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Product Development and Manufacturing in High Cost Countries - Restrictions and Options

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Abstract
This paper examines the process of product development in high cost countries. The main intention is to point out how product development can be successful in high cost countries under a comprehensive, long-term point of view.

During the last years, it has become increasingly popular to shift production plants to low cost countries: The main intention of the companies is cost saving.
However, a closer look reveals that this effect is not reached as often as it would be expected. One reason is that the potential cost savings are for the most part due to the reduction of labour costs and depend only to a limited extend on other expenditures such as raw material costs. Of course, the labour costs are much lower in countries like Romania etc., compared with France or Germany. However, if the percentage of labour costs is low, the saving effect is small, too. In any case, the effect of cost savings is limited to labour costs as the transferred products are generally produced in the low cost countries with the same technical process than in the high cost ones.

Obviously, from this point of view, it would make more sense to transfer tasks with a high intensity of labour costs, such as product development (R&D), to low cost countries. Additionally, from an economic point of view, it would be reasonable to shift product

development departments, especially if the production was already transferred. Nevertheless, from the point of view of many politicians – and also from many companies - these tasks should remain in the high cost countries.

Indeed, there are a lot of disadvantages if both the production plants and the product design and manufacturing departments are transferred. The paper wants to focus on the problem of removing the core knowledge of a company to low-cost countries and proposes at the same time a model how the product design and R&D departments can be efficiently hold in the high cost countries.

Keywords: Product design, product development, high cost country, low cost country, strategy, technological and commercial requirements.

1 Introduction

For a number of years, the manufacturing of products in low-cost countries has been popular, resulting in the closure of many production plants in high-cost countries and the transfer of production to countries where the costs for labour are lower. The reason given for such moves is that they save costs. However, when total costs and benefits for the companies are taken into account, the savings are not as high as expected. In fact, only 20 per cent of companies actually benefit from moving production abroad [1]. Even in cases where costs could be saved by moving to low-cost countries, there are nevertheless opportunities to develop and produce in high-cost countries, if the strengths of these areas are utilised and the product is designed for high-level manufacturing.

Recently, companies are increasingly considering how to keep production in high cost countries or to bring it back to these [2]. Furthermore, also the scientific side is taking care about this subject [3, 4, 5] which is now assisted more and more by funds from the government [6].

This paper describes the restrictions and opportunities for development and further activities such as manufacturing in high-cost countries.

2 Reasons for transfer to low cost countries

There is a very big difference between labour costs in Germany and China. Even within Europe, there are big differences if the cost per labour hour is taken into consideration (Table 1). For example, in Romania the cost per hour is 6% (2.34 Euro per hour) compared with Germany (39.02 Euro per hour)and even a geographically close country such as Slovakia has only 14% (5.39 Euro per hour) of the German labour costs.

Country	Labour Cost in Euro per Hour
Germany	39.02
USA	31.14
United Kingdom	24.27
France	24.21
Italy	23.19
Czech Republic	6.60
Hungary	7.83
Slovakia	5.39
Romania	2.34

Table 1. Labour cost per hour in different European countries [7]

So, at a first glance it seems convenient to transfer the product development and manufacturing to low cost countries to save costs as they are labour-cost intensive.

To give an overview of portion of the labour cost in comparison with the total prime cost, the following rough calculation was made. The data come from different sources [7], [8], [9] and empirical information belonging to the authors. The schema for cost calculation from figure 1 serves as a base for further analysis.

2.1 Consideration of the labour cost in manufacturing

In the following consideration, a common structure of the cost calculation process, leaned on [10] is used (Figure 1). The prime costs are including production, R&D, administration, sales and special sales costs. The production costs are split into material, labour and mounting costs; the material costs are divided into raw material and overhead, the labour costs into raw labour and overhead.

