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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

MANUAL FOR SELF-DIAGNOSIS OF CRITICAL TECHNOLOGICAL NEEDS FOR SUSTAINED COMPETITIVENESS AT PLANT LEVEL

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PART I - INTRODUCTION TO THE METHODOLOGY

1 The importance of Technology Management

Over the last decade, it has become evident that the globalization process of markets is irreversible. Since borders between countries are vanishing, products and services have to compete directly with those of foreign players in the market. Not surprisingly, many enterprises are now facing the urgent need to increase their competitive level to survive.

The competitiveness of a company is determined by its capacity to add value for customers through efficiently organized processes. Therefore, it is important to determine those factors that add value to our products/services from the client's perspective. Generally, this refers to competitive factors like: quality, environmental considerations, innovativeness, price, service, availability, image, presentation, performance, and variety.

However, this does not mean that the best of all these factors has to be sought. Each client or group of clients has different preferences and priorities. Therefore, a company should, according to its strategy, carefully select its target group(s) and align its products and services to their expectations (conscious or unconscious). For example, when a company aims to sell cars to the urban middle class in a developing country, the car should be reasonably priced and have low operating costs. Additionally, good credit facilities should be considered. However, an air conditioning of US$500 might add costs but no value for the clients. On the other hand, in case of selling Mercedes Benz to the upper class, the credit facility might be irrelevant, but the air-conditioning indispensable.

To achieve the required performance on the critical competitive factors, the technology applied by the company plays a key role. Therefore, technology has to be managed properly, to optimize the value adding process. For example: making a Volkswagen beetle with Mercedes Benz technology will only increase the price, but not add value from the customers point of view.

The delicate process of aligning products and services with customers expectations on one hand, and technology with products and services on the other, is covered by **Technology Management (TM)**. By applying TM, technology is redefined from just another production tool to an integral part of the company strategy focused on increased competitiveness. For this purpose, a broad definition of "technology" is being used. Most people relate it merely to the equipment at plant level. But technology is spread over all the functional areas of the organization, and is involved in almost everything a company does: its products, processes, equipment, operations, logistics, and in its human-, information-, and technical resources. TM recognizes this complex interrelationship and aims to determine the correct relation between specific technological aspects and the competitive factors of the company.

2. The technological-competitive diagnosis

The present paper offers the reader a methodological *"first-aid kit"* to determine the critical technological elements for the improvement of the competitive level of the company. The final purpose is to provide the necessary elements for the definition of innovation projects in the frame of the enterprise strategy. This methodology is known as *technological-competitive diagnosis* and, because of these characteristics, it is considered to be an important tool for TM. As a result of the implementation of this diagnosis, the company will be able to identify the most relevant technological innovation projects, like the acquisition of equipment, the introduction of new (or fundamental redesign of old) systems and/or processes, training, and R&D.

The present methodology has been designed to be applied in a short period of time and to produce results that can be implemented immediately. This is necessary because the technological environment of any organization is very dynamic, both because of the changing requirements and demands from the current and future clients, and the constant change in the technological options. For the same reason, it should be applied periodically, to avoid technologies from becoming obsolete.

Additionally, even though a certain level of analysis is always desirable, this has to be balanced against the importance of making and implementing fast decisions. It should be remembered that, as a result of the changing environment, by the time an opportunity is investigated fully it may no longer exist.

There are several moments in which the use of a Technological Diagnosis can be of considerable usefulness, as for example:

- When the organization is in the process of formulating its Strategic Plan, the Technological Diagnosis will give valuable information as regards to the linkage between technology and competitiveness, and the technological strategies and innovation projects to form part of the strategic plan.
- To strengthen the competitiveness of a specific product or service. The methodology allows to consistently monitor the technological and market environment, therefore identifying important information regarding innovations that should be incorporated into the product or service, and/or opportunities of which the company can take advantage. In these cases, the diagnosis should be executed with a certain periodicity, to be determined based on the product or service characteristics.

Normally, a technological-competitive diagnosis is carried out with the assistance of a professional consultant trained on its application. Although this is always preferable, it should be recognized that competent consultants are not always available in developing countries, and that they can be rather expensive. Therefore, adaptations to the original methodology have been made to facilitate its use as a self-diagnosis. For the same reason, a case example has been introduced. With the help of the case example, the reader will find it easier to understand the underlying calculations and to identify the relevant issues related to his/her own organization. Though being fictive, it is based on real situations found in developing countries.

3. The importance of strategy - introduction to the case example

Although the technological diagnosis described below can be applied to almost any situation, it is far to be preferred that it will be carried out against the background of a strategic plan or as part of a strategic planning exercise. The reason for this is that the present diagnosis will probably imply changes at enterprise level. These changes should be made to achieve a specific impact, in the frame of a more general strategy. If this strategy is not well defined, it should be questioned how much sense the change makes (remember: not all changes are positive).

The importance of an adequate strategy is best illustrated by the following introduction to the case example:

The case example: CleanCo

Germland is a developing country of approximately three million people, with a moderate and gradually increasing level of (industrial) development, and a relatively fair income distribution. Though being a small market, the strong local demand and projectionist policies have promoted the development of a diversified industrial sector. Many of these industries (50%) are agro-based, but during the last decades promising electronic and chemical industries have arisen.

CleanCo, producer and distributor of cleaning agents and related products, belongs to the latter group. Traditionally, it has been competing on the local market with its arch-rivals AddIt and Brush Ltd., with which it is sharing most of its markets. These so-called "ABC"-companies are all family owned and the relations between these families are not particularly friendly, mainly due to ethnic and cultural differences.

