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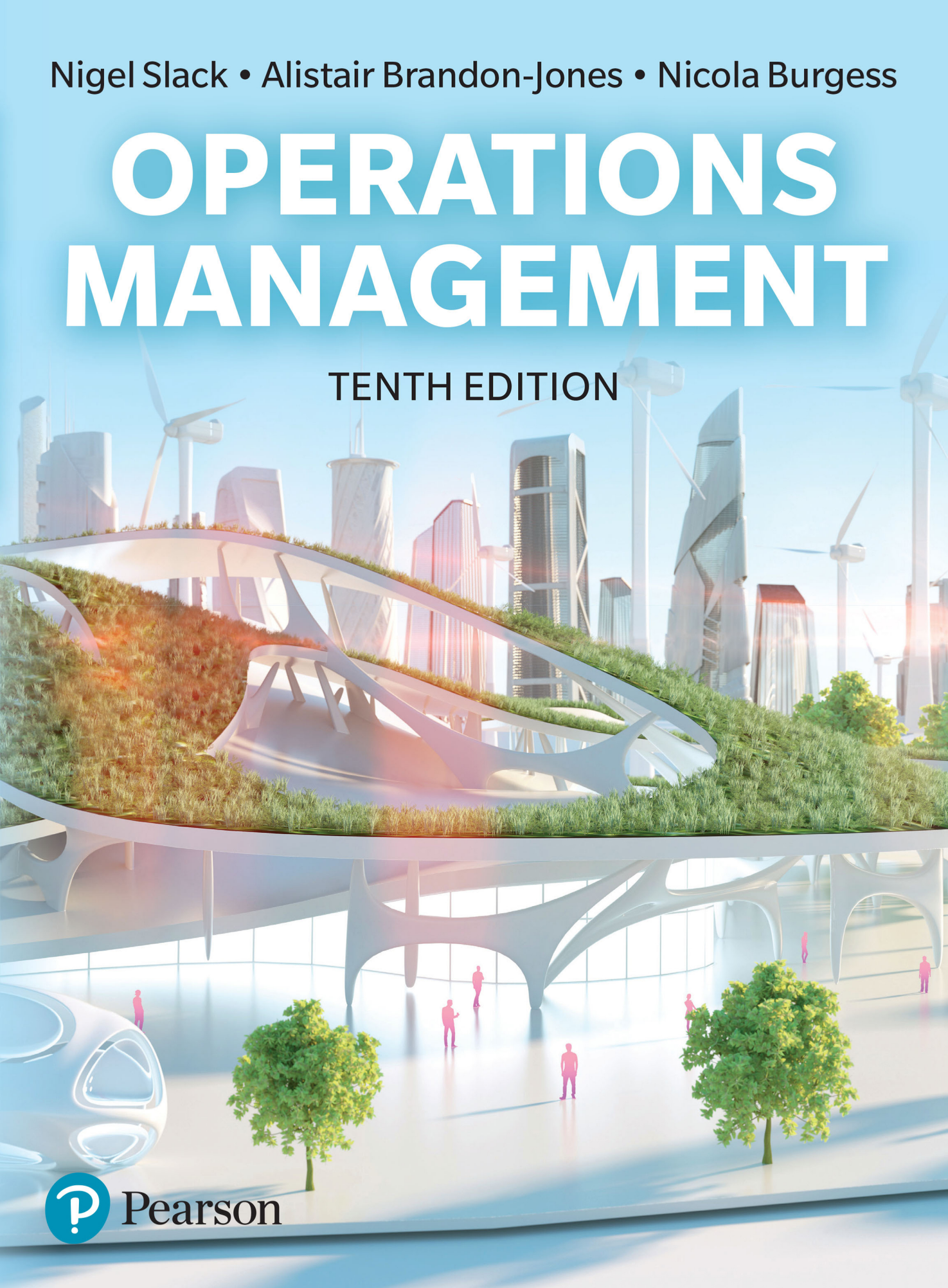
OPERATIONS MANAGEMENT

TENTH EDITION



Pearson

OPERATIONS MANAGEMENT

meaningfulness and an increase in stress. In turn, this increases the chance of job dissatisfaction, absenteeism, burnout and labour turnover. In fact, the relationship between repetitive jobs and negative psychological effects is more nuanced than this, but nevertheless it would be difficult to argue that repetitive jobs are more fulfilling than those with more variety. Moreover, it is not only the potential psychological damage of repetitive work that needs to be considered. When the repeated task is physical, as in assembly-line work, there is also the possibility of damage such as hand pain and tendonitis. Again, studies are not always totally unambiguous, but repeated movements that involve awkward positions, and especially high levels of force and repetition have been shown to be associated with physical pain and disorders.[14]

Confronting the negative effect of repetitive jobs often involves one of two 'solutions' – redesign the job so that it is less repetitive (**job enrichment**) or automate it so that a human does not have to do it. (We will deal with the idea of job enrichment in Chapter 9 (People in operations).) The automation of repetitive jobs was, for many years, confined to some manufacturing tasks. However, the increase in the use of **robotic process automation** (RPA, treated later) and even **artificial intelligence (AI)** is allowing the automation of routine tasks, such as those found in the back-office processes found in many professional services.

