

Varieties of Pollution Prevention

A Path towards Sustainable Development?

THEO DE BRUIJN / PETER HOFMAN

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CSTM UNIVERSITY OF TWENTE
PO Box 217, 7500 AE Enschede, The Netherlands
phone +31-53 489 3203 / fax +31-53 489 4850
e-mail T.J.N.M.deBruijn@CSTM.utwente.nl / P.S.Hofman@CSTM.utwente.nl

1 Introduction

Since the late eighties pollution prevention or waste minimization has become a concept which is extensively used to influence the behavior of companies towards a more environmentally friendly direction. Environmental policy previously used to lead mainly to end-of-pipe solutions. Pollution prevention (policies) on the other hand aims at minimizing waste and emissions by reduction at the source of pollution or through internal re-use of material.

Although in many publications it is stated that pollution prevention can be cost effective, most companies do not act autonomously. To stimulate the introduction of pollution prevention numerous projects have been carried out in various ways. Implementation structures differ between projects. Moreover, in pollution prevention projects various organizations can collaborate such as municipalities, trade associations, universities and consultancy agencies. These participants have to stimulate companies towards pollution prevention. In the projects which they carry out different techniques are used, such as quickscans, factsheets, prisma, or the use of indicators. In our paper we describe some typical project structures and techniques.

Our paper builds from the premise that in order to reach sustainable development the start up of processes of change in companies is necessary. Pollution prevention has proved to be one of the feasible ways to start a process of change in companies and has become an important tool for governmental environmental policy. Governing bodies at different levels in the Netherlands for example allocate funds to so-called prevention teams in order to promote pollution prevention in companies. A relevant question is than in what way pollution prevention should be stimulated. In our paper we basically ask ourselves two questions:

- 1. Which type of pollution prevention is most effective and efficient?*
- 2. Does pollution prevention lead towards sustainable development?*

These questions are answered through the analysis of various pollution prevention projects which have been carried out in the Netherlands. CSTM has evaluated both pollution prevention projects in the Netherlands (see De Bruijn et al., 1995, 1996) and in the province of North-Holland (de Bruijn & Hofman, 1998). We describe the set-up and implementation of pollution prevention projects in the paragraph 2. A number of varieties of pollution prevention are identified there. Paragraph 3 focuses on results of these projects and especially on the influence of differences in variety on the results of these projects. Paragraph 4 explores the effects of different pollution prevention projects in terms of sustainability. We end with a concluding paragraph.

2 Varieties of pollution prevention projects

2.1. Data and sources of projects

In two separate studies we have evaluated both the (1) set-up, (2) implementation, and (3) effects of various pollution

prevention projects in the Netherlands. In this paragraph we describe both the set-up and implementation of projects. In the next paragraph we will focus on the results of these projects. We mainly use data from two different evaluation studies of pollution prevention projects. In the first place we refer to an evaluation study on commission of the Dutch Ministry of Environment. In this project we studied 24 projects carried out in different parts in the Netherlands with the participation of more than 1500 companies (De Bruijn et.al. 1995). In this paper we refer to the projects within this study as 'national projects'. Secondly, we make use of an evaluation study of 11 projects carried out under the umbrella of the province of North-Holland with the participation of 182 companies (de Bruijn & Hofman, 1998). The studies showed that different varieties of pollution prevention projects are in use. In this paragraph we describe some of the differences.

2.2. *Varieties of pollution prevention projects*

On the basis of an analysis of 36 pollution prevention projects in the Netherlands we can distinguish between three pollution prevention methods:

- Pollution prevention projects according to the Prisma¹-method;
- Pollution prevention projects relying on a quickscan with a focus on material flows/installed equipment;
- Pollution prevention projects based on estimating prevention potential with the use of indicators.

• *Pollution prevention projects according to the Prisma-method*

The first experiences with pollution prevention made use of the so-called Prisma-method. This method was developed on the basis of a Prevention Manual of the American Environmental Protection Agency (US EPA, 1989). It consists of four steps, (1) planning & organization, (2) assessment, (3) feasibility study, and (4) implementation. It essentially implies an comprehensive analysis of material flows which leads to the generation and implementation of a number of prevention options (Dieleman & de Hoo, 1993).