The (traditional) products made by CleanCo can be divided in 4 groups:

- ✓ *Chlorine - under the brand name "White Rabbit"*
- ✓ *Detergents for floors and bathrooms - under the two brand names "Over" and "Done".*
- ✓ *Dishwashing paste - under the brand name "Hands on".*
- ✓ *Toilet freshener (tablets) - under the brand name "Flush".*

As a consequence of the economic crisis of the mid eighties, Germland radically changed the direction of the industrial policies from projectionist to quick liberalization. As a consequence two big multinational companies, Tornado and Tempest, have entered the local market, steadily reducing the market share of the ABC companies, especially in the Great Metropolitan Area (GMA) around the capital city of the country. Since joint action of the ABC companies was not likely, for the above mentioned reasons, each company prepared its own response.

***AddIt**, opposite to what its name would suggest, implemented what they called a Reengineering Process, which actually consisted of a severe cost-cutting programme, including staff reduction, salary cuts, elimination of several product presentations, and reduction of overhead costs like training and R&D. The results were disappointing. Total sales plunged, since the market share of the remaining AddIt products did not increase*

significantly. In spite of the cost cutting measures, costs actually increased due to lower utilization of the installed capacity (higher indirect costs), lower labor productivity, and increased quality problems (demotivated staff). As a consequence, the modest profits of AddIt turned into losses. It is expected that AddIt will soon leave business.

***Brush Ltd.** responded by focusing on its marketing strategy. Budgets for TV commercials have been doubled and advertisement in newspapers has been increased with 50%. Simultaneously, an aggressive "incentive" system for the wholesalers, a 2% commission for purchase managers, has been designed and implemented. The owners of the warehouses welcomed this initiative, since it saves them salary costs on the long run. Apparently, the strategy was relatively successful, since the sales of Brush increased slightly. However, it will be doubtful if the success will be long lasting. Though the commission offered by Brush influences the purchase managers, the final decision of what to buy is made by the consumers.*

In this context, it is important to mention that the quality of the products offered by the foreign competitors is definitely higher than those of Brush, while prices are somewhat higher. At the same time, the long lasting experience of Tornado and Tempest in diverse markets has strengthened their capacity to develop superior promotional materials, including newspaper advertisements and TV commercials. For this reason, the long term prospects for increased competitiveness of Brush are limited.

***CleanCo** opted for a long term strategy, focused on increasing the value added of the products through improved quality of the products, vertical integration, diversification of the markets and better penetration in the rural areas. It refused to participate in the "commission" system to the purchase managers of the wholesalers, since the company considers it a form of bribing, which is not likely to generate long term profits.*

Consequently, CleanCo is strengthening its distribution system to gain independence from the wholesalers. This is also coherent with the penetration strategy for the rural areas, as well as with the vertical integration policy of the company.

Recently, CleanCo completed negotiations for the development of a strategic alliance with WhipeOut, another multinational firm, which is not yet active in Germland. With this alliance, CleanCo expects to strengthen its competitive position through technology transfer, introduction of environmentally friendly technologies and improvement of its commercialization abilities.

Analysis:

Comparing the response of the three companies there are striking differences:

***AddIt** produced a typical panic reaction, a suicidal act which (unfortunately) has been committed by many enterprises in response to liberalization policies. Instead of seeking new opportunities to add value to clients, the company started a process o self-amputation, resulting in a reduction of its capacity to continuously increase the value added of its products and services. In this way it represents a striking example of Murphy's Law on Specialization: it is specializing more and more on a decreasingly few number of activities, until it is 100% specialized in nothing.*

The response of ***Brush Ltd.*** *is in the same way reactive like AddIt. It responded with aggressiveness, which is another typical reaction on liberalization policies. But the long term survivors in today's global economy do not compete by brute force but by intelligence. This does not exclude that increased aggressiveness can produce a positive impact, but this attitude has to be complemented with strategic actions at other levels. Consequently, most likely the combination of superior quality, services and marketing techniques of the foreign competitors will affect the position of Brush Ltd.*

CleanCo *is the only company which made an effort to consider modifications in its competitive strategy and integrate the concept of Technology Management in these efforts. It successfully sought a Strategic Business Alliance to improve quality through technological improvements. At the same time it is reconsidering its relation with its present clients and is looking for new clients.*

However, although CleanCo understands the importance of Technology to increase its competitiveness, it is not yet clear about the relation between the strategy of the company, the consumer preferences and the most relevant technological projects to achieve an optimal alignment between these parameters.

In this context, it is important to mention that CleanCo already implemented some significant modernization efforts at the production line level. However, for reasons that they still do not fully understand, this investments have not produced the expected results.

For the above reasons, CleanCo decided to run a technological-competitive diagnosis. The results of this exercise will be used in Part II of this paper to demonstrate the application of the methodology.