Low-volume, high-variety processes

Many of the ideas and analytical approaches described in this chapter derive largely from high-volume, low-variety processes. This does not mean that they cannot be used in low-volume, high-variety process design, but they often have to be modified or adapted in some way. For example, splitting activities into very small increments so that work can be balanced between stages (see earlier) is often neither possible nor desirable when the variety of activities is very wide. This does not mean that trying to allocate work equally between work groups is not important, just that it will need to be done in a more approximate way. Even process mapping can be problematic. Some low-volume, high-variety processes are intrinsically difficult to describe as simple step-by-step sequential activities. There may be many alternative routes through a process that can be taken by whatever is being processed. Decisions about how to treat whatever is being processed may be a matter of judgement. The exact circumstances associated with processing something may not have occurred before. If it is information that is being processed, the information may be partial, uncertain or ambiguous.

Automating processes

The majority of processes used in this chapter to illustrate various aspects of process design are essentially manual in nature. That is, they involve a person or persons performing some kind of tasks. Go back far enough and almost all processes (although they would not have been called that) would have been manual. The history of operations management could be told as one of the progressive substitution of technology for people-based effort. First it was manufacturing processes that were automated in some way; and although there are still plenty of manual manufacturing processes, there are also factories that operate virtually 'dark', with very few humans involved. The equivalent automation in many service operations, especially those that primarily process information are specifically designed information technology (IT) systems. Anyone with a bank account is the recipient of the service provided by these IT systems. They are automated mass processes, usually designed from first principles, that may be sometimes rigid and impersonal but are remarkably efficient compared with performing such tasks manually.

Robotic process automation

Yet, although what earlier we called 'core' operations processes, especially high-volume ones, have increasingly become automated, there are many processes outside the operations function that could be automated. These processes are often lower volume than routine core operations processes, yet still follow a logical set of rules. They have been called 'swivel chair' processes – meaning that people

take inputs of information from one set of systems (emails for example), process the information using rules, and then record the processed outputs into another system. Examples might include the 'onboarding' process for new employees, recording and entering invoices onto internal payment authorisation systems, entering details of client information onto customer relationship management systems, and so on. Typically, these processes are routine, predictable, rules-based and performed by professional employees whose time could be more profitably employed.

This is the area of application for what has become known (rather tautologically) as 'robotic process automation', or RPA. It is a general term for tools that function on the human interface of other computer systems. It does not, of course, use actual physical robots, rather it deploys software routines (often just called 'bots') to perform the most mundane and repetitive tasks previously done by people. Its aim is to enhance efficiency by automating the everyday processes that would otherwise require human effort. Admittedly, the same aim could be attributed to almost any IT-based automation. The difference between RPA and traditional IT systems is:

- RPA is best used away from the extremes of the volume–variety spectrum. High-volume, low-variety processes can be automated using conventional specifically designed IT systems. At the other extreme, very-high-variety, low-volume tasks are likely to need the flexible thought processes and decision-making of humans. RPA can be used in-between these extremes.
- RPA is relatively easy to develop compared with specifically designed IT systems. The latter require significant systems analysis and coding skills. RPA often uses simple 'drag and drop' instructions that can be used by people who understand the purpose of the processes being automated.
- RPA works around existing processes rather than trying to reengineer them. It is sometimes referred to as 'lightweight' IT because it tries not to disturb underlying computer systems.

The effects of process variability

So far in our treatment of process design we have assumed that there is no significant variability either in the demand to which the process is expected to respond, or in the time taken for the process to perform its various activities. Clearly, this is not the case in reality. So, it is important to look at the variability that can affect processes and take account of it.

There are many reasons why variability occurs in processes. These can include the late (or early) arrival of material, information or customers, a temporary malfunction or breakdown of process technology within a stage of the process, the recycling of 'mis-processed' materials, information or customers to an earlier stage in the process, variation in the requirements of items being processed, etc. All these sources of variation interact with each other, but result in two fundamental types of variability:

- Variability in the demand for processing at an individual stage within the process, usually expressed in terms of variation in the inter-arrival times of items to be processed.
- Variation in the time taken to perform the activities (i.e. process a unit) at each stage.

