Proceedings of the 19th CIRP Design Conference – Competitive Design, Cranfield University, 30-31 March 2009, pp229

# Design for Low-Cost Country Sourcing: Motivation, Basic Principles and Design Guidelines

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**Abstract**
Not every product can be successfully sourced in low-cost countries. Disadvantageous cost structures or extremely complex workpiece designs are the most frequent reasons for failures. A design that has been tailored to low-cost country sourcing offers the possibility of increasing potentials while reducing risks and costs at the same time. The wbk Institute of Production Science at the Universität Karlsruhe (TH) developed a new approach which ensures that the product design meets the requirements of the supplier. This paper identifies the factors influencing the design, deduces basic principles and illustrates guidelines for an adapted product design.

**Keywords**:
Design for X, Low-Cost Countries, Global Sourcing, Product Development

## 1 INTRODUCTION

Increasingly global markets are providing the possibility of sourcing, manufacturing and distribution of products in every part of the world [1]. Competitive prices are the precondition for gaining market shares in the domestic market as well as abroad [2]. The fierce cost competition is forcing companies to focus on their core competencies and to pay particular attention to their purchasing decisions. Several studies show that supply part costs currently represent 60-70% of production costs [3-4]. Thus, production itself can only offer a limited savings potential and cost reduction throughout the whole supply chain is necessary to remain competitive. Furthermore, shorter product life cycles and reduced non-value adding activities, such as the inspection and testing of received parts, are forcing companies to co-operate with their supply partners along the entire supply chain [1]. As a result, the purchasing division, a mere operational procurement department in the past, is increasingly becoming a strategic entrepreneurial planning body. Figure 1 shows the impact of purchase on corporate profits and productivity. The EBIT (earnings before interest and taxes) in engineering therefore increases by 11%, if purchasing costs are reduced by 1% [5].

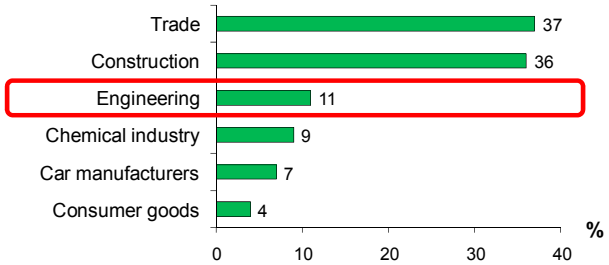



Figure 1: Increase in EBIT at a cost reduction of 1% in purchase [5]

Global procurement markets provide the basis for competitive and cost-effective products. In procurement, **low-cost country sourcing** plays a special role as considerable cost savings can be realised in this area [6-7]. In times of increasingly globalised and liberalised markets companies are required to tap these potentials in order to remain competitive.

Great sourcing opportunities in emerging markets [8-12] in the shape of cost reductions and market developments go hand in hand with huge challenges [8-10][13-14] (see Figure 2).

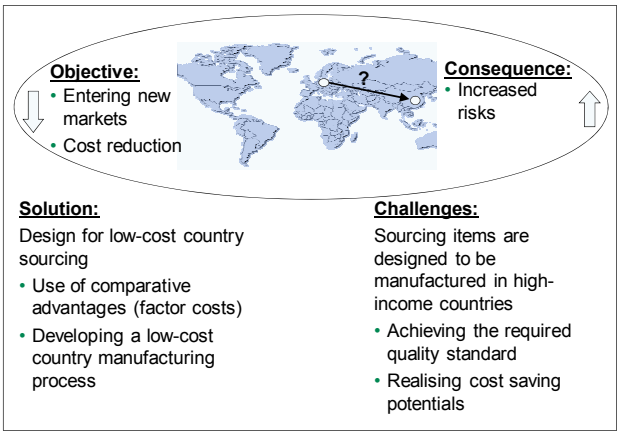



Figure 2: Interdependence of objectives and risks in low-cost country sourcing

Even relatively simple bulk products represent a considerable challenge to the purchasing department [14]. Major problems arise from insufficiently qualified low-cost suppliers, particularly with regards to quality control, production planning and manufacturing equipment [15-17]. Low-cost suppliers often do not meet the higher quality standards which are required by multinational companies. Even if promising suppliers were chosen, measures to promote development such as technical support and continuous process control at the supplier's production site are necessary in order to guarantee a reliable product quality as well as on-time delivery [15][18].

Low-cost country sourcing is stimulated by low labour costs and the new future markets that can be developed. A study has shown that labour costs which account for only 22% of those in Germany are no guarantee at all for a decrease in purchasing costs [19]. The study reveals that one in three companies pay more for sourcing their products in China than they would pay for procuring them at the local German market [19]. The companies that

were interviewed as part of this study showed a savings margin between 48% and -16% for sourcing in China in comparison to local procurement. Another study reveals, that only 28% of Western companies are very satisfied with the service quality of low-cost suppliers [20].