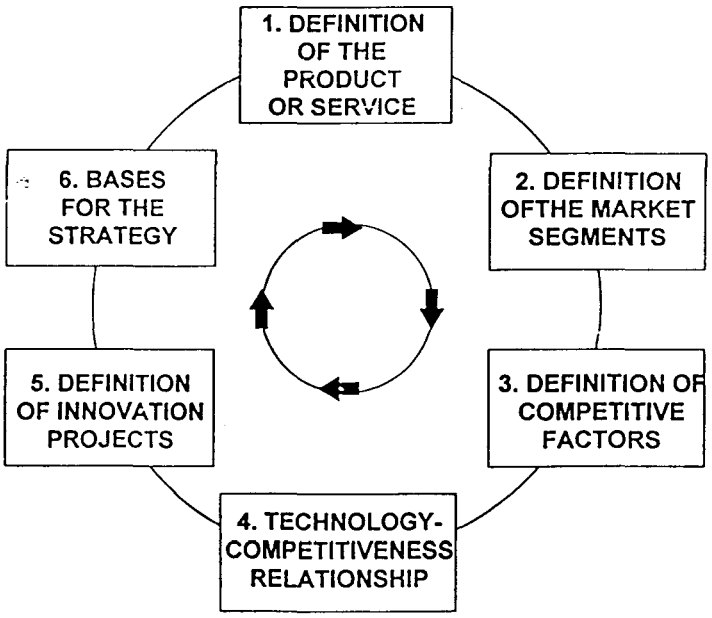
From the above example it is clear that companies with a basic strategic definition will most benefit from a technological-competitive diagnosis. However, this does not exclude that companies like AddIt and Brush Ltd. could benefit from running such an exercise. On the contrary, but only the course of the exercise will be different: As soon as they start the diagnosis, they will find out that they cannot answer some basic questions, due to the absence of a coherent framework. Through the process of applying the methodology, these companies have to answer questions never made before, which might increase their conscience for the necessity of having a coherent and proactive competitive strategy. In this sense, the present exercise will help them to formulate such a strategy.

4. The steps of the diagnosis

The consecutive steps of the diagnosis are:

1. **Definition of the product or service** to which the diagnosis will be applied.
2. **Definition of the market segments.** This follows the argument that a product or service has to be focused on specific target groups.
3. **Definition of the competitive factors.** This is to answer the question: "what adds value from the clients point of view?"
4. **Analysis of the relationship between technology and the competitive factors.** In this phase, the extend to which technology contributes to the value adding of different competitive factors will be determined. This includes the determination of the technological strengths and weaknesses.
5. **Definition of innovation projects.** Based on the results of the previous steps, it will become clear in which areas technological improvements have a mayor impact on the critical competitive factors of the company. Consequently, specific innovation projects can be formulated.
6. **Return to strategy.** The outcome of the previous process will provide important elements for the technological strategy of the company. At the same time it will feedback the general enterprise strategy, from which point one can return to the first step to maintain a process of continuous improvement.

The previous steps are graphically demonstrated in the following diagram:



An important benefit from applying this methodology is the development of a common language among key personnel from the organization, and their involvement in the definition of technological strategies and projects. Besides, the company will receive:

- ✓ a list of the competitive factors of the products or services to be analyzed;
- ✓ a list of the technological elements critical for its sustainable competitiveness, and their relationship with the competitive factors previously identified;
- ✓ a list of technological strengths and weaknesses in relation to its competitive factors;
- ✓ a list of innovation projects, ranked according to their expected impact on the technological competitive position of the products or services to be analyzed;
- ✓ support to the formulation and implementation of strategies intended to improve the competitiveness of the company.

This methodology also makes it possible to analyze the outcome of alternative scenarios or strategies, regarding changes in the market segmentation, market share, and customer preferences of a specific product or service.

In the application of TM a participative approach should be considered, which implies the active participation of different groups of staff members, specially those involved in the definition and implementation of strategic issues. This will have the advantage that different (and hopefully opposite) points of view are considered and the engagement of the participants for the implementation of the resulting projects and strategies.

PART II - THE APPLICATION OF THE METHODOLOGY

1. Definition of the product or service

The product or service to be analyzed has to be carefully defined. It has to be decided whether the methodology is going to be applied to a specific product or service, or to a group of them. In this latter case, the group of products or services have to conform a family, which means that they have to share several important characteristics, particularly the technologies involved in their design, manufacturing, and distribution.

It is equally important to define the "borders" of the business. We must have a precise answer to the question: what are we selling? The concept of "product" does usually mean much more than just the materials of which it is made; it can also include all the knowledge (procedures, designs, etc.) required to use it, certain level of service, and other information and/or attributes that make part of the product from the customers point of view.

On the other hand, the application of systems like Total Quality Management and Quality Assurance (like ISO 9000) have made it common for producers to work close together with their suppliers of products and services, which means that there might be an interrelationship between the technologies applied by both of them. At the same time, the same reasoning can be applied to the company to be analyzed if it supplies goods or services to another company.

All these circumstances have to be taken into consideration when defining the "borders" of the business to be analyzed, for the methodology to consider all the relevant technologies, including those that might be on the other company's side.

Case example: CleanCo

The products of CleanCo can be divided in four groups: Chlorine, Detergents, Dishwashing paste and Toilet freshener. Chlorine represents the lions' share of the CleanCo production, and the company recently invested in an ultramodern Chlorite plant. This vertical integration gave the company a very strong position in the local market.

Dishwashing paste and Toilet freshener are well positioned in the local market and not (yet) threatened by the international competition. Apart from this, the relative importance of these products is very limited.

Detergents faced a different situation, since new entrants were competing fiercely and gaining market share at the expense of CleanCo. Moreover, Detergents represent a significant part of the CleanCo output. At the same time filling- and distribution facilities, as well as the major part of the clients, are being shared with Chlorine, which gives the analysis a relevance beyond the Detergents. For all these reasons Detergents were a logical choice to be submitted to further analysis.

The next step, was to define the borders of the business. Although the vast majority of the clients are supermarkets and wholesalers, the borders of the business have been set including the delivery to the point where products are handed over to the consumers, which includes small grocery stores. This is consistent with the vertical integration strategy of the company.

