received. This is a Milieu issue for two reasons. First, the physical documents are needed for the purpose of the agency check and the delays in the arrival of physical documents are caused by the applicants themselves and postal service delays.
- Admission office delays the notification after academic assessment. This seems to be a Method issue, but the description of the process does not give us sufficient information to state this conclusively. Here, a process analyst would need to gather more information in order to understand this issue in further detail.

Solution 6.7

- Admission process takes too long, why?
  - Process stalls until physical documents arrive, why?
    - Agency check requires physical documents;
    - Other tasks are performed only after agency check, why?

        · Traditionally this is how the process is set up but there is no strong reason for it;

  – Agency check takes too long, why?

    · Exchanges with the agency are via post, why?

        · Agency requires original (or certified) documents due to regulatory requirements.

- Academic committee takes too long, why?
  - Documents are exchanged by internal mail between admissions office and committee.
  - Academic committee only meets at specified times.
- Admission office delays the notification after academic assessment, why?
  - Not enough information available to analyze this issue (probably due to batching—admissions office sends notifications in batches).

The above analysis already suggests one obvious improvement idea: perform the academic committee assessment in parallel to the agency check. Another improvement opportunity is to replace internal mail communication between admissions office and academic committee with electronic communication (e.g., documents made available to committee members via a Web application).

6.7 Further Exercises

Exercise 6.8 Consider the pharmacy prescription fulfillment process described in Exercise 1.6 (page 30). Identify the steps in this process and classify them into VA, BVA, and NVA.

Exercise 6.9 Consider the procure-to-pay process described in Exercise 1.7 (page 31). Identify the steps in this process and classify them into VA, BVA, and NVA.

Exercise 6.10 Consider the pharmacy prescription fulfillment process described in Exercise 1.6 (page 30). Which types of waste can you identify in this process?

Exercise 6.11 Consider the booking-to-cash process at a photography company (Fotof) described in Exercise 4.31 (page 155). Which types of waste can you identify in this process?

Exercise 6.12 Consider the following summary of issues reported in a travel agency.

> A travel agency has recently lost several medium-sized and large corporate customers due to complaints about poor customer service. The management team of the travel agency decided to appoint a team of analysts to address this problem. The team gathered data by

conducting interviews and surveys with current and past corporate customers and also by gathering customer feedback data that the travel agency has recorded over time. About 2% of customers complained about errors that had been made in their bookings. In one occasion, a customer had requested a change to a flight booking. The travel agent wrote an email to the customer suggesting that the change had been made and attached a modified travel itinerary. However, it later turned out that the modified booking had not been confirmed in the flight reservation system. As a result, the customer was not allowed to board the flight and this led to a series of severe inconveniences for the customer. Similar problems had occurred when booking a flight initially: the customer had asked for certain dates, but the flight tickets had been issued for different dates. Additionally, customers complained of the long times it took to get responses to their requests for quotes and itineraries. In most cases, employees of the travel agency replied to requests for quotes within 2–4 working hours, but in the case of some complicated itinerary requests (about 10% of the requests), it took them up to 2 days. Finally, about 5% of customers also complained that the travel agents did not find the best flight connections and prices for them. Several customers reported that they had found better itineraries and prices on the Web by searching by themselves.

1. Document the issues in the form of an issue register. To this end, you may assume that the travel agency receives around 100 itinerary requests per day and that the agency makes 50 bookings per day. Each booking brings a gross profit of € 100 to the agency.
2. Analyze the issues described above using root cause analysis techniques.

Exercise 6.13 Consider the booking-to-cash process at a photography company (Fotof) described in Exercise 4.31 (page 155) as well as the following data:

- Fotof has 25 photo studios and its latest annual turnover from photography services is 17.6 million, out of which 25% from sales to corporate customers and the rest from private customers.
- The company makes an additional 5 million revenue in sales of photography equipment and accessories at its studios.
- There are on average 3.5 photographers and 2 technicians per studio.
- On average, an in-studio session lasts 45 min, while an on-location session lasts 3.5 h (including transportation time).
- 20% of private customer shootings and 100% of corporate customer shootings are on-location. The remaining ones are on-studio.