Although low-cost countries are suitable for the production of a range of products, the examples mentioned above show very clearly that not each and every component can be successfully sourced in low-cost countries. The success of low-cost country sourcing projects is not only influenced by the respective cost structure but by several other elements and component requirements as well. The necessary technology and existing complexities of the workpiece design have an impact on the manufacturing of a product by a low-cost supplier. Companies that are considering having assemblies, components and products manufactured by a supplier in a low-cost country should therefore think about adapting their design to the local conditions.

## 2 CHANCES AND OPPORTUNITIES OF DESIGN FOR LOW-COST-COUNTRY SOURCING

A number of guidelines for *Design for Manufacturing* (DfM) already exist, i.e. product design which meets manufacturing requirements [21-22][28-30]. These guidelines, however, were implicitly created for the manufacturing conditions in the established industrial states, the so-called high-income countries. Components are oftentimes manufactured on state-of-the-art technological equipment and therefore show a very high level of complexity [23]. High-income countries focus on automated production processes in particular which represent a reliable approach to cost reduction without cutting back on quality. To allow an automated production process, specific design requirements already have to be considered in the development phase. The attempt to transfer this paradigm to other countries as well is partly responsible for the fact that outsourcing and procurement projects in low-cost countries were accompanied by unexpectedly high costs and/or quality issues or even failed because some products simply cannot be manufactured by low-cost suppliers.

If it is clear, however, as early as during the development phase that a component is to be purchased in a low-cost country, the complexity of this component can be adapted to the capabilities of the supplier without cutting back on its functionality. A special design provides the opportunity to increase the potential of low-cost country sourcing while reducing its risks. Furthermore, the design can be constructed in a manner to better exploit the comparative advantages (e.g. wage, energy and machine-hour costs etc.) of low-cost countries and to realise an extensive cost savings potential by adapting production to the local conditions. It has been, for example, pointed out that an adapted product design can increase the degree of manual labour involved in the production – as an alternative to a capital-intensive automated production [24]. This means that only a limited amount of capital is tied up and flexibility is increased [24]. Abele as well favours an adapted product design for the production in less developed countries [23]. This typically leads to less demanding, smaller process steps. On the one hand, this provides the possibility of realising long-term cost advantages. On the other hand, it represents a measure to face the lack of experts which is observed in many emerging markets and which, according to recent estimates, is very likely to increase [32]. Experts are basing their opinion on a necessary re-design of products which incurs short-term modification costs. If the specific needs and characteristics of low-cost countries are considered right from the outset, when the design is agreed upon, no major costs will incur for adapting the product to low-cost country conditions (see Figure 3).

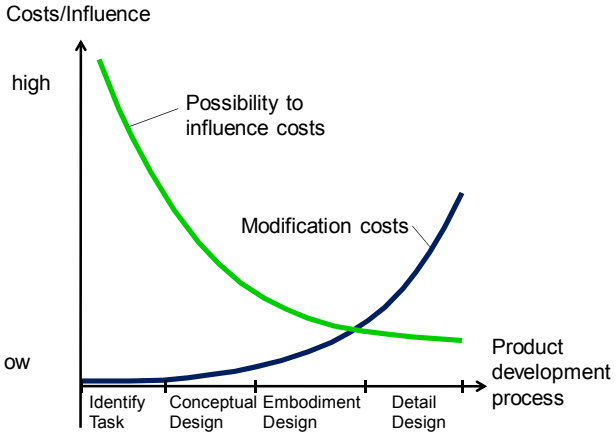



Figure 3: Modification costs and possibilities of influencing costs during the product design phase [25]

Moreover, the early product design stages offer, in general, more possibilities to influence product costs (see also Figure 3). The earlier the objectives of low-cost country sourcing are integrated into the product design process the higher the chances are to reduce costs and entrepreneurial risks. Innovative product design also paves the way for a considerable reduction of the effort and time needed to further develop and support suppliers, as this is often necessary to guarantee the required quality and productivity [23].

## 3 METHODOLOGY REQUIREMENTS

The realisation of cost savings potentials while maintaining the required quality standards represents an objective of low-cost country sourcing which can only be achieved with a systematic and methodical approach. This approach requires basic principles and guidelines serving as a comprehensive toolbox to fully tap the aforementioned potentials of a specific design for low-cost country sourcing. Since the scope of product development and design can never be gathered in all its complexities [22], those basic principles and design guidelines to be elaborated will necessarily be heuristic. This means that the abundance of influencing factors will be deliberately limited in this approach in order to develop suitable and practical solutions by means of simple rules. For this, the identification of general production factors and special aspects of low-cost sourcing is an important first step.