2. Definition of the market segments and their relative importance

When determining the market segments, three decisions should be taken with respect to the exact definition to be applied:

- ✓ *Criteria for separating the segments:* income groups, regions, characteristics of the clients, ethnic background, age, and others.
- ✓ *Time perspective:* present or desired/projected situation.
- ✓ *Measurement of the segments:* share of total sales, total profit, or other.

While making the corresponding choices, it is (again) important to consider the link with the strategy of the company.

The **criteria** for segmentation normally will be determined by the combination of the specific characteristics of the product and the strategy of the company. The purpose of this segmentation is to differentiate between groups of buyers that apply different criteria when buying the product/service. For example, a company like Benetton might be interested in the age criteria: children versus young adults; or in the regional criteria: domestic versus export markets. The income criteria might be irrelevant, since Benetton clients normally belong to the higher income groups. However, if Benetton had an explicit strategy to diversify its markets towards the middle income groups, the distinction between the higher and middle income group would be more relevant.

With respect to the **time perspective**, normally the future (desired) situation is the preferred choice. For example, if Benetton wanted to increase its sales among the middle class from 2% to 20% of total sales, it does not make much sense to run the analysis over the 2% segment, since all outcomes will be dominated by the 98% higher income segment.

In case the company does not have a defined strategy or expectation of the market development, the current situation should be taken. But in case of such a 2%-98% division of the market shares, it should be questioned seriously if the outcome of the previous section (how to divide) is correct. It is also appropriate to take the current situation when the diagnosis will be applied before a strategic planning exercise, as an input. In such a case, the information regarding current technological strengths and weaknesses will be very valuable.

In this context, it is important to mention that the structure of the methodology allows for the analysis of different scenarios ("what-if"), generating useful information regarding the potential strengths and weaknesses if certain strategic options were taken.

Finally, the **measurement** should be defined. Since most organizations will have profit generation (to assure the continuity and growth of their activities) among their main objectives, the measurements related to profits should be preferred. In this context the measures could be:

- ✓ Percentage of total net profits.
- ✓ Percentage of total contribution margin (sales price minus variable costs).

The choice between these two criteria will depend on the characteristics of the company. A percentage of total net profits will be appropriate for enterprises which are producing a limited quantity of standard products with a predictable demand. Organizations dedicated to the

fulfillment of special (tailor made) orders or with a very wide range of products could better opt for the contribution margin. The same will be true for most of the service organizations or factories working at full capacity.

The previous considerations implicitly assume that the company has developed proper systems to calculate the profit margins. Unfortunately, in most cases this is not true. In that case it might be safer to apply the contribution margin criteria.

Alternatively, the company can use a different set of criteria, based on the production, such as the **share of total sales,** or the **share of total production** related to the chosen market segments,. The advantage of these measurements is that most companies will have quick access to reliable data. However they might lead to wrong conclusions in case of substantial differences between the profit contributions of the corresponding segments.

Case example: CleanCo

Roughly the clients of CleanCo can be divided in Supermarkets, Wholesalers and Exports. However, given the present situation in which the response to the foreign competitors is focused on penetration in the rural areas and substitution of the wholesalers by direct distribution, this subdivision was considered to be less relevant. It was therefore decided to split the demand of the detergents between Urban and Rural demand, because of its strategic relevance. The exports of CleanCo are mainly concentrated in products like Flush and Hands On. In the case of detergents, because of volume and weight, transport costs are prohibitive for export.

Although the cost monitoring system of CleanCo considers gross profit margins, these does not include the distribution costs. Logically, these costs are substantially higher for rural than for urban clients. At the same time there were serious doubts with respect to the internal cost allocation mechanisms between the different packaging sizes of the products. In general, larger presentations are subsidizing the smaller ones. Since rural clients buy mostly the smaller presentations, this would further bias in favor of the rural segment. For these reasons, CleanCo decided to apply the sales volume criteria, though recognizing that the same arguments partially bias the result towards the rural markets.

As far as the time criteria is concerned, CleanCo opted for the future situation. At the moment of the diagnosis the rural sales only represented 5% of total sales, but were expected to grow to 30% of total sales in the following two years.

Summarizing, the subject of analysis in the case of CleanCo were ***Detergents,*** *sold to* ***Urban*** *and* ***Rural*** *clients of which the respective market shares were estimated in 70% and 30% of the total sales.*

3. Definition of the competitive factors

The next step is to identify the competitive factors. This refers to the criteria applied by the clients at the moment they make the buying decision, and includes questions like: "what do current and potential clients of these product or service expect from it?"; "how can a supplier delight them?" Examples of considerations taken into account by the clients are:

Compliance:	compliance with the previously specified standards by the client.
Price:	amount of money that the buyer has to pay to use the product or service.
Performance:	level of performance as perceived by the client, based on his/her expectations.
Environmental impact:	impact of the product/service on the environment, as perceived by the clients; it can be related to a green seal and the use of clean technologies.
Variety:	variety of products or services available to the client, which is related to the level of customization.
Presentation:	the way that the product or service looks like when the client is faced to the possibility of buying it; this factor can be related with the package used.
Delivery time:	time required for the product or service to be delivered to the client.
Availability:	level of effort that a client has to do to get the product or service.
Service:	kind and level of service associated to the product; its meaning will vary considerably depending on the product being analyzed.
Image:	image of the product or service, the seller and/or the producer for the clients. This can be related to a brand ("Coke is Coke")
Credit:	availability and conditions of credit for the clients.