An analyst conducted a stakeholder analysis focusing on three types of a stakeholders: the customer, the process participants, and the management (process owner and business sponsor). The main findings of this analysis are summarized below.

Customer According to the latest customer survey, customer satisfaction stands at 80% (declining from 85% in the previous year) and net promoter score at 70% (declining from 80% in the previous year). Common customer complaints exist in regards to: (i) turnaround times between the photo shooting session and the availability of pictures for review, as well as the turnaround times for delivery of digital copies and printouts; (ii) turnaround times for resolving customer complaints particularly with regard to perceived defects in the delivered digital and printed copies; (iii) mishandled or forgotten orders or special requests. Customers often make changes to their orders or additional special requests via phone or email and these changes/requests are sometimes not recorded (or recorded incorrectly) in the order management system. Changes to orders are currently handled manually.

Process Participants Staff satisfaction is also low. Over 60% of customer service staff consider that their job is stressful. The staff turnover rate overall is at an all-times high: 10% of staff left the company in the previous year and had to be replaced up from 6% the year before. The average Cost-To-Company (CTC) of a photographer at a Fotof studio is 41K per year (35K for technicians and 37K for customer service staff). The CTC at Fotof is generally in line with industry averages. The company additionally employs 20 staff at the company headquarters at an average CTC of 46K. Interviews with staff have highlighted the following issues in the process:

- Customer service staff perceive that appointment management is too time-consuming. Customers sometimes call or email multiple times to find a suitable appointment time. Customers also call frequently to change their appointments for shooting sessions or to cancel their session. About 1% of corporate orders result in a cancelation prior to the shooting, while 5% of private orders are canceled prior to the shooting.
- The late-show and no-show rates for appointments are high: 10% late-shows for in-studio sessions, 2% for on-location sessions, 3% of no-shows for on-studio sessions, and 1% for on-location.
- There are numerous customer enquiries via phone and email (on average three per order, in addition to booking-related calls or emails), be it to enquire about the status of orders or deliveries, to make changes to the order, to discuss special requests, pricing questions, as well as to report complaints with received pictures.

Management Fotof's three-years strategy is focused on revenue growth. The company seeks to achieve a revenue increase of 50% by end of 2018 organically, meaning via growth of the existing business, without company acquisitions and without opening additional retail outlets. To achieve this goal, Fotof's management is receptive to ideas to improve customer service and to expand the range of added-value services. Fotof's management perceives that additional revenue could come in great part from wedding photos, parties and ceremonies. At present only the customer who initiates the booking can place orders. But in the case of personal events and if the customer consents, there is an opportunity to sell to other event participants. Fotof's management also perceives that faster cycle times could also help to enhance sales.

Write an issue register based on the above information.

Exercise 6.14 Write an issue register for the pharmacy prescription fulfillment process described in Exercise 1.6 (page 30). Analyze at least the following issues:

- Sometimes, a prescription cannot be filled because one or more drugs in the prescription are not in stock. Customers only learn this when they come to pick up their prescription.

- Oftentimes, when customers arrive to pick up the drugs, they find out that they have to pay more than what they expected because their insurance policy does not cover the drugs in the prescription, or because the insurance company covers only a small percentage of the cost of the drugs.
- In a very small number of cases, the prescription cannot be filled because there is a potentially dangerous interaction between one of the drugs in the prescription and other drugs that the customer has been given in the past. Customers only find out about this issue when they arrive to pick up the prescription.
- Some prescriptions can be filled multiple times. This is called a "refill". Each prescription explicitly states whether a refill is allowed and if so how many refills are allowed. Sometimes, a prescription cannot be filled because the number of allowed refills has been reached. The pharmacist then tries to call the doctor who issued the prescription to check if the doctor would allow an additional refill. Sometimes, however, the doctor is unreachable or the doctor does not authorize the refill. The prescription is then left unfilled and customers will only find out when they arrive to pick-up the prescription.
- Oftentimes, especially during peak time, customers have to wait for more than 10 min to pick up their prescription due to queues. Customers find this annoying because they find that having to come twice to the pharmacy (once for drop-off and once for pick-up) should allow the pharmacy ample time to avoid such queues at pick-up.
- Sometimes, the customer arrives at the scheduled time, but the prescription is not yet filled due to delays in the prescription fulfillment process.

