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ORIGINAL RESEARCH PAPER

Supplier risk assessment strategy

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ABSTRACT

The aim of the study is to create an effective and standard risk assessment tool that provides the company with support and security in purchasing of new products. The goal was to create a tool that complements and standardizes risk assessment forms and shows rapid results. Using the procurement risk management system, the risk associated with a given product can be determined easily and in a short time. In the process, critical areas where hazards may occur can be clearly identified and the risk can be minimized if properly managed.

KEYWORDS

purchasing, supplier, risk assessment, quality

1. INTRODUCTION

Nowadays, competition between industrial companies is intensifying, forcing companies to reduce the prices of their products and improve their processes. In addition to the development of internal processes, the acquisition of purchased raw materials and semi-finished products from cheaper sources is another option. The use of new or existing suppliers for the purchased products is a possible solution.

The target of supplier risk assessment is to understand the supply risk that exists, and purchasing organizations can proactively assess the probability and impact of supply risk in advance, or reactively discover risk after a detrimental event occurs [1].

In the case of a new supplier, it is necessary to be able to meet the requirements and standards of the company. In most cases, the supplier will need to deliver a sample, and if that sample is appropriate, an audit will follow, and if this obstacle is successfully met, the supplier will need to approve the terms of purchase and other documents before applying. confidentiality agreement, quality guidelines, general procurement conditions, etc.) [1].

In the case of employing an existing supplier, this process is simpler, as the required documents are already, in part or in full, available. It is necessary to describe the regulations and requirements for the given product. The delivery and approval of product samples is similar, however, the supplier already knows the company's regulations.

At the small companies is also important to measure the anticipated threats, because it can simultaneously reduce supply risks and resource and time consumption. Especially the relational practices may be feasible alternatives and valuable to supply chain managers and purchasers [2].

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2. MATERIALS AND METHODS

In the case of purchasing a new product, there are innumerable tools available to the purchaser, supplier developers, with the help of which the supplier can be evaluated and developed. Supplier audits [3], Run @ rate [4], APQP [5] or company-specific supplier audits (GMMOG) [6], construction supplier risks [7], etc. and in the case of the first sample

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delivery, additional options are available to determine the level of detail of the documentation related to the given product PPAP Level.

The developed system provides a support as to which of the possible existing suppliers poses a risk for the given finished product [8].

In the automotive industry, it is especially important that the origin and identification of the raw material can be traced later, in the event of a possible complaint. There is a need for suppliers with stable, reliable processes [9].

Supply chain risk assessment of a very wide range of possible aspect of the system are general considerations and special features specific to that company. The synthesis of data and methods is very complex. Several literature reviews have examined and compared these methods, most notably a summary of the analysis of 140 peer-reviewed articles in the IJLSM journal [10].

3. RISK ANALYSIS

Before purchasing a new product, it is worth examining the product from several perspectives, starting with the specific customer demand (exactly what parameters, what conditions are standard between the customer and the company, can the supplier meet them?). The production process manager and the uniform approval and risk assessment of the specialists responsible for the quality area and the preparation of the products, the inspection of the construction area to the procurement area determines the possible avoidance or minimization of the problems that arise later.

When defining a risk assessment, we can define parameters that fundamentally define, influence a given risk, and other risk factors that are important but have a smaller impact on that risk. These can be weighted and evaluated in the evaluation.

3.1. General information

The header of the risk assessment document for the product to be procured should include the following for easier identification:

- Name of Product
- Material number – accurate identification and traceability in the corporate governance system
- Drawing number (version number) – in the system there can be several valid drawings for a given material number, or if the tolerances or other parameters in the drawing change, the version number makes it easy to determine exactly which drawing the risk assessment applies to.
- Project number, if the given finished product is assigned to a specific project
- Customer, connecting the end customer to the given product. It is important because in the event of a subsequent problem or during an audit, the buyer may request an assessment of the supplier risks associated with their product.
- Supplier, important information because a given product may come from different suppliers and different suppliers represent different risks.

When evaluating the risk group by area, 3 groups are defined, with a low risk value of 3, a medium risk value of 2 and a high risk value of 1.

4. PURCHASING RISK

For the assessment of procurement risks (Fig. 1), the key indicators include information on the annual planned turnover and the duration of the product or project. Risk factors include the supplier base, the competitive situation of the supplier of the given product and the tools and investments related to the product.

The key indicators are given more weight in the assessment as they are determinants of future risk.