Preferably, the selected number of competitive criteria should be limited to the 2-4 most relevant ones. It is important to consider a feedback from the clients to this respect, instead of just taking the company's perception of what is important to the client. This perception might not be realistic. For example, a well known company in the USA perceived that its clients would appreciate two deliveries per day. However, after getting some feedback on this, learned that one delivery per day was perfectly right for most of them. Thinking to provide an excellent service to its clients, the company implicitly charged millions of US$ of delivery costs on its clients for meeting a service standard not needed by them.

In order to obtain this feedback, it is highly recommended to apply questionnaires among some former, current, and potential customers. This kind of questionnaires should request a prioritization to clients, asking what is most important, and what comes next. To the question: "Is this very important, important, not so important or irrelevant?" many

respondents will incline to respond "important" and "very important" Forcing them to choose, will generate more significant differences between the preferences.

At the same time it is recommended to avoid using ambiguous or too general terms; one example is the use of the term "quality", which might cover in just one word almost everything, unless a more specific definition is employed.

Annex 1 provides with a small questionnaire that can be used with some of the company's clients, in order to obtain fast and more reliable information regarding the criteria on which they base their purchasing decision.

This questionnaire will also supply useful information about the company's competitive position in relation to its main competitors and other important characteristics about the markets in which it competes.

Once we have the information regarding the market segments, their relative importance, and the competitive factors, the Competitive Profile Matrix can be completed. Through this matrix, of which an example is given in the continuation of the case example, the relative importance of each competitive factor is being determined.

Case example: CleanCo

CleanCo selected the following three competitive factors:

- ✓ ***Price:*** *given the present market conditions created by the foreign competition, price is important. However, for the rural areas, where incomes are substantially lower, price is even more important than in the urban areas.*
- ✓ ***Delivery time:*** *This is extremely important in the urban areas, due to a combination of stiff competition between supermarkets (which tend to lower the stocks in their warehouses, to reduce capital costs) and a high offer of substitutes (which creates severe competition for shelf space in the supermarket). In rural areas clients are more used to longer delivery times.*
- ✓ ***Environmental impact:*** *This may not yet be an important consideration for the inhabitants of Germland, but it is expected that is will be on the medium term. Foreign competitors already offer products which include this aspect (competitors sell their products as "environmentally friendly") and it is expected that, at least among urban clients, taking into account environmental considerations will quickly gain importance. Moreover, there are serious signs that the Government is taking steps to strengthen the legislation to this respect.*

Applying the information obtained so far, the Competitive profile of CleanCo is:

CleanCo - Competitive profile *Detergents*								
Segment	*Market share*	*Price*		*Delivery time*		*Environmental impact*		*Total*
Urban area	*70%*	*2*	*70%*2= 1,4*	*4*	*70%*4= 2,8*	*3*	*70%*3= 2,1*	
Rural areas	*30%*	*4*	*1,2*	*1*	*0,3*	*1*	*0,3*	
Market Demand	*100%*		*2,6*		*3,1*		*2,4*	*8,1*
Relative importance (% of total)		*2,6/(2,6+3,1+2,4)= 32%*			*38%*		*30%*	*100%*

Explanation of the matrix:

- ✓ **Market share** column: according to the *future sales expectation,* as defined in section II.2.
- ✓ **Price, Delivery time** and **Environmental impact** columns: the first column of each factor refers to the relative importance given on a scale of 0 to 4, according to the following scale:

0 = irrelevant:	*the purchasing decision is not influenced by this particular factor;*
1 = of little importance:	*there is some relationship between the Competitive Factor and the purchasing decision, but it is of little relevance;*
2 = of certain importance:	*the factor is not a determinant of the purchasing decision, but it influences it;*
3 = very important:	*the purchasing decision is strongly influenced by this Competitive Factor;*
4 = of critical importance:	*the client will not buy the product/service if its performance in this factor is not satisfactory.*

The figure in the second column is obtained by multiplying the market share by the score assigned to the relative importance. For example: in the case of the "Urban - Price" cell, the calculation is: 70% of 2 = 0,70 x 2 = 1,4.

- ✓ **Market demand:** This is the sum of the values of the two market segments for each competitive factor. In this case, the total value of each competitive factor is: 2,6 + 3,1 + 3,3 = 9,0. By dividing the values of the competitive factors through the value of the Total Demand, the relative importance is obtained. In the case of CleanCo, the delivery time demonstrated to be the most important competitive factor, with: 3,1/8,1 x 100% = 38%. However, the differences between the three factors are relatively small.

The above implies that, in function with the achievement of the company strategy, the delivery time of the product is an important element. Therefore, within the general Technology Management efforts, it should receive a corresponding level of priority.

At this stage, it is interesting to analyze, what the outcome of the first stage of this analysis would have been, in case the existing market shares (95% urban, 5% rural) had been applied, instead of the future market shares:

CleanCo *Competitive profile* *Detergents*								
Segment	*Market share*	*Price*		*Delivery time*		*Environmental impact*		*Total*
Urban area	*95%*	*2*	*1,9*	*4*	*3,8*	*3*	*2,85*	
Rural areas	*5%*	*4*	*0,2*	*1*	*0,05*	*1*	*0,05*	
Market Demand	*100%*		***2,1***		*3,85*		*2,9*	***8,85***
% of total			***24%***		***43%***		***33%***	***100%***

From the above matrix we can learn that, under the present conditions, delivery time is relatively more important and price less. This leads to the conclusion that the strategy to increase rural demand, implies the need to give more attention to the price aspect. The relative importance of the environmental aspect is hardly influenced by the previous simulation, since environment is not an-issue for rural clients.