When making assumptions to analyze these issues, you may choose to equate "oftentimes" with "20% of prescriptions", "sometimes" with "5% of prescriptions" and "very small number of cases" with "1% of prescriptions". You may also assume that the entire chain of pharmacies consists of 200 pharmacies that serve 4 million prescriptions a year and that the annual revenue of the pharmacy chain attributable to prescriptions is € 200 million. You may also assume that every time a customer is dissatisfied when picking up a prescription, the probability that this customer will not come back after this experience is 20%. You may also assume that on average a customer requires 5 prescriptions per year.

Based on the issue register, apply Pareto Analysis to determine a subset of issues that should be addressed to reduce the customer churn due to dissatisfaction by at least 70%. Customer churn is the number of customers who stop consuming services offered by a company at a given point in time. In this context, this means the number of customers who stop coming to the pharmacy due to a bad customer experience.

Exercise 6.15 Write an issue register for the procure-to-pay process described in Exercise 1.7 (page 31).

Exercise 6.16 Consider the pharmacy prescription fulfillment process described in Exercise 1.6 (page 30) and the following issue:

- Sometimes, the customer arrives at the scheduled time, but the prescription is not yet filled due to delays in the prescription fulfillment process.

Analyze the possible causes of this issue using a cause-effect diagram or why-why diagram.

6.8 Further Readings

Value-added analysis, cause-effect analysis, why-why analysis, Pareto analysis and PICK charts are all part of a wide array of techniques included in the Six Sigma method (see the box on "Related Disciplines" in Section 1.2 on page 3). Conger [28] shows how these and other Six Sigma techniques are applicable to business process analysis. Meanwhile, waste analysis is one of the core techniques of Lean Six Sigma, which combines Six Sigma with elements from the lean manufacturing, which itself stems from the Toyota Production System.

A comprehensive listing of Six Sigma techniques is maintained in the iSixSigma portal.[2] A given business process improvement project will generally only make use of a subset of these techniques. In this respect, Johannsen et al. [72] provide guidelines for selecting analysis techniques for a given BPM project.

Straker's Quality Encyclopedia[3] provides a comprehensive compendium of concepts used in Six Sigma and other quality management disciplines. In particular, it provides definitions and illustrations of the 6 M's and the 4 P's used in cause-effect diagrams and other concepts related to root cause analysis. A related resource—also by Straker—is the Quality Toolbook, which summarizes a number of quality management techniques. Originally the Quality Toolbook was published as a hardcopy book [170], but it is nowadays also available freely.[4]

Why-why diagrams allow us to document sequences of cause-effect relations that link factors to a given issue. A related technique to capture cause-effect paths is the *causal factor chart* [142]. Causal factor charts are similar to why-why diagrams. A key difference is that in addition to capturing factors, causal factor charts also capture conditions surrounding the factors. For example, in addition to stating that "the clerk made a data entry mistake when creating the PO", a casual factor chart might also include a condition corresponding to the question "in which part of the PO the clerk made a mistake?" These additional conditions allow analysts to more clearly define each factor.

The issue register has been proposed as a process analysis tool by Schwegmann & Laske [159][5] who use the longer term "list of weaknesses and potential improvements" to refer to an issue register. Schwegmann & Laske suggest that the issue register should be built up in parallel with the as-is model. The rationale

[2] http://www.isixsigma.com/tools-templates/.

[3] http://www.syque.com/improvement/a_encyclopedia.htm.

[4] http://www.syque.com/quality_tools/toolbook/toolbook.htm.

[5] The sub-categorization of the 6 M's given in Section 6.4.1 also comes from Schwegmann & Laske [159].

is that during the workshops organized for the purpose of process discovery (see Chapter 5), workshop participants will often feel compelled to voice out issues related to different parts of the process. Therefore, process discovery is an occasion to start listing issues.

Another framework commonly used for qualitative process analysis is Theory of Constraints (TOC) [56]. TOC is especially useful when the goal is to trace weaknesses in the process to bottlenecks. The application of TOC to business process analysis and redesign is discussed by Laguna & Marklund [85, Chapter 5] and by Rhee et al. [140].