

# The product process analysis – A tool to develop critical, creative and systemic thinking skills

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## INTRODUCTION

Globally, the proportion of the population with sustainable consumption awareness is increasing. According to market research firm NielsenIQ, the majority (73%) of global consumers say they “definitely or probably [would] change their consumption behavior to reduce their impact on the environment” (NielsenIQ, 2019). In many countries around the world, quality and health but above all environments are considered the main drivers of sustainable purchasing decisions (Statista 2021). The adoption of the 17 UN Sustainable Development Goals supports this trend. Subgoal 12, “sustainable consumption and production,” accordingly formulate the claim that the satisfaction of the needs of current and future generations must not be at the expense of the ecological carrying capacity of the earth, nor lead to the violation of human rights (cf. UBA & BMU). Against this background, the product process analysis offers a suitable teaching method to answer the question: how, what, for what and with which [ecological, social, and economic] consequences are produced and consumed?” (PÖW, 1987, p. 19).

The product process analysis (PPA) was developed by the Project Group Ecological Economy (PÖW) to provide various stakeholders (such as employees, trade unions, citizens’ initiatives, politicians, consumers, consumer groups as well as companies) with an information tool that can be used to view products and services holistically. In this way, well-founded sustainable decisions can be made. Thus, PPA has not been developed as a teaching method. However, in this article, we show the possibility of designing learning processes with PPA.

PPA is suitable for all learners in secondary and post-secondary education (ages from about 12 to 99). Learners do not need any specific prior knowledge. The great advantage of PPA is that learners use their own experiences as consumers to systematically gather information and evaluate it.

Our own experience often shows how difficult it is when shopping in the supermarket to decide whether foodstuffs such as coffee or bananas have been produced sustainably or what social and ecological impacts are associated with purchasing these products. The assessments are even more difficult for more complex products, such as a cell phone, a washing machine, or even an electric car. Even if the product line analysis of consumers cannot be used directly at the point of sale, it is a suitable method in school education to deal with one's own needs and characteristics of sustainable products and services.

To reduce the amount of work required to collect and process all relevant information, the method of PPA was didactically and methodically prepared for implementation in schools (Retzmann, 2000, p. 14). The aim of the use in school lessons is not to be able to apply the technical analysis procedure methodically flawlessly, but above all to develop creativity, communication, criticism, and problem-solving skills. Of course, knowledge and skills for carrying out the method and knowledge about its limitations are also necessary. Learners are thus enabled to reflect on their consumption, and they are then able to make more informed product decisions at the point of sale.

In the following, the theoretical basis for the application of PPA will be presented. Then it is shown how the method is received in science and practice. The concrete implementation of the method is illustrated with an example and some practical tips.

## **THEORETICAL BACKGROUND**

The theoretical starting point for developing the product line analysis lies in the criticism of traditional economics (Waldmann, 1992, p. 167). The instruments of classical economic theory were insufficient to make differentiated statements about the ecological and social impacts of economic production processes. Against this background, the "Project Group Ecological Economics" (PÖW) developed a method that took into account the following aspects (PÖW, 1987, pp. 15-17):

- Human consumption needs
- Natural resource consumption included in value creation processes
- Social and environmental costs in value creation processes
- Various economic areas
- Production and consumption as a whole
- Openness to other scientific disciplines, such as social sciences

The concept of PPA was then used in the 1970s in Germany in environmental education. It was didactically-methodologically prepared for the school sector to teach responsible use of the earth's natural resources. The pedagogical aim was to develop a sense of ecological responsibility in young people (Retzmann,

2000, pp. 8-10). The focus of ecologically and economically oriented learning was to convey an individual's "readiness to act in the face of complex and collective [environmental] problems." Ecological judgment and action formed the basis (Retzmann, 2000, p. 9).

The adoption of Agenda 21, in which a globally significant political commitment to "sustainable development" was declared, expanded the predominantly ecologically oriented ideas of the economy. The sustainability triangle symbolized the equal consideration of ecological, economic, and social aspects as a future strategy of human activities. The PPA refers to this theoretical view. The PPA (see Figure 1) expresses this threefold perspective. At the same time, the three sustainability dimensions are linked to the theoretical model of the product life cycle derived from economics.