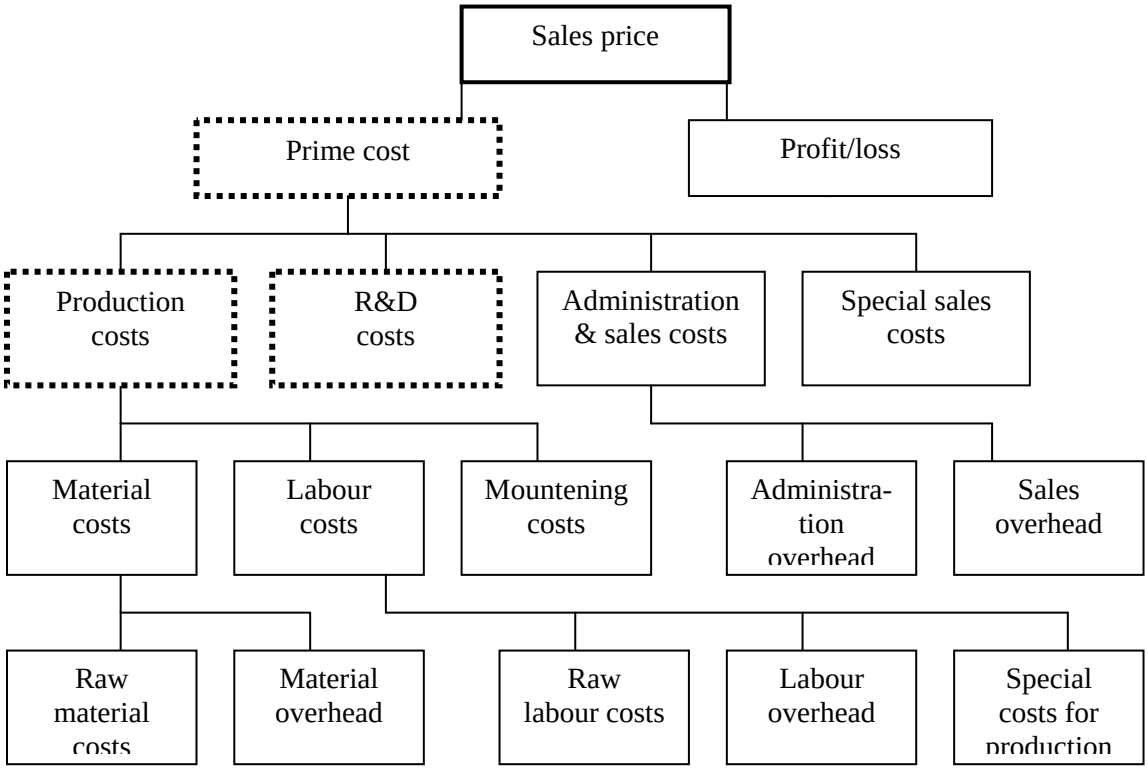

Figure 1. Principle cost calculation, leaned against [10]

The raw material costs are approximately 40 percent of the total prime cost and the overhead is 4 percent. If we have a look at the manufacturing costs, they are 10 percent with an overhead of 13 percent. If it is taken into account that both the material overhead and the labour overhead consist of 50 percent of labour costs, the part of the labour cost, based on the prime cost, is 9 percent. If the 10 percent raw labour costs are added, these costs are in total 19 percent. If the material costs and the overhead that is not depending on the labour are added, there is following result:

Labour: 19 percent – Material and not labour depending costs: 49 percent.

In total, these costs include a portion of the prime cost from 19 plus 49 percent, in total 68 percent. According to our rough estimation, this implies that if only the manufacturing plant

was shifted to low cost countries, it would only be possible to influence the labour cost to a total extent of 19 percent of the total prime cost. The material costs, such as steel and oil, are in a world wide purchasing process more or less the same and are generally not depending on the location where they are used.

If the manufacturing plant was shifted from France to Romania, approximately 90 percent of the labour cost could be saved; as a consequence, these costs would be reduced from 19 percent down to 2 percent. So, the prime cost would be decreased from 100 percent to approximately 83 percent. This means a cost saving from 17 percent.

However, in a comprehensive point of view, also additional costs have to be taken into consideration if the location is moved to low cost countries such as

- Cost for shifting the production plant
- High additional cost to make the plant running
- High cost for coordination
- Additional travelling and transport costs
- Different quality standards in different countries
- Communication and language problems
- Intercultural differences

If the production lines are transferred to other countries, they have to be dismounted, transported and mounted again. After that, the quality of the line has to be adjusted again to make it running as before. The new employees have to be trained, in the best case before the manufacturing plant is dismounted. So, for the new employees high costs for training have to be taken into consideration. On the other hand, the quality standards in low cost countries are on the whole lower, compared with high cost countries. The high initial training effort and the quality problems as well as the cost for the transfer of the plant have to be considered. Furthermore, during this process, no production is running and the cost of the production equipment brings no cost savings.