The latter emphasizes (again) the importance of a clearly defined strategy for the development of appropriate Technology Management measures, and to incorporate these consideration while running a technological-competitive diagnosis.

4. The technology-competitiveness relationship

The next step is to establish the relationship between the Competitive Factors and Technology. The objective of this analysis is to find an answer on two questions:

- ✓ Which are the most relevant technological elements in relation to their influence on the selected competitive factors?
- ✓ What is the relative position of the company, at the level of the individual Competitive Factors?

With respect to the technology, the following 5 main categories might be considered:

- ✓ **Equipment and infrastructure:** This refers to all machinery, vehicles, infrastructure and buildings, excluding hardware for information systems.
- ✓ **Product and process technology:** This includes the design of the products (standards, functional considerations, etc.) and processes (steps, sequence, etc.), quality of the inputs used, packaging, distribution mechanisms, taste, etc.
- ✓ **Information technology:** The capacity of the information systems to provide essential information for decision making at all levels and facilitate the swift satisfaction of customers needs.
- ✓ **Human resources:** The general ability of staff members to fulfill their goals: knowledge, abilities, level of motivation and creativity, etc., including aspects like their capability to: work with minimum errors, to assume responsibility, to work independently, to solve problems, to participate in teamwork, etc.
- ✓ **Logistics:** The organization of work, plant layout, material handling, storage, maintenance, etc., aspects that are important to guarantee that activities are executed in the predetermined order, smoothly, timely and without unnecessary dead times.

We should consider these 5 categories, identifying all the relevant **technological elements**; that is, those technologies that influence significantly at least one of the previously defined competitive factors. After doing this, we determine the relative position of the technological elements by following these two steps:

1. Determining the relative importance of the technological elements, in relation to each competitive factor.
2. Establishing the relation between relative position with the relative importance of the technological elements.

With respect to the technological elements, the analysis should be focused on the ones which are most determinant for the corresponding competitive factors.

Defining and specifying the competitive factors

Before starting the above mentioned exercise, it is important to clearly define each competitive factor and subdivide them in their most relevant components.

Case example: CleanCo

Price:

Price is the disbursement made by the final client to acquire the product. This excludes the additional costs made by the client, like transport to the shop and time invested. In the case of detergents, this can be justified since it is a massive consumption good, which is normally bought together with many other products.

The current price of the detergents of the three ABC companies is close to US$1,20 per liter, while the new foreign competitors Tempest and Tornado entered the market with a price of US$1,40 per liter. However, it is expected that increased competition will result in price wars and will therefore reduce the average price to US$1,00 - US$1,10 within the next few years.

The price structure of the CleanCo detergents is:

Raw materials.....50%
Production costs.....10%
Administrative costs.....20%
Marketing 8%
Capital costs.....5%
Transport costs.....2%
Net profit margin.....5%
Subtotal:.....100%
Margin wholesalers.....10%
Margin retailers.....5%
Total:.....20%

From the above follows that raw materials, administrative costs, production costs and the margin of the wholesalers are the main factors that influence the price.

Obviously, this implies that technological improvements related to these price components are more likely to have a strong impact on the competitive factor "price". In the case of the production costs, the technologies applied by the industry are relatively standard and the conversion process is quite simple. Therefore, no mayor impact of technological changes is to be expected at this level.

It is important to observe that marketing costs are likely to increase due to aggressive competition. At the same time, the strategy to substitute the wholesalers will push up the relative share of the transport costs.

Delivery time:

In the case of detergents the delivery time can be defined as the time span between the identification of a purchase need by the retailer and the reception of the order by her. Most products are delivered to wholesalers, which implies that the delivery time between wholesalers and retailers is beyond the control of the producers.

The most relevant competitors of CleanCo currently have delivery times between 15 and 25 days. However a drastic change is expected, due to the influence of Tempest and Tornado. The delivery time will probably decrease to no more than 5 days in 2-3 years.

In the case of CleanCo, the average delivery time can be divided in the following components:

Order registration	*1 day*
Order processing (incl. credit and discount approval)	*5 days*
Order preparation	*1 day*
Transport	*4 days*
Backorders 5%, 20 days delay	*1 day*
Subtotal	***12 days***
Wholesale - retail	*8 days*
Total	***20 days***

As follows from the above information, the critical components for the delivery time are order processing, transport and the delivery time between wholesale and retail.

Environmental impact:

For the purpose of the present analysis, environmental impact was defined by CleanCo in terms of the perception of the final consumer. In the case of detergents, the following elements should be considered to influence this perception:

- ✓ *The formula: raw materials, chemicals, concentration, etc.*
- ✓ *Packaging materials: type, size, amount, weight, etc.*
- ✓ *Process: environmental efficiency (water-, energy- and raw material consumption; level of pollution).*
- ✓ *Certification and recognition: compliance with standards (like ISO 14.000) and "green labels".*

Since environmental concern is relatively new for Germland, the ABC companies have little or no knowledge and experience to this respect. In the case of Tempest and Tornado, environmental concern among consumers in their home markets has been an issue since the beginning of the seventies. For this reason they count on a 25 year experience in the definition and implementation of environmental strategies.

In the case of Germland the formula and packaging materials are considered to be most important for determining the environmental perception of the consumers. "Green labels" and certification are not perceived as critical on the medium term.

Selecting the most relevant technological elements

The next step is to select the most relevant technological elements. At this stage, no formal evaluation will be done. The purpose of the step is to select around 10 - 15 elements for further evaluation.