As this paper deals with a newly defined research area, it is essential to provide a basis that paves the way for further research. First of all, this article aims at presenting a structure that provides this necessary framework. The aspects relevant to the further development or re-design of existing products shall be easily identified thus resulting in the creation of a flexible range of design guidelines. These guidelines shall not necessarily be implemented into rigid, dogmatic approaches but rather serve as creative ideas designers can individually adapt [26].

## 4 PRODUCT DESIGN - BETWEEN MARKET REQUIREMENTS AND COMPANY PRINCIPLES

A product draft basically determines the shape, material and manufacturing process of the individual components as well as the joining process for putting them together [25][27]. Design therefore evolves around these three parameters which defines the designer's options.

Shape, material and manufacturing process are highly inderdependent. The ideal functional shape of a component thus depends on the material used. A supporting structure, for example, can come in different shapes, depending on whether it is made from cast iron or welded steel (see Figure 4). The relatively brittle grey cast iron is to preferably loaded in compression and, as a bracket, is therefore to be supported downwards. Since steel, in contrast, is characterised by a high tensile strength, suspended constructions constitute an excellent use of materials.

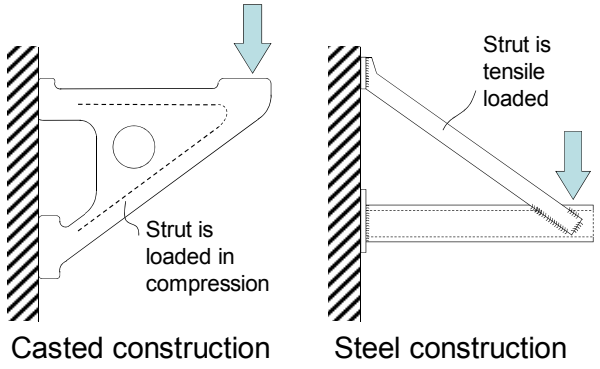



Figure 4: Shape of a cast iron and a steel construction as a result of the material and manufacturing process used

This example illustrates that the shape of mechanically stressed components needs to comply with the characteristics of the respective material in order to achieve a good material utilization while maintaining its original function. This is necessary to manufacture the component cost-efficiently. While in this case the chosen material determines the shape, the correlation between design and material can also be vice versa. If the shape of a component is roughly defined in the design draft, a material is to be chosen which fulfils the mechanical function most efficiently with respect to the given conditions.

There is a third aspect as well which needs to be taken into account: which is the most appropriate manufacturing process? On the one hand, not every shape can be efficiently designed in various manufacturing processes. Since cast iron components must be removed from the mould after casting, drafts are necessary. On the other hand, not every shaping and joining process is compatible with every material. While steel sheets or tubes can be bent into different shapes, the same does not apply to cast iron components.

Ehrlenspiel speaks of the triad of shape, material, manufacturing process [21]. Ashby adds a fourth, equally important aspect: function [27]. While the triad describes the material aspect of the product, functions can be seen as customer requirements (e.g. derived by quality function deployment). Supply and demand form a price that customers are willing to pay which can serve as a basis for the company to determine its target costs. The market, therefore, does not only determine the **function** of a product but also its maximum **cost**. In this context, functions also cover ergonomic, aesthetic and quality features. Since customer requirements can vary greatly with regards to the respective cultural sphere, the regional market particularities are to be taken into account.

Companies themselves add an additional range of requirements which have an impact on the options in product design. Companies set up a strategic and operational framework which forms the basis for product design requirements. If the corporate identity demands that the product is “Made in Germany“, the design must meet the product target costs and functions for production in Germany. Existing supply networks can also create restrictions, such as achieving the aim of a constant and full utilisation of production capacities, for example. Further product design requirements arise from the supplier network. The components in question must be first of all **producible** by low-cost countries. Chapter 1 showed clearly that this cannot be taken for granted. A non-fulfilment of a requirement can *in extremis* lead to the consequence that no supplier can be found who is able to meet the basic preconditions for the order. Should the complexity of the order exceed the supplier’s competencies, severe quality issues might be the result. This could incur additional costs, such as quality assurance measures or supplementary supplier development. “Producibility by low-cost suppliers“, as the major requirement, represents a precondition for achieving the function and cost targets.

The design, therefore, must meet the requirements of the market as well as those of the company. It is the product more than anything – defined by the shape, material and manufacturing process of all components – that provides the link between market and company (see Figure 5).

