Is the 80 - 20 Principle a Friend or a Foe? Critical Remarks on the Dominant Flat Gradient-17206

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Abstract

Introduction

The well-known 80 - 20 principle, also known as the Pareto principle, describes the fact that usually 80 % of the result is achieved by 20 % of the effort, because many probability distributions are caused by a power-law.
This principle is valued in the realm of project management and management in general because of the fast progress which generally takes place in the first fifth of the process. If the final result is not exactly specified or resources are spent wisely, 100 % of the planned result will be reached easily.
However, in nuclear business safety is a principal parameter. Therefore precision is inevitable. In long-lasting projects the bad end of the Pareto-distribution is dominant:
The very shallowly-inclined gradient at the end of the graph means that results at that point come at a very high effort and cost. The graph reaches the 100% only asymptomatically, meaning the initially projected results are never met.
Especially if in earlier project phases the Pareto principle is applied very successfully, a lot of work is transferred to the future. For example, in decommissioning projects the waste often is badly characterized causing an enormous effort in the process of characterization and qualification.
Especially if funding or time are limited, it is important to be aware of the asymmetric distribution of applied work and result.

General aspects of the 80 - 20 principle

The 80 – 20 distribution was discovered by the Italian mathematician Pareto at the end of the 19th century and is still widely applied in statistics and management [1]. The principle states that for many distributions a relation of 80 % to 20 % applies due to a power law. This is also true for the population distribution of large versus small towns, for wealth distribution and for many tasks, where 80 % of the results are achieved within 20 % of the effort.
For this reason the 80 – 20 distribution is often used in a positive context to show how fast progress can be achieved. The other side of the medal is that for the last few percent of a planned result the effectiveness of the task is nearly zero. This is the reason for applying the principle to the nuclear business. In the nuclear licensing and supervising procedure safety is a principal parameter. Therefore approval of all parameters is inevitable. In long-lasting projects the very shallowly-inclined slope of the Pareto distribution (Fig 1) is dominant, meaning that the final results need large monetary and temporal resources.
In terms of project management in a project, where a 100 % result is definitely needed, the last 20 % will take up at least 80 % of the resources. In multi-phase projects earlier project phases, which were not entirely finalized, may necessitate additional resources at the end of the entire project and even make entire projects fail.

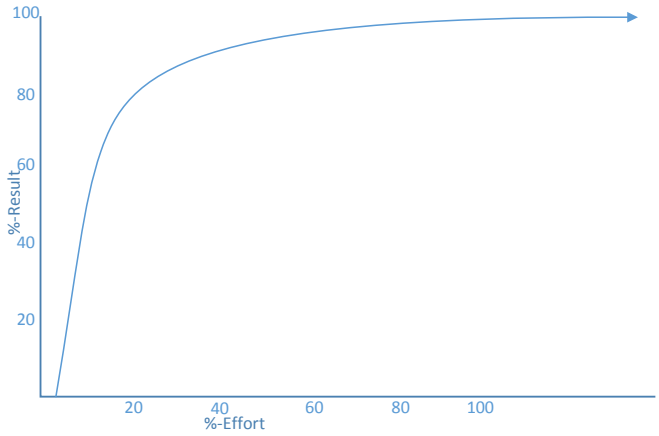

Figure 1: Typical graph of a 80 – 20 distribution

Another trouble with the power-law distribution is the very asymmetric distribution of results and resources. Usually resources are planned in a linear manner. This suggests that the results are proportional to the applied resources. If the project result in contrast is reflected by a power-law distribution, this means that in the beginning the results clearly exceed the applied resources, whereas in the end the relation of progress versus resources becomes progressively worse. For this reason projects are often stopped before the projected result has been reached.
In a highly asymmetric distribution the prediction of the final result and the extrapolation over the inflection point may also be very difficult without knowing the slope after it.
To safely reach the estimated result in the starting phase of a project, more resources than estimated have to be applied. Due to the steep slope of the progress, the results in this project phase are usually estimated satisfactory. However, strictly speaking, if 50 % of the goal are not reached in 10 % to 15 % of the project life-time, multiplication of resources may not be enough in the end phase. This means that prolongation and higher costs are inevitable.