Critical commentary

Some commentators are critics of the very idea of thinking in terms of 'processes'. They claim that defining jobs as processes incites managers to look on all activities as a machine-like set of routine activities, verging on the mindless. At best, it encourages going through the stages in a process without thinking about what is really involved (what is known as 'box ticking'). At worst, defining all activities into the straitjacket of 'process' kills the essential humanity of working life. The counterargument is that this is a misunderstanding of what is (or should be) meant by a 'process'. A process is simply a framework, around which you can think about who should do what, and when. It simply means that one has thought about, and described, how to do something. Processes need not necessarily be formal, highly constrained or detailed – though they might be. When a process is seen as being too rigid, it is usually because it has been designed inappropriately for its volume–variety position.

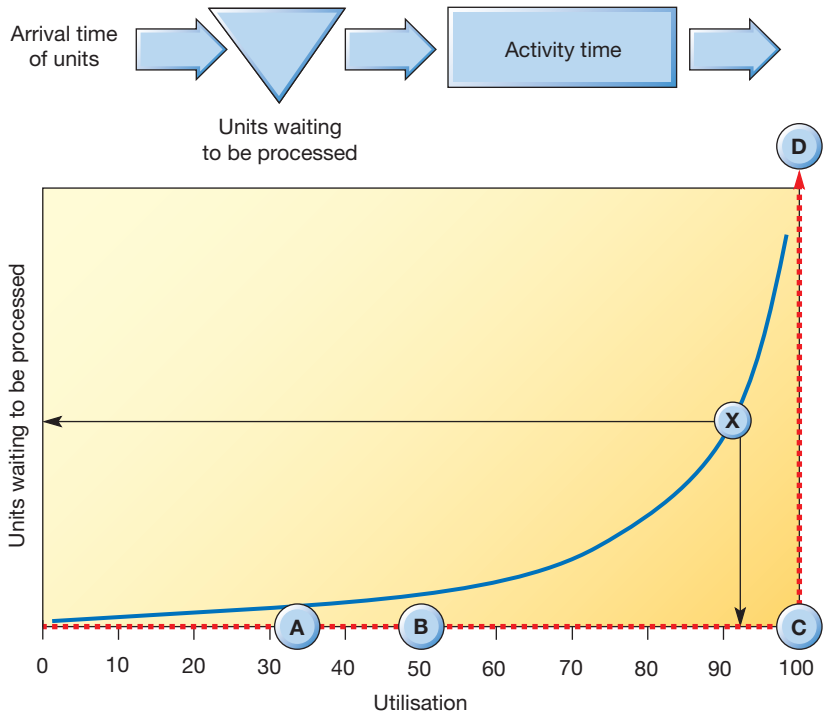


Figure 6.15 The relationship between process utilisation and number of items waiting to be processed for constant and variable arrival and process times

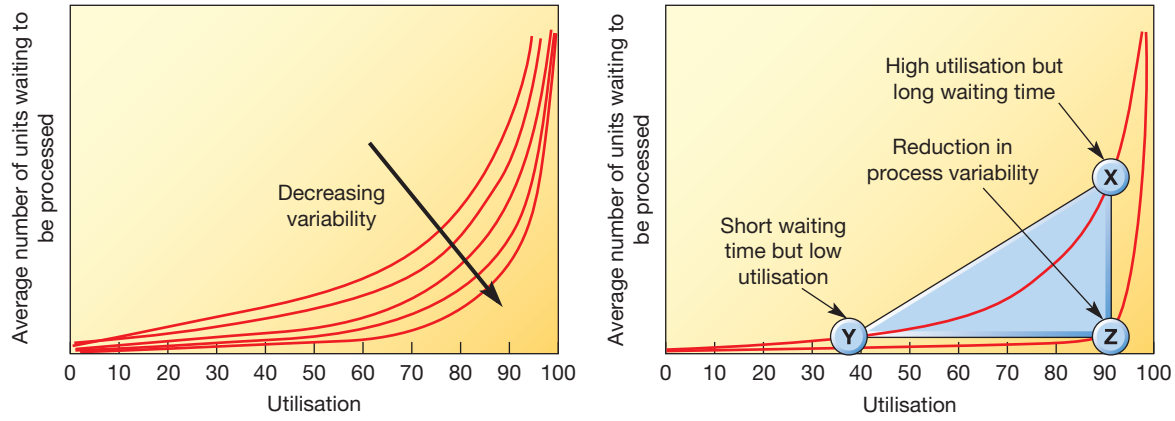
To understand the effect of arrival variability on process performance it is first useful to examine what happens to process performance in a very simple process as arrival time changes under conditions of no variability. For example, the simple process shown in Figure 6.15 comprises one stage that performs exactly 10 minutes of work. Items arrive at the process at a constant and predictable rate. If the arrival rate is one unit every 30 minutes, then the process will be utilised for only 33.33 percent of the time, and the items will never have to wait to be processed. This is shown as point A on Figure 6.15. If the arrival rate increases to one arrival every 20 minutes, the utilisation increases to 50 per cent, and again the items will not have to wait to be processed. This is point B on Figure 6.15. If the arrival rate increases to one arrival every 10 minutes, the process is now fully utilised but, because a unit arrives just as the previous one has finished being processed, no unit has to wait. This is point C on Figure 6.15. However, if the arrival rate ever exceeded one unit every 10 minutes, the waiting line in front of the process activity would build up indefinitely, as is shown as point D in Figure 6.15. So, in a perfectly constant and predictable world, the relationship between process waiting time and utilisation is a rectangular function as shown by the red line in Figure 6.15.