Agenda 21 expanded the strongly ecologically oriented environmental education by teaching sustainable development (ESD). Education should now change people's corresponding ways of thinking and acting in the guiding idea of sustainability. All people should acquire the necessary competencies "to be actively and responsibly involved in shaping a sustainable future for humanity" (Pelegri, 2018, p. 20). Specifically, learners should develop a so-called "Gestaltungskompetenz" (design competence). This implies that individuals learn

- global interdependencies (competence in systemic thinking),
- to think ahead (competence to anticipate),
- to act empathically and in solidarity (normative competence),
- to include uncertainties and future forecasts (strategic competence) and
- wanting to participate in collective decision-making processes (interpersonal competence) (cf. Wiek et al., 2011; De Haan, 2008).

The learning process is based on the concept of action-oriented teaching (Jank & Meyer, 1994). The independent work of the learners is at the center of the organization of the lessons. During their PPA, the teachers support the learners by advising them in their research and helping them to evaluate the results of their research. However, the action is clearly in the hands of the learners. They have the responsibility for their learning process. PPA provides an opportunity to address these youth skills and develop them if done several times.

## LITERATURE REVIEW

Using a PPA in secondary and post-secondary education is a very new idea that the authors are pursuing. It is to be expected that there is hardly any literature on the use of PPA in the classroom. The translation of "Produktlinienanalyse" into English "production process analysis" did not lead to any hits. It is exclusively received in German in scientific discourses and practical application. The literature evidence used, which is almost solely limited to the German-speak-

ing area, clarifies that the method has not yet been able to spread in the international educational context.

It is striking that the method is mainly implemented in economic education contexts (Retzmann, 2000; Pelegri, 2018). Sustainable economics must address problems such as climate change, energy and resource scarcity, waste disposal, and social inequalities. Sustainability-oriented methods in economic education demonstrate the necessary social change towards more sustainability. In particular, economic, living, and consumption styles need to be more responsible and equitable.

### **EXPLANATION OF THE TOOL**

PPA is a method that allows learners to compare different products. It provides essential information about a product (or service) regarding its need satisfaction, environmental impact, social impact, and economic efficiency over the entire life cycle.

This information is compiled by considering four perspectives (PÖW, 1987, p. 18):

- The need orientation: At the beginning of the investigation, it is asked which need is to be satisfied by consuming a product or service. The environment of the product / service is also taken into account.
- The vertical view: A product is considered from raw material extraction and processing, transport, production, trade and distribution, consumption, to disposal. These phases form a product line.
- The horizontal view: The phases of a product process analyzed in the vertical view are examined concerning their effects on the three dimensions of nature, society, and economy. For each product process analysis, a criteria grid is developed for each size, with the help of which the effects of the product line variant can be determined.
- Comparison of variants: Since the product process analysis is intended to be an instrument on the way to a socially and ecologically oriented economy, the comparison between different variants of products, services, production processes can be an indication of the most environmentally and socially compatible form. One of the alternatives can also be the zero variant, in which the product is not produced or sold at all.

The product process matrix is at the heart of the PPA (see. Figure 1).

| Dimension/<br>Criteria |   | Production Prozess |           |               |       |             |           |
|------------------------|---|--------------------|-----------|---------------|-------|-------------|-----------|
|                        |   | Raw<br>Materials   | Transport | Manufacturing | Trade | Consumption | Recycling |
| Nature                 | Energy and<br>Cost of<br>materials      |                    |           |               |       |             |           |
|                        | Pollutants<br>in air, water<br>and soil |                    |           |               |       |             |           |
| Society                | Health<br>compatibility                 |                    |           |               |       |             |           |
|                        | Job<br>satisfaction                     |                    |           |               |       |             |           |
| Economy                | Company<br>position                     |                    |           |               |       |             |           |
|                        | Cost and<br>Quality                     |                    |           |               |       |             |           |

Figure 1 - Template of a product process analysis

It determines the information acquisition process. Vertical and horizontal views are related to each other in the matrix. Thus, the interactions between the natural environment and the human economy become apparent.