If the plants are built completely new in the low cost countries, some of the mentioned costs such as for training will be the same, but some as the costs for the transfer of the plant will drop. However, if the same technology is used, the cost for the manufacturing equipment will be similar. So, other methods are needed to save costs: The process has to be adjusted more for handmade production and assembly. Only in this case, a higher benefit can be expected. However, handmade production implies in most cases less process stability and the risk of more failure. In automotive business in high cost countries, the required quality is very high, so handmade production makes no sense from a quality point of view.
Especially during the shift period of the manufacturing plant, there are high additional costs for coordination. For example, a lot of trained employees need to be sent during the first period of manufacturing to the low cost country to train the local employees - but still on the pay roll of the high cost country. Later, the coordination cost will be reduced if the tasks are more and more shifted to the low cost countries. But nevertheless, the big distances still will cause a lot of additional costs if the need of communication is considered: International flights, internet communication – but also a loss of data and information over the big distance will cause supplementary expenditures.
Even shifts of plants within Europe can cause problems because of different intercultural behaviour and thinking. Examples are different standards of quality, but also different perceptions of values and time as well as diverging communication or negotiation

philosophies. Language problems are often difficult, too, because not everybody will be able to speak the fixed common language and according to the intercultural differences, even the perceived significance of the language can differ. This goes both for Europe and even more for non-European countries like China where intercultural misunderstandings can cause a high time consumption and coordination effort. The results are additional costs, too.

All these problems have to be taken into consideration over a longer period of time during which much less than 17 percent of the prime cost savings can be reached due to the discussed additional costs.

2.2 R&D costs and the shift to low cost countries

So far, we have discussed the influence of labour costs in general. The costs for product development are approximately 8 to 9 percent, according the upper mentioned sources. If we count with that number, it is necessary to have now a closer look at the structure of the labour cost of R&D. If the R&D is outsourced, the price per hour is around 50 Euro. If the costs for the engineer are considered, it is seen that these are 50 percent. The rest includes buildings, equipment, such as computers, software licences, administration and so on. Some of these costs are more or less identical around the world, such as licences for software. The rest can be influenced, e.g. the rent for buildings or costs for administration. In total, approximately 50 percent of these remaining costs can be influenced by outsourcing into low cost countries, the same as the labour costs.
That means over all, around 75 percent of the R&D costs can be influenced by a transfer to low cost countries. That means, from these 8 percent of the prime costs for product development, 6 percent can be influenced by a transfer.

If it is compared with the share of production cost in percent, it would make more sense to shift R&D to low cost countries than production. Of course, the amount of money which could be saved would be much higher in production. Nevertheless, it would make sense to transfer product development to low cost countries, too, if only these figures were taken under account.

However, the transfer of R&D implies a lot of disadvantages:

- Loss of knowledge in the high cost countries
- Cost for shifting the product development
- Lower output per hour
- Mostly lower quality
- Intercultural differences
- Big distances to customer
- Communication problems
- Risk of data loss

At the other side, it is reasonable to locate the product development and manufacturing together, because a close relation of these two departments makes sense in order to develop and to manufacture besides each other. So, the knowledge transfer is running smoothly. However, if both are transferred to low cost countries, also the knowledge will be transferred and will be lost in the high cost countries. Additionally, most of the remaining departments, such as administration, will be transferred to low cost countries because there can be saved money as well.
Of course, this shift of the product development causes in principle the same problems as mentioned in the previous section. The output per hour is in most of the low cost countries

worse, compared with high cost countries and the same is valid for the quality of the developed product.
Nevertheless, the training and education has been improved a lot during the last decade in many low cost countries. For example, in India the engineers for the software development are well educated. At the same time, the motivation is high as there is often a huge pressure in order to improve the social standing. So, these people are often working hard and the still remaining lack of knowledge will disappear during the next years, similar to what has occurred in Japan. After the second world ware, Japan faced a similar situation than India today and managed to reduce the lack of knowledge and skills within some decades.
Similar developments can be observed as far as regards the quality of the work of the designers. The knowledge to develop – instead of producing and selecting - quality becomes more and more aware into the heads of the employees.