Calculation of annual planned turnover (**AT** as planned turnover) Based on the forecasts, the planned turnover of the maximum quantity must be multiplied by the purchase price of the given product. Care must be taken to ensure that the calculation is made in a single currency in all cases. The values of the evaluation for this example show a value of EUR 100 000, with a value of 10 on the 100 scale.

- 3 points – below 10,000 EUR
- 5 points – value of 50,000 EUR or more
- 10 points – value of 100,000 EUR or more

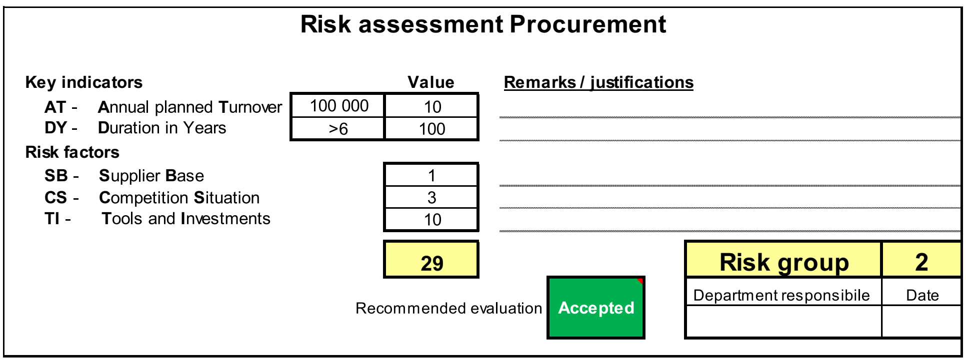


Fig. 1. Purchasing risks
(*Source*: author)

- 50 points – value of EUR 150,000 or more
- 100 points – value of EUR 250,000 or more

But this scale can be developed by each company on its own, depending on the size of the volume, the higher the value, the greater the risk.

Duration in years (DY) means the life of the product, the life of the product as predicted or estimated by the customer. The risk increases with maturity, since the life-span of a product is relatively short, it does not pose as much risk, but if there is a long-term demand for the given product, changes with a negative impact on the supplier (supplier behaviour, bankruptcy, name change, . . .) difficult to weigh. Structure of the 1–100 scale in the given example:

- 3 points – a period of less than 1 year
- 10 points – 1–3 years
- 30 points – 3–6 years
- 100 points – longer than 6 years

In the case of risk factors, the lowest risk at the **Supplier Base (SB)** values is if the given product can be manufactured within a group of companies or with a strategic supplier. And the biggest risk is if you use an unknown supplier for your company or in the market. Scale structure:

- 3 points – a strategic supplier approved for series production can be used or manufactured at a subsidiary
- 10 points – approved but not used for series production
- 30 points – a new but known supplier can be used
- 100 points – if it is only possible to use a new supplier unknown on the market to procure the given product, this may result from the production technology or in some industries the supplier is required by the end user.

The **Competitive Situation (CS)** depends on the presence of suppliers of the product on the market. The fewer opportunities there are in the market to purchase a particular product, the greater the risk.

- 3 points – more resources are available to purchase the product
- 30 points – few suppliers are available in the given product market (2–3)
- 100 points – only one supplier is available (Monopoly position)

Tools and Investments (TI) investigates the hazards associated with tools and other investments associated with the product under investigation.

- 3 points – No tools or investments required, product acquisition time <4 weeks (simple, standard parts)
- 10 points – Ordering tools or minimal investment required Product purchase time is 4 weeks longer but shorter than 3 months (simpler tools)
- 30 points – Tools order and investment are also required, the time to purchase the product and related tools is between 3 and 6 months. (more complex tools)
- 100 points – Tools or investments need to be put into operation, the purchase time is longer than 6 months (investment in machinery, systems, or even building expansion and conversion investments)

In addition to the use of fuzzy logic and multi-criteria decision methods in risk assessment, the logarithm-based calculation method is often used for weighting. The most important factors are emphasized [11, 12].

In the financial field, the logarithmic utility function is commonly used for the portfolio problem [13, 14].