### AIM OF THE TOOL

Conducting a product line analysis in educational processes has four objectives (Österreich, 2011, p. 5):

- Learners identify what needs they want to satisfy and discuss the need to meet that very need.
- Learners analyze different alternatives or variants of a product or service to fulfill this need.
- Learners recognize the consequences of these alternatives for the individual and society, for nature and the economy.
- On this basis, learners can weigh the ecological, social, and economic consequences.

In conducting the analysis, learners are empowered to,

- assess various sources of information about a product holistically (analytical thinking),
- assess the impact of the production process of a given product on themselves, others, the environment, and the economy (systemic thinking),

- to deal critically with the sources of information (critical thinking),
- be able to discuss their values with other learners (critical thinking),
- being creative in the production of new products (creative thinking).

## PROCEDURE

The implementation of the PPA is not clearly defined. The authors present here an ideal-typical course planning, which must be adapted with regard to the learners, the teachers, the products and the spatial situation. Here, a sequence in four phases is presented, which refers to the theories described and, at the same time, is based on a didactic- methodical trial (Schütt-Sayed, 2020, p. 334).

1. **Introductory phase:** First, a product or service must be selected for a PPA that plays a prominent role in the learners' lifeworld. Depending on the age group or previous education, these can be very different products or services. The central task of a PPA is to compare different variants of a product or service. Here, for example, one could compare an iPhone7 and a Fairphone3. To illustrate the procedure, a PPA on smartphones is presented here. After this fundamental decision by the teacher, the learners must now be activated and motivated. Ideally, a needs analysis is carried out first. To do this, the learners are asked who owns a smartphone and what is important to them when buying a smartphone. These questions should activate and motivate the learners for the subsequent analysis by making them aware of why they use a particular product. Subsequently, it is essential to clarify what needs are behind a product. One needs to have a smartphone, for example, to communicate with friends. Another is the smartphone as a status symbol. After identifying the needs, the next step would be to get the learners to think about hidden components in their smartphones. Following this, they need to consider what impact the smartphones they produce, and use have on themselves, others, the environment, and the economy. Here it would be helpful to start an initial discussion in the learning group about their opinions. The conversation should be kept short. At the end of the discussion, the learners should agree on two smartphones to be analyzed in more detail. Likewise, the essential investigation criteria must be determined in the introductory phase.
2. **Implementation phase:** The second phase is the most extensive in terms of time, in which the learner's research and evaluate the relevant information. The implementation phase begins with the learners being divided into groups of four to five. The different groups can now decide which products they want to analyze. The number of groups per product should be approximately equal. After the learners have been divided up, they should research relevant information. The teacher can provide prepared literature for this: a report about the smartphone from an IT magazine or product information from the manufacturer's website. However, learners can also research the

necessary information themselves on the Internet. While learners research the information, they fill in the so-called production process matrix. The matrix is the core of the analysis. Any information that can be found is then recorded in the matrix. Figure 2 shows an example of a completed production process matrix for the Fairphone: The columns show the product life cycle. The rows show the test criteria, each in the form of a given question. The groups should check all requirements for each production process step of a product. An example might look like this: In the column 'Raw materials' and the row 'How employees are treated', one is entered 2 by the learners. Behind this number is an inquiry by the learners. Their evaluation is based on the information that only raw materials from conflict-free mines in the Congo are used for the Fairphone. Therefore, the evaluation of this information with the school grade 2 (in Germany, one is the best grade and six the worst) is based on the learners' assessments. This jointly developed assessment is very important for the learning process so that the students have to enter into discussion among themselves. This makes their attitudes and values regarding this information visible. The teacher should also point out that the learners should always pay attention to the given information source when evaluating it. This is because the author's perspective (e.g., the manufacturer) may be different from the perspective of an independent IT magazine.