Regardless of these positive developments, also here intercultural and communication problems are likely to appear. That means there will be still high costs for coordination and travelling.

The above discussion shows that there are different pros and cons for transferring the R&D to a low-cost country – or to keep it in the high cost one. Furthermore, independently from the supplier's decision, a company will often be forced to maintain product development nearby the customer.
So, there could be one more reason to shift product design departments to low cost countries. Indeed, several big companies place product development in low cost countries in order to make product application for their customers and keep at the same time the development of new products in their native countries.
But the border between product development and application is fluid, so why not take the advantage of lower salaries in the customers' countries?

2.3 Summary and application to different branches in the industry

The discussed numbers are not valid in general, but they are reflecting main tendencies.
For example, in mass production of products with low complexity, the development costs can be 5 percent of the prime costs and in very specific manufacturing equipment, even 15 percent are possible. The same goes for the share of raw material costs.
Depending on these numbers, it makes more or less sense to shift one or another department to low cost countries.

3 How to keep business in high cost countries

In order for production in high-cost countries to be viable, labour costs must be a very small part of the overall prime cost. In order to achieve this objective, products must be developed for automated production.
Our argumentation deals in very general terms with costs for labour and raw materials. A more differentiated view would have to include all aspects of costs and prices, and the market situation for each product.

3.1 Labour and labour overhead cost for automated production

To enable production in high-cost countries, the quantities produced have to be high in order to reduce R&D costs per unit, and to enable automation in the manufacturing process. Product development thus has to be for automated and highly-integrated production, in order to keep labour costs down to a low proportion of the overall prime costs.
A project in Dresden, recently reported in the Handelsblatt [11], deals with exactly this point. In this case, the operating costs for the manufacture of chips (wafers) in Germany are not

higher than in Asia. The reasons for this are simple: 87% of costs are for buildings and technology, and only 13% for personnel and energy. Salaries for engineers and managers in Asia are also now similar to those in Germany. The results of the project also emphasise that the developers need constant feedback from production; failure to control the whole production process will, in the long term, result in loss of competence in R&D.
If you take into account the fact that there are a lot of extra costs involved in relocating production to low-cost countries, such as travel expenses, building a new plant and so on, the prime cost of high-cost countries can be competitive. Of course, the level of automation needed reduces the number of workers in the first stage, but for high-tech production, which requires a lot of know how and highly qualified people are needed. And there will be new jobs for example in design and manufacturing of the production equipment, which are mostly located in such high-cost countries.
Furthermore the suppliers will have better conditions to settle in these continents too.
The alternative would be production in low-cost countries, which means, perhaps one person in the purchasing department will remain and all other workers will no longer be needed any in the high-cost countries.

Of course there are many further points which have to be taken into account, such as

- Infrastructure
- Taxes
- Education and knowledge
- Motivation of workers.

These so-called location factors have been subjected to intensive analysis and regarded as highly significant in special location change models [12]. According to these, it is important to consider the orientation for each company (e.g. orientation towards materials, work, taxes, energy, turnover, logistics) in order to identify and allocate weighting to the location factors. The location model is then used to reach the required optimisation. In this optimisation process, it is necessary to decide whether the model should be oriented to profits, costs, return on investment, or other criteria.
If the orientation is towards sales, costs and the quality of the product, and thus customer satisfaction, play a special role. Customer satisfaction should be the most important consideration, but is very difficult to assess (as shown in the recent discussion on Customer Relations Management).
Let us assume that the customer satisfaction with products from high-cost and low-cost countries is the same. We then come to the subject of the price calculation, or unit costs. We do not, at this point, want to go into the relative advantages and disadvantages of full costing or direct costing, just to point out that in comparing R&D and production in various countries, the “correct” allocation of unit costs and contribution to profitability in order to cover the overheads is decisive. An example of this is forgetting to add the costs for the headquarters (administration, finance, R&D, distribution, etc.) in the correct proportion to the costs of production removed to a low-cost country. This must be done according to a formula which properly takes into account the cause of the costs.
A further important point is to be identified in the ancillary wage costs. These are largely dictated by the laws of the country involved (health and pension insurance, social security payments, etc.) and can often be nearly as high again as the actual wages. This needs to be observed carefully in the comparison. The more units produced and sold, over which these overheads can be spread, the smaller the proportion of the price, thus maintaining the competitiveness of the high-cost country.