Operations principle

Variability in a process acts to reduce its efficiency.

However, when arrival and process times are variable, then sometimes the process will have items waiting to be processed, while at other times the process will be idle, waiting for items to arrive. Therefore, the process will have both a 'non-zero' average queue and be underutilised in the same period. So, a more realistic point is that shown as point X in Figure 6.15. If the average arrival time were to be changed with the same variability, the blue line in Figure 6.15 would show the relationship between average waiting time and process utilisation. As the process moves closer to 100 per cent utilisation, the average waiting time will become longer. Or, to put it another way, the only way to guarantee very low waiting times for the items is to suffer low process utilisation.

The greater the variability in the process, the more the waiting time–utilisation relationship deviates from the simple rectangular function of the 'no variability' conditions that was shown in



(a) Decreasing variability allows higher utilisation without long waiting times

(b) Managing process capacity and/or variability

Figure 6.16 The relationship between process utilisation and number of items waiting to be processed for variable arrival and activity times

Figure 6.15. A set of curves for a typical process is shown in Figure 6.16(a). This phenomenon has important implications for the design of processes. In effect, it presents three options to process designers wishing to improve the waiting time or utilisation performance of their processes, as shown in Figure 6.16(b):

- accept long average waiting times and achieve high utilisation (point X);
- accept low utilisation and achieve short average waiting times (point Y); or
- reduce the variability in arrival times, activity times, or both, and achieve higher utilisation and short waiting times (point Z).

To analyse processes with both inter-arrival and activity time variability, queuing or 'waiting line' analysis can be used. This is treated in the supplement to Chapter 11. But do not dismiss the relationship shown in Figures 6.15 and 6.16 as some minor technical phenomenon. It is far more than this. It identifies an important choice in process design that could have strategic implications. Which is more important to a business, fast throughput time or high utilisation of its resources? The only way to have both of these simultaneously is to reduce variability in its processes, which may itself require strategic decisions such as limiting the degree of customisation of products or services, or imposing stricter limits on how products or services can be delivered to customers, and so on. It also demonstrates an important point concerned with the day-to-day management of process – the only way to absolutely guarantee 100 per cent utilisation of resources is to accept an infinite amount of work-in-progress and/or waiting time.

Operations principle

Process variability results in simultaneous waiting and resource underutilisation.

Summary answers to key questions

6.1 What is process design?

- Design is the activity that shapes the physical form and purpose of both products and services and the processes that produce them.
- The design activity is more likely to be successful if the complementary activities of product or service design and process design are coordinated.

6.2 What should be the objectives of process design?

- The overall purpose of process design is to meet the needs of customers through achieving appropriate levels of quality, speed, dependability, flexibility and cost.
- The design activity must also take account of environmental issues. These include examination of the source and suitability of materials, the sources and quantities of energy consumed, the amount and type of waste material, the life of the product itself and the end-of-life state of the product.

6.3 How do volume and variety affect process design?

- The overall nature of any process is strongly influenced by the volume and variety of what it has to process.
- The concept of process types summarises how volume and variety affect overall process design.
- In manufacturing, these process types are (in order of increasing volume and decreasing variety) project, jobbing, batch, mass and continuous processes. In service operations, although there is less consensus on the terminology, the terms often used (again in order of increasing volume and decreasing variety) are professional services, service shops and mass services.