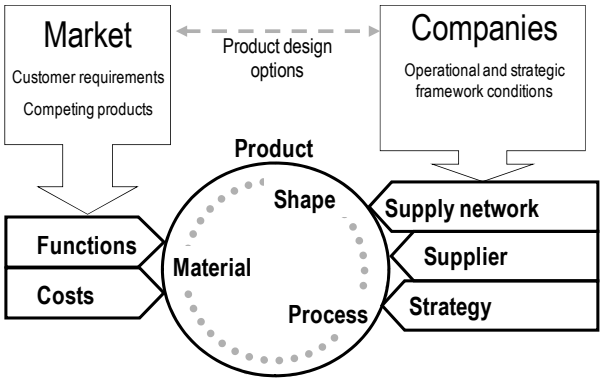



Figure 5: Impacts on product design

## 5 DESIGN FACTORS FOR LOW-COST COUNTRY SOURCING

Basically only a few product design requirements need to be added in order to achieve a *Design for low-cost country sourcing.* Existing requirements, however, need to be weighted differently. Figure 6 shows five essential factors which, with regard to [21-23], need to be taken into account in adapted product development and design: expenditure of labour, processing time, material used, requirements on manufacturing equipment and necessary employee qualification and training. The order of these factors corresponds to the usual hierarchy applied in high-income countries to large-scale production. According to this concept, an extensive use of material, for example, can be accepted if the expenditure of labour can be reduced [21]. With regards to low-cost countries, the order of priorities is vice versa. Since the availibility of employees, in general, reduces in disproportionate terms to an increase in their qualification whereas the costs rise in disproportionate terms to the qualification of the employees. Therefore companies should try to refrain from employing specialists. Due to the technological conditions of these countries, employee qualification and manufacturing equipment requirements are to be reduced. The basic requirement, therefore, is that suppliers must be **able to produce** a specific design (see also chapter 4). If a product **design is adapted to the competencies** of employees and manufacturing equipment, staff and technological requirements are low, suitable suppliers can be found more easily or made possible at all, the risks to incur quality issues are

diminished and procurement prices reduced. Furthermore, quality issues can hereby be prevented.

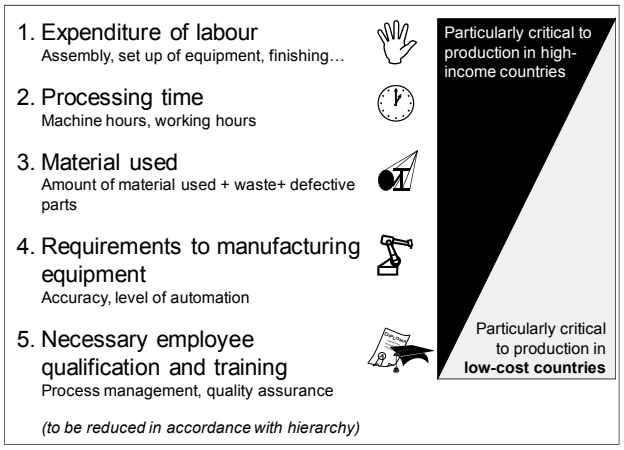



Figure 6: General production factors and their significance with regards to the country that the production is located in

Expenditure of labour, processing time and material used have a direct impact on production costs which will be reflected in the procurement price. The qualitative requirements on manufacturing equipment and employees (point 4 and 5) negatively influence prices as well. The five factors listed above can only be minimised individually to a certain extent. However, compromises are necessary. The hierarchy of these factors serves as guidance to find compromises for each production site. One factor may be improved at the expense of a less critical one but a compromise shall never be achieved at the expense of a factor of higher priority. This concept gives basic orientation. In view of optimisation, the particular factor costs in the sourcing country as well as the cost structures of production in the country need to be finally taken into account. A **design adapted to the cost structure** means that the dominant cost drivers will be reduced by constructive measures.

With regards to low-cost country sourcing, not only the five general production factors are to be considered but the aspects illustrated in Figure 7 as well: different cultural and specialist background of suppliers, long hauling distances, tariffs and taxes, costs for coordination and support, product piracy and knowledge drain as well as the dynamics of framework conditions. The eleven major factors will be looked at individually in the following.

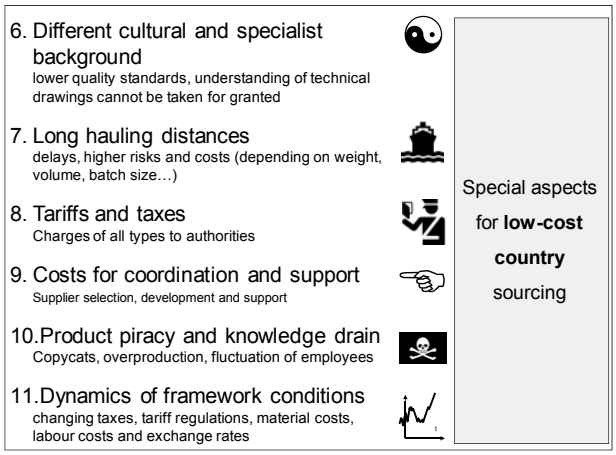



Figure 7: Special aspects of low-cost sourcing

### 5.1 Expenditure of labour

Since labour costs in low-wage countries are *per definitionem* lower, the use of labour can be increased. Companies can hereby refrain from a strongly automated manufacturing process which, in turn, reduces high initial investment costs and cost of capital on the one hand, and, on the other hand, lowers the requirements on the production equipment as well as on employee qualification and training. Complex manufacturing equipment always needs to be set up, monitored and maintained by specialists.