| Dimension/<br>Criteria |   | Production Prozess |           |               |       |             | Average<br>Total |           |
|------------------------|---|--------------------|-----------|---------------|-------|-------------|------------------|-----------|
|                        |   | Raw<br>Materials   | Transport | Manufacturing | Trade | Consumption |                  | Recycling |
| Nature                 | Energy and<br>Cost of<br>materials      | 0                  | 0         | 4             | 0     | 0           | 0                | 4         |
|                        | Pollutants<br>in air, water<br>and soil | 2                  | 0         | 2             | 0     | 0           | 0                | 2         |
| Society                | Health<br>compatibility                 | 2                  | 0         | 0             | 0     | 0           | 0                | 2         |
|                        | Job<br>satisfaction                     | 0                  | 0         | 0             | 3     | 0           | 0                | 3         |
| Economy                | Company<br>position                     | 0                  | 0         | 2             | 0     | 0           | 0                | 2         |
|                        | Cost and<br>Quality                     | 0                  | 0         | 0             | 0     | 1           | 0                | 1         |

Assessment school grades (Germany): Overall score = 2,33

| Dimension/<br>Criteria               | Raw Materials                                     | Grade    |
|--------------------------------------|---|----------|
| <b>How employees are<br/>treated</b> | <b>Use conflict-free materials<br/>from Congo</b> | <b>2</b> |

Figure 2 - Example of a filled production process matrix (fairphone)

1. Reflection phase: In the third step, the students are asked to reflect on the analysis results. After that, it is essential that the learners reflect on their results again. After the matrix has been completed as far as possible, the last step is for the groups to present their results to each other. Each group should then answer the following questions (Östereicher, 2011, p. 110):
  - How would you evaluate the results?
  - What consequences do I draw for myself from these results?
  - What actions should be taken to improve the situation?
  - What actions can I personally take as a consumer or producer to improve the situation?
  - What actions should companies and politicians take to improve the situation?
  - Which actions should already be taken for granted?
  - Which criteria are still insufficiently investigated and should therefore be better researched?
  - Which ecological and social innovations can be derived from the results?

Answering these questions is the central basis for assessing the consequences of consumption and thus identifying the need for action to develop a product or service further. The learners are therefore able to weigh up the consequences and the need for action.

4. Reporting phase: The last step is summarizing all the results in a report and formulating a personal conclusion. The form of the information can be freely chosen: a video, a presentation, a classic report. The report should contain at least four bullet points:
  - The completed production process matrix
  - A summary of all relevant information
  - An evaluation of the individual information
  - A reflection on the consequences and possible alternative actions

The following table gives an overview of the process:

| Learning phase | Time    | Teaching-/Learning activity   | Method/ Social Form Media                          |
|----------------|---------|---|--|
| Introduction   | 20 min. | <ul style="list-style-type: none"> <li>- The teacher gives a presentation introducing the learners to the problem of cell phone production and the theory of PPA.</li> <li>- The following questions lead to the problem of the cell phone issue: “Who of you has a smartphone?”, “What is important to you when buying a smartphone?” “What do you need a smartphone for?”, “What needs does your smartphone satisfy?”, “What is hidden in your smartphone?”, “What impact does the smartphone have on me, others, the environment, and the economy?”</li> <li>- The learners reflect on their needs. They recognize the relevance of the “cell phone problem.” They work out the effects of their satisfaction of needs on local and global contexts.</li> <li>- They scrutinize a product or service for the underlying need, taking into account the environment.</li> <li>- They will learn the definition, objectives, and process of PPA.</li> </ul> | Teaching/learning conversation, plenum, ppt slides |