6.4 How are processes designed in detail?

- Processes are designed initially by breaking them down into their individual activities. Often common symbols are used to represent types of activity. The sequence of activities in a process is then indicated by the sequence of symbols representing activities. This is called 'process mapping'. Alternative process designs can be compared using process maps and improved processes considered in terms of their operations performance objectives.
- The throughput time, work-in-progress and cycle time aspects of process performance are related by a formula known as Little's law: throughput time equals work-in-progress multiplied by cycle time.
- Variability has a significant effect on the performance of processes, particularly the relationship between waiting time and utilisation.

CASE STUDY

The Action Response Applications Processing Unit (ARAPU)

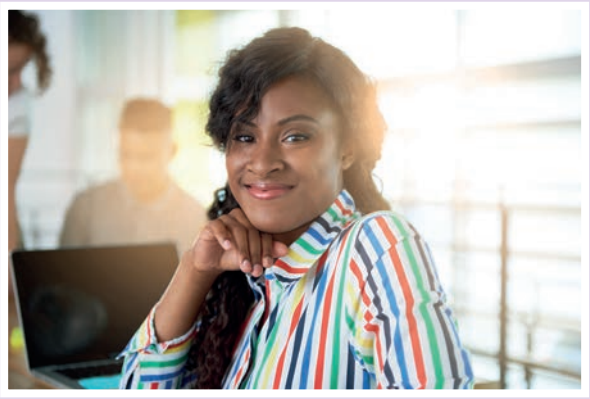
Introduction

Action Response is a London-based charity dedicated to providing fast responses to critical situations throughout the world. It was founded by Susan N'tini, its Chief Executive, to provide relatively short-term aid for small projects until they could obtain funding from larger donors. The charity receives requests for cash aid, usually from an intermediary charity, and looks to process the request quickly, providing funds where and when they are needed. *'Give a man a fish and you feed him today, teach him to fish and you feed him for life. It's an old saying and it makes sense but, and this is where Action Response comes in, he might starve while he's training to catch fish'* (Susan N'tini).

Nevertheless, Susan does have some worries. She faces two issues in particular. First, she is receiving complaints that funds are not getting through quickly enough. Second, the costs of running the operation are starting to spiral. She explains: *'We are becoming a victim of our own success. We have striven to provide greater accessibility to our funds; people can access application forms via the internet, by post and by phone. But we are in danger of losing what we stand for. It is taking longer to get the money to where it is needed and our costs are going up. We are in danger of failing on one of our key objectives: to minimise the proportion of our turnover that is spent on administration. At the same time, we always need to be aware of the risk of bad publicity through making the wrong decisions. If we don't check applications thoroughly, funds may go to the "wrong" place and if the newspapers get hold of the story we would run a real risk of losing the goodwill, and therefore the funds, from our many supporters'*.

Susan held regular meetings with key stakeholders. One charity that handled a large number of applications for people in Nigeria told her of frequent complaints about the delays in the processing of the applications. A second charity representative complained that when they telephoned to find out the status of an application the ARAPU staff did not seem to know where it was or how long it might be before it was complete. Furthermore, they felt that this lack of information was eroding their relationship with their own clients, some of whom were losing faith in them as a result: *'trust is so important in the relationship'*, they explained.

Some of Susan's colleagues, while broadly agreeing with her anxieties over the organisation's responsiveness and efficiency, took a slightly different perspective. *'One of the really good things about Action Response is that we are more flexible than most charities. If there a need and if they need support until one of the larger charities can step in, then we will always consider a request for aid. I would not like to see any move towards high process efficiency harming our ability to be open-minded and consider requests that might seem a little unusual at first'* (Jacqueline Horton, Applications Assessor).



Others saw the charity as performing an important counselling role. *'Remember that we have gained a lot of experience in this kind of short-term aid. We are often the first people that are in a position to advise on how to apply for larger and longer-term funding. If we developed this aspect of our work, we would again be fulfilling a need that is not adequately supplied at the moment'* (Stephen Nyquist, Applications Assessor).

The Action Response Applications Processing Unit (ARAPU)

Potential aid recipients, or the intermediary charities representing them, apply for funds using a standard form. These forms can be downloaded from the internet or requested via a special helpline. Sometimes the application will come directly from an individual community leader but more usually it will come via an intermediary charity that can help the applicant to complete the form. The application is sent to ARAPU, usually by fax or post (some are submitted online, but few communities have this facility).

ARAPU employs seven applications assessors with support staff who are responsible for data entry, coding, filing and 'completing' (staff who prepare payment, or explain why no aid can be given). In addition, a board of non-paid trustees meets every Thursday, to approve the assessors' decisions. The unit's IT system maintain records of all transactions, providing an update on the number of applications received, approved and declined, and payments allocated. These reports