Most of the initial pollution prevention projects in the Netherlands made use of this method, sometimes in a slightly moderated form. The implementation of these project types requires active involvement of the participating companies as they play a significant role in the gathering of data, the analysis of material flows, and in the generation of prevention options. Thus, this pollution prevention method requires significant investments from companies and project agencies in terms of money and time. For example, the first two stages of planning and organization and assessment typically took around 30 to 70 days from the company, and around 20 advisory days from the researcher, in the first original Prisma project (Dieleman & de Hoo, 1993: 251). In following projects based on these experiences time was managed more efficiently with an average of 20 days spent by companies for the whole project (information from the national projects, De Bruijn et.al. 1995: 78). Summarizing: Prisma requires a high level of involvement of companies, is a costly method and uses a thorough and comprehensive analysis of the environmental situation.

At the start of pollution prevention government agencies and companies (mainly in the larger category) had the ability and willingness to make these investments. Later on the call for more efficiency and the targeted introduction of pollution prevention in small and medium-sized companies (SME's), with less investment capacity associated to them, increased the need for cheaper and less time consuming pollution prevention methods. These new methods of pollution prevention are based on a more quick assessment of the opportunities for pollution prevention in companies and are less comprehensive than the original Prisma-method.

• *Pollution prevention projects relying on a quickscan*

The basic idea of the quickscan method is reflected in its name: quickly scanning material flows of a company in order to assess the scope for pollution prevention. Companies participating in these projects have a relatively passive role. In most cases data is gathered through a number of visits by prevention experts combined with data provided by the company. This leads on the one hand to a broad picture of both overall material flows and a general idea of the most promising areas to focus a more specific assessment of possible prevention options on, and on the other hand to a number of specific options which were relatively easy to identify in the analysis. It is then expected that companies will further explore prevention options on the basis of the quick scan, while they can already implement (obvious) options which were generated during the quickscan. The number of days invested in these projects is considerably lower than for Prisma projects: the number of days varies from 0,5 until around 3 (De Bruijn & Hofman, 1998: 22). While in most cases the scan is focused on the material flows in companies, this is often accompanied by a focus on installed equipment in order to assess the technical state of the art in the company. This is mostly applied in branches of industry where production techniques are quite similar and homogeneous. Improvements are then partly customized by prescribing state of the art techniques and/or equipment. Summarizing, quickscans are relatively cheap to implement, require little involvement of the company itself, and are

¹ Prisma is a Dutch acronym for Project Industriële Successen Met Afvalpreventie, in English: Project Industrial Successes with Pollution Prevention.

focused on mapping the potential for pollution prevention.

- *Pollution prevention projects based on estimating prevention potential with the use of indicators*

A third broad category of pollution prevention makes use of indicators in order to assess the potential of prevention in companies. An important aspect of these types of projects is the comparison of companies within branches of industry. On the basis of data provided by companies in these projects a specific company can identify areas where it scores relatively weak in terms of resource efficiency or amount of waste and emissions. Apart from this also companies' results can be compared with results feasible on the basis of best available techniques for specific branches. In these projects the amount of time spent by companies is small and comparable to or lower than prevention quick scans. However, the number of advisory days for researchers tends to be higher than for quick scan, as significant amounts of time are spent to develop useful indicators (see for example van Berkel, 1996: 82).

Because of the element of comparison, governments and intermediary organizations are in favor of the use of indicators. Companies are more reluctant. They don't like to be compared with competitors. They also almost always think that their own production process is too company specific for comparison. General indicators are therefore hard to use. For this reason until now only projects have been carried out that tried to develop indicators. In our studies hardly any projects were present that made use of existing sets of indicators. This of course makes a comparison with the two other types of projects difficult.

On the basis of evaluation of various pollution prevention projects it is noticed that project methods have shifted from (extensive) prisma to less time-consuming modified prisma or quick scan methods. In the next paragraphs we try to answer the question what the implications of this shift are for (1) the results in terms of the generated and implemented options and their level of profundity and (2) the follow-up of pollution prevention in participating companies.

3 Results of pollution prevention projects

We divide the results of the projects in companies in (1) direct effects through implementation of prevention options and (2) long term effects through the possible follow-up of pollution prevention in companies. Information on the results of pollution prevention projects are based on in depth studies of the impact of projects at the company level. For 36 projects, a total of 65 companies was interviewed to gather specific information on the nature of generated and implemented prevention options and the level of embeddedness of pollution prevention in the companies. To assess the implications of the use of quick scan methods the main comparison is made between the results of national projects (mainly prisma), and projects at the provincial level (mainly quickscan). In the second place provincial projects are analyzed more specifically and have been divided in projects where companies have spent less and more than three days in the project.

3.1 Direct effects of pollution prevention projects

Direct effects have been measured for the following aspects to assess both effects and profundity of options and measures:

- Number of generated options and implemented measures;
- Effects of implemented measures on environmental & financial performance of companies;
- Meaning of types of measures for production processes and the organisation of production.