While identifying the technological elements, it is important to be consistent in determining the adequate level of the elements. In the case of "equipment", defining an element like "production equipment" would be to general, while "labeling machine" might be to specific. In this case "bottle filling lines" would be appropriate. At the same time it would be irrelevant to compare "bottle filling lines" with "telephones" instead of "communication equipment"

The above does not exclude that once it is determined that the technology used in the "bottle filling lines" is critical in relation to the competitive factors, it turns out to be the labeling machine which is the bottleneck. However, for the average participant in the self-diagnosis it will be too complicated to relate the labeling machine to "price" or "environment".

Case example: CleanCo

In the following table the results of a brain-storming session in CleanCo on the relation between the technological elements and the competitive factors are presented. Since no formal evaluation is being made, elements are only mentioned once. For example, Filling lines is related to both price and delivery time, but since it is mentioned in the price-equipment cell, it is not repeated in the next cell. Elements which were considered to be important for further evaluation are marked with "bold".

For the convenience of the participants in the brain-storming session, the most relevant aspects of each competitive factor have been listed in the first row of the table.

Competitive Factor **Technological Aspect**	**Price** Raw materials Administration costs Production costs Margin wholesalers	**Delivery time** Order processing Back orders Transport Wholesale - Retail	**Environment** Formula Packaging Process efficiency Labels and certification
Equipment	**Filling lines** Warehouses	Communication equipment	
Information Technology	**Financial administration software** **Production planning and monitoring software**	Computer equipment	
Human resources	**Flexible functions**	**Organizational culture**	
Logistics	**Decision making processes**	**Transport planning**	
Product and process technology	Quality assurance system		**Packaging materials** **Cleaning agent**

Quantifying the relation between the technological elements and the competitive factors

With the results generated above, the quantification of the relation between the technological elements and the competitive factors can be done. For this purpose, the "strength" of the relation between de technological element and the competitive factor is multiplied by the relative weight given by the market demand, as will be shown in the continuation of the CleanCo example.

Case example: CleanCo

In the following matrix, CleanCo listed in the column to the left all the Technological Elements previously defined. Afterwards, they rated the relationship between each Technological Element and each Competitive Factor:

CleanCo - Competitive profile Detergents							
TECHNOLOGICAL ELEMENT	**Price** Raw materials Administration costs Production costs Margin wholesalers		**Delivery time** Order processing Back orders Transport Whole sale - Retail		**Environment** Formula Packaging Process efficiency Labels and certification		**Relative Importance**
Market Demand (from II.3)		**32%**		**38%**		**30%**	
Filling lines	3	32%*1= 0,96	3	38%*3= 1.14	2	30%*2= 0,60	0,96+1,14+0,60= **2,70**
Financial administ. software	3	0,96	4	1,52	0	0,00	**2,48**
Production planning and monitoring software	2	0,64	3	1,14	1	0,30	**2,08**
Flexible functions	1	0,32	2	1,36	0	0,00	**1,64**
Organizational culture	2	0,64	3	1,14	4	1,20	**2,98**
Decision making processes (decentralizing)	3	0,96	4	1,52	0	0,00	**2,48**
Transport planning	2	0,64	4	1.54	2	0,60	**2,78**
Packaging materials	3	0,96	1	0,38	4	1,20	**2,54**
Cleaning agent	1	0,32	0	0,00	4	1,20	**1,52**

The rating in the above matrix has been given in accordance to the following classification:

0 = irrelevant: *the Technological Element does not have any relationship with this particular Competitive Factor.*

1 = of little importance: *there is some relationship between the Element and the Competitive Factor, but it is of almost no relevance.*

2 = of certain importance: *the Technological Element is not a determinant of the Competitive Factor, but it influences it.*

3 = very important: *the Competitive Factor is very influenced by this Technological Element.*

4 = of critical importance: *the Competitive Factor will not reach an appropriate level if the performance of this Element is not completely satisfactory.*

As an example, CleanCo assigned a "3" to the relationship between "Filling lines" and "Price", since they considered that the impact of adequate filling lines on the price of the products was "very important".

*Then they multiplied the Market Demand (from the Competitive Profile matrix, section II.3) by this relationship: 32% * 3 = 0,96. They applied the same procedure for all the relationships between each Technological Element and each Competitive Factor.*

Finally, in the column to the right they calculated the ***Relative Importance*** *of each Technological Element by adding the values obtained for its relationship with the three Competitive Factors. Once again, in the case of "Filling lines" the procedure was: 0,96 + 1,14 + 0,60 = 2,70.*

This table offered valuable information for CleanCo, since they were able to determine the most relevant Technological Elements. They become more evident when listing them in descending order, according to their Relative Importance:

Technological Element	Relative Importance
Organizational culture	2,98
Transport planning	2,78
Filling lines	2,70
Packaging materials	2,54
Financial administ. software	2,48
Decision making processes (decentralizing)	2,48
Production planning and monitoring software	2,08
Flexible functions	1,64
Cleaning agent	1,52

The next step is to determine the **Technological Position** of the Technological Elements. For this purpose it is necessary to evaluate each Technological Element, in relation to the technological state of the art. In this case various points of reference can be taken: the global leader, or the leader in the markets where the company is competing; the present situation or the (expected) future situation.

In general we would advise the refer to the expected level of the market leader at the markets where the company aims to compete.