Purchasing risk can be assessed by calculating a logarithm based on 10, adding the basic indicators by multiplying its logarithm by the sum of the risk factors, and rounding to the nearest whole number. Formula:

$$\log(\mathrm{AT} + \mathrm{DY})*(\mathrm{SB} + \mathrm{CS} + \mathrm{TI})$$

$$\log(\mathrm{AT} + \mathrm{DY}) = \log(10 + 100) = 2{,}04139$$

$$(\mathrm{SB} + \mathrm{CS} + \mathrm{TI}) = 1 + 3 + 10 = 14$$

$$2{,}04139*14 = 28{,}57 \approx 29\,\mathrm{point}$$

The risk group rated below 20 points as low (1 risk group) between 20 and 40 points for medium risk and 41 points for high risk. However, the competent representative of the area who makes the assessment will decide individually on the basis of the inherent risks of purchasing the product to accept or reject the purchase of that particular product. In the case of low and medium risk, there is no need to justify acceptance, but in the case of low and medium risk, rejection is required. In the case of high and medium risk groups, justification must be given (there may be a measure to avoid or minimize the hazards).

5. PRODUCT DESIGN AND APPLICATION RISKS

In the case of product design and application risk assessment (Fig. 2), key indicators include critical tolerances and information on user experience. Risk factors will include the product development process, any claim costs incurred, and the values of the raw material.

In the case of purchased parts, it is very important what function it performs in the finished product produced by the company. **Critical Tolerances (CT)** can be understood as the main characteristics that affect the operation of the finished product, for example, if a product is further processed in the case of a semi-finished product, it is not a critical parameter for customer function, only the tolerance specified by the company in the drawing documentation must be in accordance with it. If, on the other hand, the product purchased as a part (no further operation takes place on the product or on that particular surface) can be understood as critical for the customer and function.

- 3 points – no main characteristic (critical tolerance) the component does not affect the operation of the system
- 10 points – 1–3 function relevant parameters
- 30 points – more than 3 critical parameters

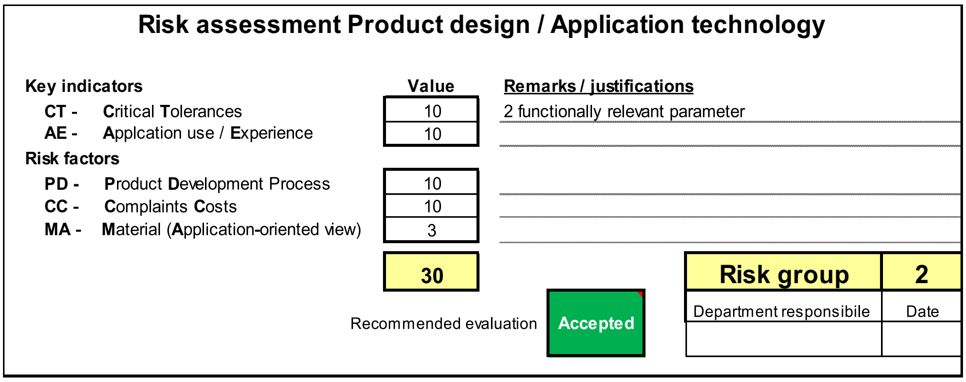


Fig. 2. Product design and application risks
(*Source*: author)

- 100 points – part, product requiring complete documentation, no further processing

The importance of prior Application Experience (AE) in relation to the purchased product is extremely important, because if there is already prior knowledge, it can help apply good examples and experiences. The lowest risk is if experience with the purchased component is already available in the application technology/product design. (3 points). Potential weaknesses/risks are known and can be eliminated. (For example, the problem of residual dirt in hydraulic applications). The next level (10 points) is when prior knowledge of the problem is already in place, but it has not been completely eliminated. (e.g. deburring problem). However, if the company has only minimal experience with that component in application engineering/product design. (30 points, for example, application of new production technologies for the company). However, the highest risk is if the company has no experience at all with application technology/product design related to the given product, so the risks are also largely unknown (e.g. specification of materials unknown to the company).

Among the risk factors influencing the base indicators, the **Product Development process (PD)** is one of the determining components. The lowest risk is if there is no need for engineering work on the purchased part, as it has already been fully developed (1 point), but a slightly higher risk is if the product development process is based on joint design with the supplier (10 points), if the supplier controls in total product development you will have 30 points. In special cases, there may be joint design between the end user and the supplier (100 points). The engineering activity related to product design also includes the necessary testing and calculation services.

Complaint Costs (CC) and their implications can affect the risk of purchasing a product. If the complaint cost reaches a certain threshold per claim (for example, the cost of a complaint ≤ € 100,000 per claim to the end user) and there is no risk of personal injury related to the product, the risk is 3. However, if the value is € 100,000 <complaint cost to the end user in case of damage ≤ € 1,000,000 and no risk of personal injury then this value is 10 (e.g. wind turbine component). There is a higher risk if the complaint cost is € 500,000 <complaint cost for damage to the end user ≤ € 1,000,000, but there is a direct risk of personal injury of 30 points (e.g. automotive parts). The highest risk is if the cost of the complaint is over € 1M and there is an imminent risk of personal injury, and if this part is a safety component or is shipped to the US market TREAD-Act market (Transportation Recall Enhancement, Accountability and Documentation) 100 points. Such products may be, for example, components for railway trains.