These results have to be compared with the costs of the projects (in a broad sense). Among other things we looked at:

- Total costs of a project;
- Level of the companies' involvement.

Moreover we looked at the amount of participating companies.

Table 1 summarizes some of the outcomes.

Table 1 Characteristics and Results of Pollution Prevention Projects

(Source: De Bruijn & Hofman, 1998: p. 46)

Criterion (as average)	National projects 1995	Provincial projects 1998
Costs per project (Dutch guilders)	464.000	245.000
Number of companies per project	27	33
Method of prevention	PRISMA	mostly quickscan

Companies' involvement in number of days	20	7
Options per company	23	15
Measures per company	7	5
Type/depth of measures	also fundamental measures	mostly good housekeeping

First of all we recognize the trend towards cheaper, quickscan projects. Furthermore the number of *generated options* and *implemented measures* varies between projects and between companies. The provincial projects score slightly lower than the national projects. Within provincial projects the group with companies spending less than three days in the project scores significantly lower for both the number of generated and implemented options.

Only a small number of the generated options are also implemented by the companies. The most important factor influencing this decision is costs. Options are only implemented when they have a relatively short payback period. It is remarkable however, that after implementation of options most of the companies can not give details on effects of those measures, both financially and environmentally. The general picture is that investments have been paid back through cost reduction in two to five years. Measures also lead to reduced environmental impact through reduction in energy use, material use and waste and wastewater production. Remarkably, precise figures could hardly ever be provided by our respondents.

An analysis of the *profundity of the measures* (implemented options) taken by the companies shows that in prisma projects measures are generally more profound and have and sometimes imply changes of the production process and organization of production, whereas in projects dominated by the quickscan method most of the measures taken can be described as good housekeeping measures. Analysis of both national and provincial projects shows that the amount of time invested by the companies in the projects is positively associated with the profundity of the generated and implemented options (De Bruijn et.al. 1995: 94; De Bruijn & Hofman 1998: 42). Environmental success doesn't come 'at a bargain'. Good results require commitment, time and money. This is illustrated in table 2.

Table 2 Average costs of pollution prevention projects

Average costs (in Dutch guilders)	National projects	Provincial projects
	1995	1998
Costs per project	464.000	245.000
Costs per companies	17.185	7.424
Costs per option	747	495
Costs per measure	2.455	1.485

Table 2 shows that in terms of average costs the quickscan projects are interesting. As we have seen the results of the projects lag behind prisma projects. It is especially hard to get to fundamental measures without making the investments in time and money.

3.2 Long term effects of pollution prevention projects

We have investigated whether the pollution prevention projects have had a sustained impact on the behaviour of companies. In the first place we have asked four questions:

- to what extent has the project led to increased knowledge of the firm regarding material flows;
- has there been a follow up of the project?;
- to what degree does the company make use of the concept or method of pollution prevention?
- did the company generate and implement options independently after the project?.

Both in national and provincial projects most companies indicate that a positive relationship exists between knowledge of material flows and the pollution prevention project. However, two thirds of the companies which have invested less than three days in the pollution prevention project indicate that their knowledge in material flows has not increased.

For a majority of all companies in the projects there has been a follow up after the project. This follow up takes different forms: from indepently and periodically generating options until further research about material flows and waste streams. Here companies in the provincial projects which have invested less time the majority of companies indicate that there has been no follow up after the project.

Although some companies generate options independently after the project most companies indicate that no further use is made of the method used in the pollution prevention project.

A majority of companies generate and implement options independently after the project. For some companies this is part of a more or less structured process, for most companies these are incidental measures.

In the second place, for the provincial project we have analyzed the level and form of environmental management in participating firms both before and after the project, and have estimated the impact of the pollution prevention project in the case of a change in level of environmental management. We have looked at investment patterns, the use of information and the implementation of an environmental management system.

Investments patterns vary between companies, some companies have stable levels of investments while others have much variable investments. Most of the companies (90%) indicate that environmental issues play a role in the direction of investment patterns. However, none of the companies indicate that the direction of investments has changed as a result of the pollution prevention project. With regard to information sources for environmental issues more than half of the companies indicate that the branch association is the most important source, while suppliers are mentioned by one third of the companies. The use of information sources has not shifted in companies as a result of the pollution prevention projects.

At the beginning of the project most companies had a positive attitude regarding the environment and were in the initial stage of implementing some form of environmental management, see table 3.