The mathematical procedure to be applied to obtain the Technological Position is the following: the Relative Position is multiplied by the Relative Importance (from the last matrix) and divided by 4. Referring to the first line of the following example, the calculation is: 1 * 2,70 / 4 = 0,68.

By subtracting this value from the relative importance, the "Technological Gap" can be determined (first line of the next example: 2,70 - 0,68 = 2,02). The higher this value, the stronger the potential impact of technological improvements on the competitive position of the company.

Case example: CleanCo

CleanCo evaluated its Technological Elements in the following way:

CleanCo - Competitive profile *Detergents*				
	Relative position	**Relative importance**	**Technological position**	**Technological Gap**
Filling lines	**1**	(from last matrix) 2,70	1*2,70/4= 0,68	2,70-0,68= **2,02**
Financial administ. software	**1**	2,48	0,62	**1,86**
Production planning and monitoring software	**2**	2,08	1,04	1,04
Flexible functions	**1**	1,64	0,41	1,23
Organizational culture	**2**	2,98	1,49	**1,49**
Decision making processes (decentralizing)	**1**	2,48	0,62	**1,86**
Transport planning	**3**	2,78	2,09	0,69
Packaging materials	**0**	2,54	0,00	**2,54**
Cleaning agent	**1**	1,52	0,38	1,14

The above table is based on the results of an internal workshop, in which key employees related to production, marketing, selling, and financial activities were invited to participate. It allowed the management of CleanCo to determine the Technological Elements in which they should take immediate action, in order to positively impact their competitiveness.

The following table shows the Technological Elements in descending order, according to their corresponding Technological Gaps:

Technological Element	**Technological Gap**
Packaging materials	2,54
Filling lines	2,02
Financial administ. software	1,86
Decision making processes (decentralizing)	1,86
Organizational culture	1,49
Flexible functions	1,23
Cleaning agent	1,14
Production planning and monitoring software	1,04
Transport planning	0,69

5. Definition of innovation projects

The results obtained above contain critical information for the definition of innovation projects. This will be explained in the continuation of the CleanCo example.

Case example: CleanCo

Taking a close look at the results of the exercise realized by CleanCo, two important intervention areas can be detected:

The first is related to the ***filling lines*** *and* ***packaging materials.*** *In the situation of CleanCo the filling lines were a main obstacle for multiple reasons:*

- ✓ *Due to imperfections in the filling lines (bottle filling/closing and plastic bag sealing) considerable amounts of (semi)finished products were being lost (in some cases up to 20%). This has a considerable impact on the costs of raw materials, which is the main cost component of the final product. This also has a considerable impact on the environment.*
- ✓ *Lack of flexibility in the production process was pushing up stocks in the warehouses, while at the same time creating backorders through shortages of finished products.*

At the same time the packaging material most used was plastic (bottles and bags), which is known for its negative impact on the environment. Therefore, it was concluded that a feasibility study should be carried out to identify filling equipment that could use more environmentally friendly packaging materials and which would facilitate shorter set-up times. At the same time, the materials used and the filling method applied should guarantee a considerable reduction in the quantities of lost (semi) finished products.

The second project refers to the ***administrative procedures.*** *As we saw before, the administrative area represents the second biggest cost component. As followed from the discussion during the corresponding sessions, software support is poor in this area, but at the same time the dispersion of tasks and the hierarchical decision making procedures was creating duplication of work, considerable delays in administrative procedures (like order processing) and lack of information due to delays (like stocks of finished goods). The typical solution for such a situation is a Just In Time or a Reengineering exercise, which was also the project selected by CleanCo.*

ANNEX 1:

QUESTIONNAIRE
INFORMATION FROM YOUR CUSTOMERS

In order for you to obtain fast and more reliable information regarding the criteria on which the buyers of products and/or services like yours base their purchasing decision, we provide you with a small questionnaire that you can use with some of your clients.

This questionnaire will also provide you with useful information about your competitive position in relation to your main competitors, the level of satisfaction of your current customers with your products and/or services, and other important characteristics about the markets in which you compete.

We recommend to adapt the questionnaire to your particular characteristics and needs, and send it by fax, or just have someone phone call some people in your target group, including former, current and potential customers. You will rapidly obtain useful information that you can use to redefine your strategies and to implement changes in your products and services.

QUESTIONNAIRE

We will highly appreciate your filling out the following questionnaire. Your answers will help us improve our products and services by fully satisfying your needs.

When choosing your supplier, what factors do you take into consideration? Rank the following factors in ascending order (assign "1" for the most important factor, "2" for the next one, and so on)	FACTOR	**How would you rate our company?** Rank the following factors in ascending order (assign "1" for the most important factor, "2" for the next one, and so on)
	Fulfillment of delivery dates	
	Environmental considerations	
	After sale service	
	Quality of the products or services acquired	
	Interest shown by the supplier's employees in my needs and concerns	
	Manners of the supplier's employees	
	Guaranty	
	Price	
	Flexibility to introduce changes in design	
	Flexibility to introduce changes in volume	
	Other (please specify)	

1. Which are the most important reasons that make you buy our products/services?
   1. _____
   2. _____

2. How did you know about our products/services?

   _____
   _____
   _____

3. What do you consider "a good quality product or service"?

   _____
   _____
   _____

4. What do you like from our company?
   1. _____
   2. _____

5. What do you think that we can improve to serve you better?
   1. _____
   2. _____

6. What do you like from our products/services?
   1. _____
   2. _____

7. What do you think that we can improve in our products/services to better satisfy your needs?
   1. _____
   2. _____

8. Any additional comment?

   _____
   _____
   _____
   _____
   _____

Thank you!