3.2 Consequences for the Product development and further departments

The R&D department requires a sound knowledge of production processes in order to be able to create products for a suitable product price. Hence there is a close relationship between product engineering and manufacturing necessity, which will no longer be possible if production is re-located to a far-way low-cost country. As a consequence, the R&D and related departments will also be moved to the low-cost country. The labour costs for these departments will also be lower, even if output is lower and there are additional costs for the coordination of the operation. The further question presents itself: Why not also move management to the low-cost countries. The labour costs would be lower. A counter-argument to this is always the claim that there are not enough highly-qualified people in these countries. This may sometimes still be true today, but standards of education and the relevance of education to the real needs of industry is growing too as transfer of knowledge to low-cost countries continues.

To avoid this, manufacturing (but not only manufacturing) should be continued in the high-cost countries, if this makes sense. R&D can also be kept in the high-cost countries, if its quality is higher than R&D in the low-cost countries. Thus the processes and the quality must be much higher in order to compensate for the difference in costs. If the products are designed appropriately for a high level of automation, it will be not easy to copy them cheaply with manual production processes.

Thus, it is essential to improve education, beginning at school, up through universities, going on with continuous further training on the job.

3.3 How to keep product development in high cost countries

Assumed, the transfer of manufacturing and product design department to low cost countries makes sense, if:

- Labour costs are much lower compared with high cost countries
- The share of the labour cost in total are high
- No definite requirement for the shift is given

A big benefit for the transfer to low cost countries is only given, if the shares of the labour cost are, as mentioned, in total high. So, if production plants have only a small part of labour cost, it can be hold in high cost countries.

To manage this, there are different restrictions. One is the product has to be designed for mass production, to reduce the share of labour cost. An other is, higher quantities of parts are needed which are planed to produce. If there are different variations, the management of these has to be very good, form the design point of view, as well as from the manufacturing.

Of course, in a first step, less employees in the manufacturing field will be needed, but on the other hand, the working places can be hold in high cost countries. If these working places remain, it makes less sense to transfer the product design departments to low cost countries, because a close link between product design and manufacturing is needed to design for manufacturability.

In production plants, there will be new jobs, because automation needs higher qualified workers, which are mostly available in high cost countries. This is the main strength of these countries and should be worked out more in the future.

It will not be possible to buy the new complex manufacturing devices in low cost countries, because of the complexity and the need to have close relation design/manufacturing in this case too. That means, there will be created new jobs to design and produce this manufacturing equipment.

Subcontractors will be perhaps close to the customers too, so they will produce in these high cost countries, because there is no statistic need to go to low cost countries.

The high degree of manufacturing brings further benefits. For example, the automated manufacturing processes can be made for higher statistic product quality, compared with hand assembly. The working conditions for the employees can be made with high level automated processes more convenient, so the output can decrease and the lost working days, lost by disease.
So in total the labour cost will decrease additional.

Overall the employment rate will increase in the first step, in the second the employment rate will increase again. Especially the first period is not good, but the alternative, to shift of the product development and manufacturing to low cost countries means the lost of more jobs and the knowledge will be lost too, which will be the main problem in the future.

Of course, if a customer in a low cost country pushes a subcontractor to produce in his country, this will be perhaps a strategy, which is often followed. This can be supported by the tax system of some countries.

4 Conclusion

In general, there are good and bad sides of shifting product development and manufacturing from high to low cost countries. This process brings a benefit only, if the shares of labour costs in these processes are high, because these costs can mainly be influenced by shifting the departments to these countries. If there is an analysis, only some shifts bring real benefit. Mostly the expected result is behind, because the share of labour was too small and a lot of additional factors are not considered, such as intercultural problems which consume extra costs.

To keep product design and manufacturing in high cost countries, the products have to be designed for automated manufacturability to reduce the part of labour costs. One condition to reach this target is high quantities or similar products.

This is the way to preserve employment in these countries in the future, and to increase knowledge and competence in R&D. In a long term, these high automated manufacturing processes will created a strong need for more and high qualified employees, which are available in high cost countries.

So it is possible to design and manufacture products in high-cost countries if the conditions are suitable. If this is not done, we will become a “third world” country in the future. It is not possible for a country to survive on services alone.

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