Table 3 Environmental management in companies, before and after the pollution prevention project

Level of environmental management	Number of companies	
	before project	in 1998
defensive	-	-
beginner/positive	12	8
active	7	8
pro-active	1	4

Also a significant number of companies were active with regard to environmental issues and had a partial or fully functioning environmental management system. None of the companies participating in the projects are regarded as defensive with regard to environmental issues, and it can be concluded that pollution prevention projects generally do not reach companies which are laggards with regard to the environment. We have also assessed the level of environmental management after the project, see table 3. For around one third of the companies in the pollution prevention there was a change in the level of environmental management as estimated before and after the pollution prevention project. Although the project surely has not been decisive in all cases, in some case the project has played an important role. However, for none of the companies which invested less than three days in the project a change in the level of environmental management can be witnessed, while for a majority of the companies which spent more than three days in the project this is the case.

3.3 Conclusions

Prevention quick scans have become a widespread method for pollution prevention projects. Quickscans are relatively easy to carry out, are relatively cheap and more efficient than pris ma projects and often involve more companies per project. However the choice for projects focusing on a quick assessment of prevention potential in companies leads to relatively little engagement of the companies themselves. This also has implications for the number and nature of generated and implemented options. In projects where companies invest more time in the pollution prevention project the generated options are more tailored to the specific company and likely to be more profound. The number of implemented options in companies is also higher in these projects.

Participation in pollution prevention projects has shifted from larger companies to SMEs. Participating companies in recent projects at the provincial level are relatively small companies with less than 100 employees. Earlier projects at the national level had participation of relatively larger companies. For both national and provincial projects it appears that the participating companies are certainly not among stragglers with regard to environmental issues, and in some cases they are front-runners regarding environmental issues in their specific branches. The number of generated and

implemented options is also dependent on the branch of industry of participating companies. A tentative conclusion is that companies from branches which receive more incentives at the branch level, for example through voluntary agreements and an active branch association, have less to gain in pollution prevention projects. On the other hand, branches with less incentives and involvement at branch level, both from government bodies, branch associations or other intermediaries, are likely to benefit more from pollution prevention projects but are also more difficult to reach.

An interesting development concerning the more difficult to reach companies can be found in a second approach of the province of North-Holland (see Molier et.al., 1996). Since a few years certain aspects of pollution prevention, such as an analysis of the material flows, can be included in the requirements of the environmental permit. In the Netherlands most companies fall under the authority of their municipality for their environmental permit. In order to stimulate the municipalities to use this competency a training was set up. In this training civil servants working in the environmental departments were made familiar with concepts of pollution prevention. The idea is that they will use this knowledge when negotiating with companies concerning the (renewal) of their permit. The first, direct results of this second approach (in terms measures within companies, costs of the project, etc.) are less positive than the results of the stimulating approach towards intermediary organizations. In terms of the kind of companies that are likely to be involved it may be a very interesting approach. Municipalities can take care of the group of laggards since this group nearly always has problems with their permits. This more coercive approach can thus facilitate the diffusion of the concept of pollution prevention.

Apart from generating options within the project it is important to what extent the project has follow up within and outside the company. Within the companies there often was a follow up in different ways. The focus on pollution prevention has been stimulated for the majority of the participating companies. Most of the companies are also independently involved in the generation of new options. However, not much has changed in most companies with regard to environmental management and organization, for example with regard to investment patterns or the division of tasks. Both for national and provincial projects companies stay busy with the development and implementation of new options, but this does not imply changes with regard to the organization. It is a limited process of change.

We have found that for companies who have invested more time in pollution prevention projects, the degree of integration and continuation of pollution prevention was significantly higher than for companies who invested less time. For a lot of companies the pollution prevention project is a one time experience directed to the generation and implementation of options, but only limited learning effects have been created with regard to the process side of pollution prevention, such as gaining insight, and making use of, a pollution prevention method. Companies foremost view pollution prevention as a technical project. In the case of prevention quick scans companies rarely get familiar with this process side of pollution prevention. In more traditional Prisma projects the process of pollution prevention is more a part of the project, for example because of the project group which is installed within the company.

4 Pollution prevention from a sustainable perspective

Pollution prevention projects give satisfying results at first sight. Both the environmental performance as well as the economic performance of participating companies often improves, although exact figures prove to be hard to provide. The majority of participating companies and the initiators of the projects are also satisfied. A few comments can be made however.

After a decade of intensifying the goals and implementation of environmental policy the 'low hanging fruit' has been picked (De Bruijn, Groenewegen and Grolin, 1997: 175). The real challenge for the coming years is in forcing fundamental, structural changes in the production and consumption system. After all, sustainable development will have to result in these changes. Sustainable production implies a continuous process of improvement directed towards transformation of production processes and management with a focus on far-reaching de-materialization of both processes and products in the contexts of product chains and in regions.