### 5.2 Processing time

The processing time is used to allocate the machine hour rates and wages to the units produced. The higher the processing time, the higher the costs per unit. Since labour costs and machine time in particular are cheaper in low-cost countries, a higher processing time is acceptable if this leads to benefits in other areas. It is therefore possible, for example, to use a cheaper material which requires a slower production process.

### 5.3 Material used

Although the factor of material used was considered of relatively medium importance in Figure 6, it is of higher priority in absolute terms. This is to be explained by the fact that the relative share of material costs in production costs in low-cost countries is usually higher than labour and machine hours, for example, are cheaper. The economic use of material, thus, accounts for a relatively sharp reduction of the total costs. Ehrlenspiel et al. recommend in this respect also minimizing material costs for production in China [21]. By substituting material costs with labour costs, it would be possible to reduce the amount of material used if, for example, several parts were joined manually instead of machining components from a block – a procedure which is labour-saving but material-intensive. Furthermore, as early as during the design phase, it needs to be taken into account that material shall be used which can be procured from local suppliers in order to prevent the use of expensive imported material.

### 5.4 Requirements to the manufacturing equipment

The machine-hour costs in low-cost countries are, in general, lower than in high-income countries. Precision and reliability though are oftentimes also lower if local equipment is used [6]. In order to prevent product quality issues, relatively low requirements are to be set to the manufacturing equipment. This is part of the basic principle of creating a **design adapted to the competencies** of the supplier. These requirements and their fulfilment are also **adapted to the cost structure**, since the investment in high-quality manufacturing equipment in low-cost countries is relatively expensive compared to the labour costs in these countries.

### 5.5 Required employee qualification and training

The level of qualification and training of employees in low-cost countries is, generally speaking, much lower than in high-income countries [32]. Qualified employees are rare and, for that reason, disproportionally expensive (e.g. expatriate) [23]. A **design that is adapted to the competencies** of the employees must therefore compensate for their usually lower qualification.

### 5.6 Different cultural and specialist background of suppliers

The suppliers' different cultural and specialist backgrounds can be the reason for serious misunderstandings [31]. While it can be expected of domestic suppliers to implicitly understand the aspects of

an order, these are to be explicitly communicated to a foreign supplier. This, in turn, has an impact on the product **design which needs to be adapted to the communication needs** of the supplier. Misunderstandings are to be prevented from the outset by a simple, explicit design, illustration and specification of the quality features. Quality criteria can only be successfully communicated if the designers make sure that the critical features can be specified. Several geometries such as threads or undercuts are subject to standards. A reference to the respective standard spares the communication of detailed information between customer and supplier and is therefore in line with the adapted communication needs. This only applies though, if the recipient understands the reference, has access to the respective standard and is capable of complying with it. This procedure can fail if the supplier lacks the standardised tool to manufacture the required standardised geometry. Product design in line with standards is therefore only adapted to the communication needs of the respective cultural sphere.

### 5.7 Long hauling distances

Long hauling distances are a result of the geographical location of low-cost countries. Since goods that were manufactured in low-cost countries can oftentimes not be transported overland, they need to inevitably be transported by ship or even by aeroplane. Eastern European countries are an exception to this rule. The transport and transfer of goods incurs costs and leads to insecurities and a loss of time. These disadvantages are to be reduced by a **design adapted to transport requirements**.

Sea freight costs are directly dependent on the volume of the goods whereas the costs for the more expensive air transport are based on weight [23]. It is therefore another important task of the product designers to minimise the relevant factor. Furthermore, significant economies of scale apply for all kinds of transport which should not be neglected [23]. The shipment of small entities (less-than-container loads = LCLs) per kilogram costs about 40 to 50 percent more than the shipment of full containers (full-container loads = FCLs) [23]. The same applies to the transport of goods by road or by train before and after shipping [23]. The transfer of goods in full container loads as well tends to be faster, cheaper and incurs less risks [23]. Therefore, large batches are in principle a goal which needs to be assured as early as in the design phase. Large sourcing-batches can be induced, for example, by particularly choosing and designing standardised modules and components to be produced by low-cost-suppliers. A design adapted to transport requirements therefore focuses on an efficient use of transport volumes, an easy logistic handling as well as an easy, efficient and – due to the relatively poor infrastructure in low-cost countries – safe packaging.