There are several reasons:

- In the steep slope of the project, start corrections and quality control have to be very effective or will have no corrective result.
- If the exact final state at the target is not specified prior to the planning, changes of the process will cause costs and effort near the end of the process.
- Details, which are being changed in the course of the process generally have a high impact on costs and lifetime.

Effects on decommissioning projects and waste management

Decomissioning and waste management are highly-regulated processes in the procedure of licensing and supervision. In this context the acceptance by the regulator or independent expert is critical for all measures.
In decommissioning projects the major thread with the 80 – 20 principle is if the regulator or the independent expert has further requirements right before the permission to start. The resulting changes usually not only cause a delay because they have to be applied and approved by the regulator but also because they trigger changes in the entire documentation, which also have to be implemented. This may extend the starting point significantly and the changes in the planning and the instrumentation may cause further questions. In a licensing procedure

usually not only one step is necessary but a successive or iterative approach (see Figure 2).

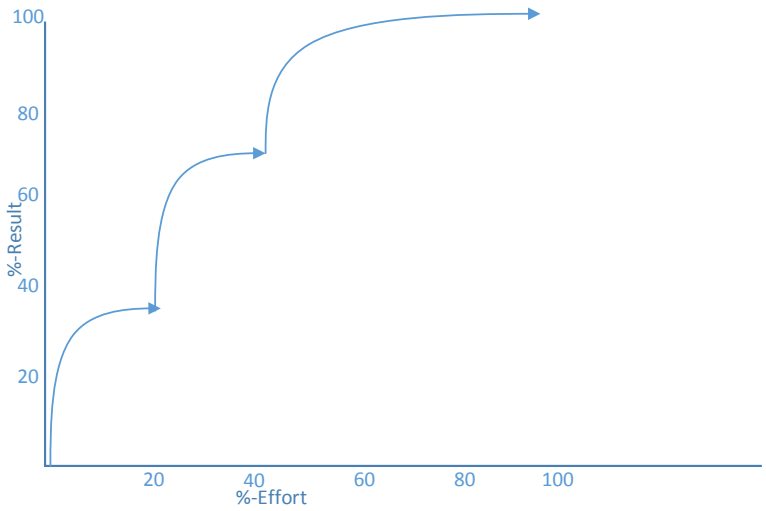

Figure 2: Iterative readjustment of the project to enhance effectivity

In waste treatment the principle also applies to a process qualification as it is necessary in Germany [3]. According to the German Radiation Protection Ordinance [4] only qualified methods approved by the Federal Office for Radiation Protection (BfS - Bundesamt für Strahlenschutz) can be applied in waste management.
The principle waste treatment method and the respective quality control plan are produced rather easily. After the first feedback of the regulator things go into more detail and usually several documents have to be written. In Germany this qualification process takes between 1 and 3 years depending on the complexity of the topic and the effectiveness of the work.

For legacy waste this principle applies in a special way. The preliminary waste acceptance criteria (WAC) Konrad were first issued in 1995 in a draft that was valid until 2010, when the document became official for the first time. The waste produced prior to 1995 has to be entirely requalified including redeclaration as not all nuclides had to be declared at that time (see Table 1).
The waste which was produced without qualified procedure has to be requalified according to the methods applied. The waste (which was) produced according to the first draft in 1995 [2] has to be requalified in regard to additional nuclides, additional proofs and the compositional declaration in regard to compounds that may pose a threat to the ground water [5,6]. The latter alone means that all documentations have to be reviewed and at least 10 % of the work need to be redone. For the other two scenarios between 30 % and 100 % are realistic.