In the literature you can find two perspectives on how the transformation process shall and should take place: eco-efficiency vs. systems change (Schot, Brand and Fischer, 1997). Eco-efficiency means 'doing more with less' (see for instance Schmidheiny, 1992). Assuming that businesses will perceive a growing pressure (from governments and other stakeholders), companies will be forced to change their production step-by-step. Business will have to minimize their inputs. Eco-efficiency therefore means (Schot, 1997):

- de-materialization;
- maximizing the use of renewable inputs;
- minimization of the use of energy;

- increasing the ability to recycle products.

The eco-efficiency vision proclaims a step-by-step improvement out of the conviction that eventually this will lead to sustainability.

Others point out that more efficiency will not be enough (see for instance Clark and George, 1995; Huber, 1995). Moreover, eco-efficiency does not pay attention to social dimensions of sustainability (for instance inter- and intra-generational equity). They question whether more efficiency in actual production structures in the end will lead to a sustainable level of industrial production. This leads to a plea for more structural changes. The second perspective therefore is called “systems change”. The core of the systems change perspective is that businesses -and the economic system- need to be perceived as part of larger social and ecosystems. Consequently they need to be compatible with these larger systems. Within the systems change perspective emphasis is put on value-change and on more fundamental structural changes.

From these perspectives, what role can pollution prevention than play in the transformation process? Our analysis has shown that pollution prevention is especially focused on production processes, does not necessarily lead to profound changes or improvements in these production processes, and does not or only in a limited way lead to grounding of the continuous process of pollution prevention. Furthermore the projects do not necessarily reach the right companies. In the projects we have analyzed pollution prevention has proven to be more of an instrument for the diffusion of techniques, cleaner production methods and cleaner technologies, but less of an instrument for the development of cleaner production methods or cleaner technologies. And related to this, pollution prevention projects are recognized to have problems in reaching those companies who could benefit most from diffusion of both cleaner production methods and cleaner technologies. Often the companies which participate already are inclined to look for improvements in both their technology and management. Pollution prevention in current practice also is aiming at individual companies instead of provoking cooperation (Oldenburg and Geiser, 1997: 104).

Therefore four major tasks are at hand. In the first place it is important to design projects in a way which is cost effective but does not lead to a weakening of the process side of pollution prevention. In our view commitment and involvement of the company is vital. Otherwise the concept of pollution prevention won't be embedded into the organization. Sustainable development at least asks for a continuous process of improvements. The contribution of a one-time experience is limited.

In the second place avenues have to be explored in order to induce laggard companies to participate in pollution prevention projects. The approach chosen in North-Holland, where a strong connection has been made between the permit-system and pollution prevention, is interesting from this perspective. Although the direct results in terms of concrete measures in companies may be less than in the current projects, it is important to reach this category of companies.

Thirdly, pollution prevention projects should not focus solely on the firm level. Pollution prevention can also be employed out of the perspective of a value chain or at the level of an industrial estate. Again, it might be harder to initiate these kinds of projects. In the end however they contribute more to the route towards sustainable development than just optimizing the environmental performance at the firm level.

Last but not least, it is important to strengthen the commitment of relevant partners. Besides implementing concrete projects, attention should be paid to the building of a network or consortium. This consortium can initiate and coordinate activities. Partners in the consortium can be for instance municipalities, trade associations, consultancy agencies, universities and research institutes.

5 Concluding remarks

Pollution prevention can lead to improvements in efficiency and reductions in waste and emissions. Most pollution prevention projects succeed in realizing this for the participating companies. However there are indications that a significant number of companies would also have taken these steps without participating in a pollution prevention project set up by outsiders. Companies which are more defensive about environmental issues, and would probably benefit most from pollution prevention projects, are also most difficult to reach.

Our research indicates that in order to move beyond the one time impact of a pollution prevention project, and for companies to use pollution prevention as a concept for environmental management and organization, it is necessary for companies to go through a learning process. This implies that companies have to invest significant time in those projects and should not play a passive role. Therefore the danger associated to more extensively making use of quick scan methods for pollution prevention is that it does not lead to sustained improvement in companies through structural use of the method of pollution prevention. It is often a one time experience and in this sense in order to be effective should be repeated regularly. The cost associated with this will however be hard to come up with for governments involved in stimulating pollution prevention. Taking advantage of the initiatives, knowledge and capacities of partners, by building a consortium, can overcome some of the shortcomings of pollution prevention projects in a practical way.

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