### 5.8 Tariffs and taxes

Whereas inside the EU, for example, the freedom of goods is enshrined in EU legislation, the import and export regulations for low-cost countries as well as the different tax regulations in these countries need to be taken into account. A **design adapted to tariffs and taxes** is required in order to minimise the amount of charges paid to the different authorities. The amount of outsourced products and/or the manufacturing concept can have an impact on tariff rates. The tariff rate for the import of roller bearings, for example, amounts to 8%, whereas only 6% are to be paid for bearings already incorporated in a housing. Furthermore, a considerable product share in ingoing material which is not manufactured in the EU can turn the product into a non-EU product. If such a product is sold to a customer resident in a country which signed a free trade agreement with the EU, the customer is nevertheless obliged to pay tariffs for this product.

### 5.9 Costs for coordination and support

The costs incurred by the coordination and support of suppliers in low-cost countries are in general higher than for supplier relations within high-income countries. On the one hand, this is a result of the different cultural and specialist background of the suppliers. On the other hand, the long geographical distance between customer and supplier complicates a close cooperation. Meetings face-to-face generally require a longer preparation, more time and expenses, particularly if an interpreter is needed to overcome language barriers [31]. Even if a design which is adapted to the compentencies and the communication needs of the supplier in particular reduces the scope of support, additional measures should nevertheless be taken into account.

It is a matter of fact that the increase in coordination costs is at least proportional to the number of players involved, i.e. manufacturers, raw-material suppliers and hauliers. The number of different product components leads to higher costs as well. If these are produced by the same supplier however, synergy effects are to be expected. This can only be achieved if the components are similar in their material and manufacturing process. This illustrates clearly that a **design that is adapted to coordination needs** is required to create the necessary preconditions for a simple supply chain with low costs for coordination and support of the suppliers. An appropriate product structure and/or segmentation can make a huge contribution to these improvements.

### 5.10 Product piracy and knowledge drain

There are different reasons why product piracy and knowledge drain are an important issue in low-cost countries. One aspect is a different mentality which is characterised by low loyalty and a high fluctuation of employees. Knowledge about products and manufacturing processes are therefore easily spread. In China, this development is going even further. State intelligence services considerably promoted industrial espionage in Western companies and research institutes [33]. Technology theft and product piracy were also facilitated by laws and their application [33].

Two different scenarios for the approaches to *Design for low-cost country sourcing* are to be distinguished:

1. The selected supplier uses free capacities for overproduction. The manufactured products or even defective parts enter the market without the customer's knowledge. For this to happen, the items, of course, must be saleable. However, even individual components can be saleable, especially spare parts [31].
2. Copycats manage to gather information about the product and/or its manufacturing process by the supplier which allows them to produce copies.

A range of measures should be taken in order to face the challenges mentioned above [33-35]. A **design adapted to anti-piracy needs** constitutes a basic element.

There are two diffferent appropriate strategies that can be combined though in order to prevent product piracy and knowledge drain. First of all, the relevant knowledge can be spread to several independent suppliers by segmenting the product into suitable manufacturing units. It is to be ensured that no single manufacturing unit is marketable on its own, contains key technologies or significant clues that point to the end product. This strategy is particularly appropriate if the final assembly is to be carried out in the domestic production plant [36].

Another possibility would be to design a sourcing unit in a fashion that it is not usable without a “key component“ and therefore not saleable. The key component, which is exclusively manufactured for the supplier, is provided to the supplier in the exact amount needed for the volume of the order. Overproduction is therefore not possible. Copycat activities can be prevented by the impossibility of obtaining the key component or the high degree of difficulty in copying it [37].

### 5.11 Dynamics of framework conditions

Low-cost countries are undergoing rapid changes as newly emerging markets. China serves as the perfect example of high dynamics [31]. Annually changed tax deductions with massive modifications for export products, for example, are accounting for considerable insecurities on the manufacturer’s side. A **design that is adapted to the dynamics of the market** aims at preventing or reducing the effects and implications and the added costs resulting from a change in the factors mentioned in Figure 6 and Figure 7. Companies need to identify the dynamics that are relevant to the enterprise and its product. Parameters such as the availibility and the price of energy and materials, freight conditions, export regulations etc. are subject to potential modifications and fluctuations which cannot be influenced. A design that is adapted to the dynamics of the market shall pave the way for seizing opportunities while limiting risks. Flexibility is of key importance in combination with the prevention of critical dependencies and the principle of risk spreading. The risk of supply bottlenecks can be diminished if backup material can be used in production. Another possibility would be permanent cost savings by gearing towards a flexible use of the currently less expensive material.