Table 1: Comparison of WAC with regard to the required nuclides and other requirements needed for waste documentation

Timeframe	**Required nuclides**	**WAC**	**Further requirements**
1970-1990	< 20	Asse	-
1990-1995	65	Eram	-
1995-2010	108	Konrad (preliminary)	Qualified procedure [2, 4]
2010-2014	190	Konrad (Rev 1)	Additional Nuclides [2, 5]/ compositional declaration
2014-2016	199	Konrad (Rev 0)	-

In some of the cases, the waste had to be treated according to the existing requirements in order to safely store it into the interim storage. The documentation was delayed into the future, because at the time of waste treatment the acceptance criteria were not finalized. In the context of the 80 – 20 principle this meant that you could keep the process going doing 80% - 90 % directly with 20-30% of the effort, but delay 70% - 80 % into the future. Some of the data needed will no longer be present, others will become harder to acquire, meaning that this procedure doubles the effort needed for the documentation.
Since the revision of the waste acceptance criteria Konrad in 2010, a more detailed documentation is required.

In the context of legacy containers the 80 – 20 principle has to be applied to the requalification of the containers according to the actual WAC [6] as well. In the past, far less documentation of materials and procedures were required, making it extremely difficult now to prove a production of the container according to modern requirements. In the case of metal containers, compensating measures like finite element models, non-destructive assay and destructive analyses of samples have to be applied. Also in this context, this requalification requires large effort and sometimes the required proofs cannot be obtained.
This leads to the critical question, which also arises from the 80 – 20 distribution: at which point is it more reasonable to restart the process, because the effort for the mending of the missing documentation or proofs is bigger than a new start of production or project, where all boundary conditions are clear and therefore all requirements can be met easily?

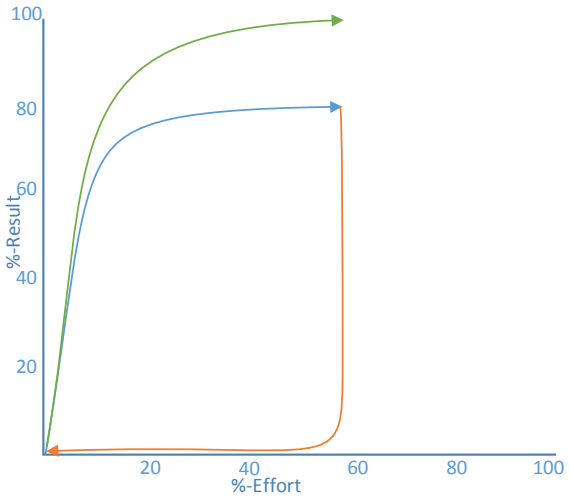

Figure 3: Restart of the process after a phase without any progress using different boundary conditions resulting in a higher initial effectiveness reflected by a steeper and more continuous gradient of the graph.

Lessons learned

The documentation nowadays is a principle parameter of the nuclear business. No permission is granted without a flawless documentation. The same is true for waste treatment and waste characterization.

The lessons learned from the point of decommissioning, waste management and documentation are that it is wise to start the waste treatment as soon as possible and to collect all existing information even if it is not originally needed in the process. After treatment of the waste, the documentation should be submitted as soon as possible, increasing the probability of the responsible person still being in charge and able to answer questions possibly posed by the regulators

The general lesson learned for project management is that if you start a project think of the 80 – 20 distribution and calculate for 110 – 120 %, (more resources at the start of the project) then you will securely reach 100 %.

Obtaining proofs and other tasks are not to be postponed into the future, otherwise the amount of work will multiply due to repeated starts of the system each time with the known shape and results on resources and result (see Figure 2 but with longer arrows at each step)

Conclusion

The 80 – 20 principle is a great advantage, if you start a project and respect the asymmetric distribution of applied resources and results in your project plan. Especially in long-lasting projects with changing perspectives, this asymmetric distribution may cause massive delays and expansion of costs, because small changes near the end cause large/big effort due to consequences on the existing data. If the proper goal of a project is not entirely known in the beginning, it is very probable that the last 5 – 10 % of the result will cause major financial threat and extensions of the estimated time frame. If funding or time are limited, it is almost impossible to readjust a project in the estimated frame of resources. In this case a complete restart of the project may be more reasonable than a long-lasting change management with uncertain results.

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