| Learning phase | Time             | Teaching-/Learning activity   | Method/ Social Form Media   |
|----------------|------------------|---|---|
| Execution      | approx. 180 min. | <p>Participants conduct their product process analysis for two comparable products.</p> <ul style="list-style-type: none"> <li>- The teacher introduces the work assignment and divides the learning group into groups of 4. (recommended minimum number of learners: 8)</li> <li>- The teacher distributes selected articles or gives access to the articles.</li> <li>- Learners read through the given articles and filter out the relevant information and content.</li> <li>- They arrange the information into a given product process matrix.</li> <li>- The learners present product-related data over the entire life cycle of a product (iPhone/ Fairphone) and recognize which effects and consequences are associated with this in ecological, social, and economic terms.</li> </ul> | Group work, Work order, shared document with product process matrix |
| Reflection     | 60 min.          | <ul style="list-style-type: none"> <li>- Comparison of the different results in plenary, e.g., on the Smartboard.</li> </ul>  | Plenum, Worksheet "Reflection Questions"                            |
| Report         | 60 min.          | <ul style="list-style-type: none"> <li>- Learners prepare a report (production process matrix, summary of all information, evaluation of each information, reflection of consequences, possible alternative actions).</li> <li>- Learners formulate personal conclusions from the PPA.</li> </ul>   | Group work, Report Template   |

## **EXPECTED OUTCOME**

The PPA enables the learners to reflect on their satisfaction of needs and assess the ecological, social, and economic consequences of their actions. They develop recommendations for action for the future. The most important outcome, however, is to guide learners in practicing critical thinking!

## **ALLOCATED TIME**

Depending on the learners' previous education, 5 to 6 hours are needed to run through a complete PPA. In particular, the time required for the execution phase is quite variable. Learners who develop a great deal of ambition need significantly longer to research and complete the product process matrix than groups who use many of the teacher's prepared texts.

## **SETTING, PLACE LAYOUT**

The PPA method can be carried out in average classrooms. Internet access is helpful, and it is also advantageous if the groups do not hinder each other during the work phase.

## **NECESSARY MATERIALS**

The teacher has to decide in which form the information material should be provided with the learners in mind. In a learning group that is used to working independently, the main research work can be transferred to the learners. Less experienced groups need more precise guidelines and more information about the products or services. This is especially important because otherwise, the motivation suffers significantly if the research results are unsuccessful.

## **NUMBER OF PARTICIPANTS**

Since at least two product process matrices are to be compared at the end of the implementation phase, four learners must work in each of two learning groups: i.e., at least eight learners.

## **ROLE OF STUDENTS**

The learners become - depending on the preparation and support by the teachers - experts of the PPA. They have to be very active in shaping their learning process. This must be learned gradually. The more PPA the learners do, the more practiced they become in actually taking responsibility for their learning process. The learners must be very well accompanied by the teachers in this process.

## **ROLE OF TEACHER**

Teachers need to find a good balance between guidance and counseling. They must have the courage to gradually reduce the stringent control of the lessons in order to offer the learners ever greater opportunities to control their own learning process. Nevertheless, the teachers must be ready to support the learners at any time. This applies both to the information about the products studied and to the methodological course of the PPA. In the phases 'introduction' and 'reflection' the role is rather 'guidance'. In the phases 'execution' and 'report' the role is rather 'counselling'.

## **STEPS TO USE THE TOOL**

From the teacher's point of view, excellent preparation of the content of the chosen product or service is an essential basis for a successful PPA. In addition, the teacher must be taught in accompanying learning processes. The learners have sufficient freedom but are also sufficiently guided in the decisive phase to achieve the goals.

## **ASSESSMENT**

The success of a PPA can be measured very well by the results. The teacher can evaluate the completed product process matrix and the elaborated report, preferably with the learners.

## **STUDENTS' FEEDBACK**

In evaluating our implementations, the learners expressed their great interest in the PPA. The information research was especially popular among the learners. All learners described the discussion of the different product process matrices as a crucial and stimulating phase of the method.

## **CONCLUSION**

The method of product process analysis is not an 'original' didactic method, yet teachers can use it very well in learning situations. It ensures an intensive insight into assessing the ecological, social, and economic interrelationships of products and services. Working with the PPA places high demands on the learners' independence. They must be able, or be enabled by the teachers, to take responsibility for their learning process. To be able to assume this responsibility, the PPA is relatively clearly structured so that the learners can concentrate well on the content-related assessment of the products and services. The teacher's excellent content preparation ensures the learners' learning success.

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