## 6 BASIC PRINCIPLES OF THE DESIGN FOR LOW-COST COUNTRY SOURCING

Chapter 5 pointed out how the basic principles of the *Design for low-cost country sourcing* are deduced from the main factors. Figure 8 gives another overview.

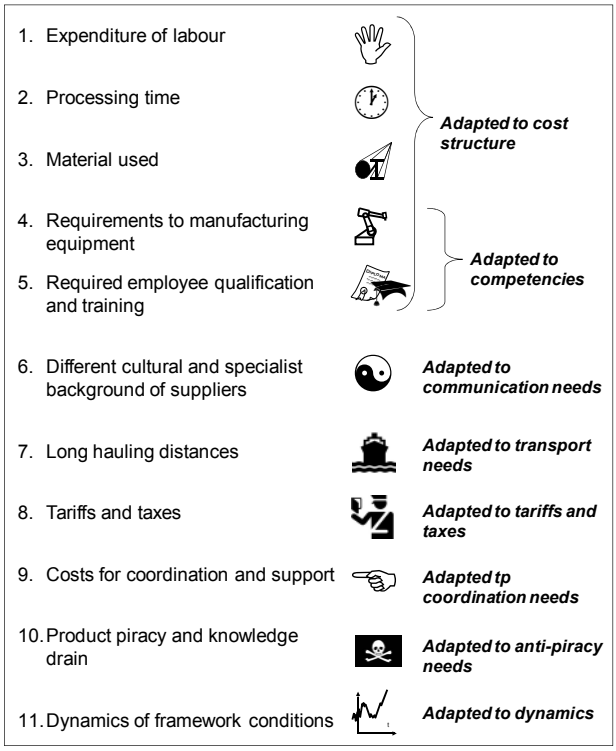



Figure 8: The main factors and the deduced basic principles of the design for low-cost country sourcing

The all encompassing paradigm is ***simple, clear, safe***. These three basic design rules apply always and everywhere, and most of the guidelines can be traced back to them [22]. For low-cost country sourcing however, they are of even greater importance. A *simple* design is **adapted to the respective competencies**, a *clear* assignment of functions and specifications reduces the risks of errors and, above all, is **adapted to the respective communication needs**. A *safe* design can be seen as a way to prevent errors.

## 7 DESIGN GUIDELINES FOR THE DESIGN FOR LOW-COST COUNTRY SOURCING

Following are specific visualised guidelines to the basic principles of a design for low-cost country sourcing as explained in chapter 5 and 6. Some of the design proposals also refer to other basic principles than indicated in the headline which is noted in the respective figure.

### 7.1 Adapted to the respective cost structure

Instead of choosing an expensive material aiming at a high surface quality, additional time and money should be spent on finishing the surface of a less expensive material.

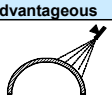
| Guideline | disadvantageous | advantageous |
|---|---|---|
| Desired characteristics achieved by surface finishing instead of by high-quality material |  Stainless steel without surface finishing |  Cheaper steel, finished with anticorrosive |
| **Basic principle** | | |
| Adapted to the respective cost structure |  Bulk plastic part, material selection for a flawless surface |  Cheaper structural foam is coated afterwards |

Figure 9: Finishing less expensive material

The lower wages in low-cost countries should be either used in pre-assembly or in final assembly. Moreover, larger transport units are easier and cheaper to transport.

| Guideline | disadvantageous | advantageous |
|---|---|---|
| As much of the assembly to be carried out in the low-cost country |  |  |
| **Basic principle** | | |
| Adapted to the respective cost structure<br>(adapted to the respective transport needs) | | |

Figure 10: Increased use of wage advantages

### 7.2 Adapted to the respective competencies

If possible, zero backlash shall be realised by elasticity instead of exact fit which creates a robust system.

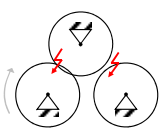
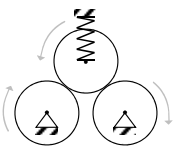
| Guideline | disadvantageous | advantageous |
|---|---|---|
| Function is robust against manufacturing inaccuracies |  |  Elasticity compensates for positional errors |
| **Basic principle** | | |
| Adapted to the respective competencies<br>(adapted to potential errors) | | |

Figure 11: Robustness vs. manufacturing inaccuracy

Early, multi-tier inspections ensure that errors are detected in time and limit potential damage.

| Guideline | disadvantageous | advantageous |
|---|---|---|
| Reliable quality checks on several levels at an early stage of the supply chain (in any case prior to transport) |  |  |
| **Basic principle** | | |
| Adapted to the respective competencies<br>(adapted to the respective risks) | | |

Figure 12: Early and simple quality checks

### 7.3 Adapted to the respective communication needs

The understanding of Western and international standards cannot be taken for granted. Explicit technical specifications that are easy to understand facilitate communication.

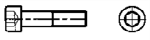
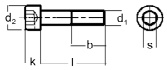
| Guideline | disadvantageous | advantageous |
|---|---|---|
| Domestic standards are to be given in explicit specifications |  |  |
| **Basic principle** | | |
| Adapted to the respective communication needs | | |

Figure 13: Foregoing standards or using regional standards

### 7.4 Adapted to the respective transport needs

If similar or different elements are designed in a fashion that allows them to be fit into each other or to be packed closely reduces package size and transport costs.

| Guideline | disadvantageous | advantageous |
|---|---|---|
| Using voids in order to reduce pack size |  |  Space-efficient stacking (without stucking together) |
| **Basic principle** | | |
| Adapted to transport needs |  Housing elements need huge space |  Housing elements fit into each other |

Figure 14: Reducing transport volumes

### 7.5 Adapted to tariffs and taxes

If technical components or assemblies are subject to different tariffs, an adapted design of supply and product structures can pay off.

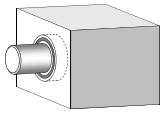
| Guideline | disadvantageous | advantageous |
|---|---|---|
| Influence official classification of import articles by means of design |  Loose Bearing<br>Tariff rate: 8% |  Bearing as part of Assembly<br>Tariff rate: 6% |
| **Basic principle** | | |
| Adapted to tariff and tax regulations | | |

Figure 15: Adapt Design to tariff and tax regulations

### 7.6 Adapted to the respective coordination needs

It is preferable to design whole modules in line with low-cost country sourcing. A multitude of individual sourcing units, produced by different manufacturers, leads to higher costs for coordination, support and logistics.

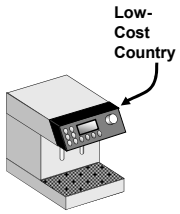
| Guideline | disadvantageous | advantageous |
|---|---|---|
| Whole modules instead of individual parts are to be preferably defined and designed for low-cost country sourcing |  |  |
| **Basic principle** | | |
| Adapted to the respective coordination needs<br>(adapted to transport needs, adapted to the respective cost structure) | | |

Figure 16: Sourcing complete modules

### 7.7 Adapted to anti-piracy needs

A product is to be segmented in a fashion that no manufacturing unit on its own runs the risk of being copied.

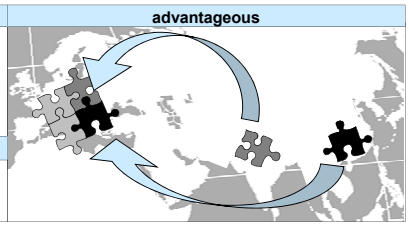
| Guideline | advantageous |
|---|---|
| Segmenting product in manufacturing units which are only interesting for copycats in their combination |  |
| **Basic principle** | |
| Adapted to anti-piracy needs | |

Figure 17: Designing key components

### 7.8 Adapted to the respective dynamics

If the long-term availibility and the price development of raw material are subject to insecurities, alternatives are to be in place from the outset to ensure that the supplier can continue production with alternative materials or semi-finished products at low costs.

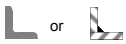
| Guideline | advantageous |
|---|---|
| Alternative material as an option |  or <br>"emergency solution" designed with back-up material<br>  ABS or SAN<br>Compatible thermoplasts which can serve as alternatives can be used on the same machine |
| **Basic principle** | |
| Adapted to the respective dynamics | |

Figure 18: Considering an alternative design

## 8 SUMMARY AND OUTLOOK

In times of globalisation, the increasing importance of low-cost country sourcing needs to be taken into account. The realisation of cost saving potentials while maintaining the required level of quality at the same time can only be achieved by a systematic and methodical approach. Basic principles and design guidelines are necessary in order to adapt the products to the capabilities of the supplier and to the conditions in low-cost countries.

The article at hand first presented the motivation and the aim of constructing a design for low-cost country sourcing. The major factors influencing the design were pointed out from which basic principles for an adapted product design were deduced. These basic principles were finally illustrated by examples and design guidelines.

The introduced design guidelines are currently being applied and validated at one of the world's leading manufacturers of sensors, safety systems and automatic identification products for industrial applications. The company is developing a new product which will be sourced from China.

In addition to this, the current research aims at delivering a comprehensive framework which follows the stages of the general product design process as e.g. described in

[22]. For each design stage a step-by-step procedure shall guide the user to solutions which fit the needs of low-cost country sourcing but do not neglect the numerous other objectives and constraints of the design process. This will finally result in a holistic, flexible and expandable *Design for Low-Cost Country Sourcing* methodology.

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