From an application engineering point of view, the use of certain raw materials can be an additional hazard.

- 3 points – tested materials, no doubt about the applicability of the materials
- 10 points – raw material or handling, development is technically and time critical
- 30 points – lack of knowledge or controllability of raw material or its handling

Product design and application risks can also be calculated by calculating a logarithm based on 10, adding the basic indicators, multiplying their logarithm by the sum of the risk factors, and rounding to the nearest whole number.

Formula:

$$\log(CT + AE)*(PD + CC + MA)$$

$$\log(CT + AE) = \log(10 + 10) = 1{,}301$$

$$(PD + CC + MA) = 10 + 10 + 3 = 23\,\text{point}$$

$$1{,}301*23 = 29{,}923 \approx 30\,\text{point}$$

The limits of the risk group valuation are the same as the values of the procurement part. The proposed assessment must be justified in case of deviation. Once adopted, the elements of the quality and production area are evaluated.

6. PRODUCT QUALITY AND PRODUCTION RISKS

The risk is based on the number of process steps and manufacturability, and the risk-increasing factors are the technological, raw material, distance of the supplier and the controllability of the required characteristics (Fig. 3).

The **Number of Process steps (NP)** depending on whether the supplier employs a subcontractor or the manufacturing process steps are connected together it can carry risks.

Notes for deriving the process step classification:

Steps for annotating the process to obtain classification: Assembly stages: The complete assembly and the assembly of the individual parts are considered as one process step.

Standard parts: For example, rolling elements, grease/oil, seals, washers, screws, other standard parts are considered as a series of work on fittings.

Non-Standard Parts: All workflows that change the condition of parts, including heat treatment, surface treatment, and workflows, count as one session.

- 3 points – up to 5 production steps, which are mostly connected to each other with integrated process monitoring
- 10 points – 5 production process steps (not connected) without sub-supplier
- 30 points – 5 production process steps with subcontractors (heat treatment)
- 100 points – more than 5 production steps with complex tools or complex purchased parts (such as controllers, motors, etc.)

Manufacturability (M) explores the hazards that arise during the manufacture of a product. Analyses the product according to critical tolerances (material, size, shape, and position tolerances). In the case of deviations from the tolerances, account must be taken of the effects specific to production, such as deformations during heat treatment, possible dimensional distortions in the case of castings, shrinkage, etc.

Evaluation:

- 3 points – tolerances can be easily produced with designed manufacturing technologies
- 10 points – with designed manufacturing technologies, tolerances cannot be produced reliably.
- 30 points – tolerances or the product require 100% inspection

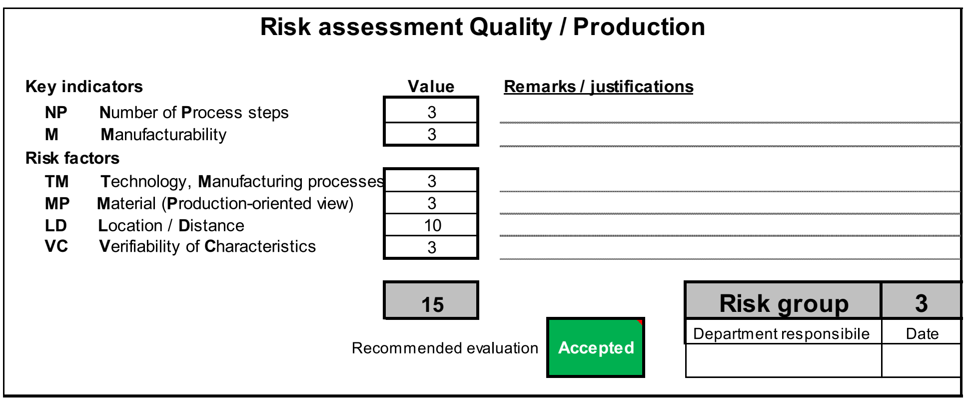
In the case of **Technological and Manufacturing process (TM)** aspects, attention is also the basis of all criteria. Factors can be process-critical and time-critical.

- 3 points – supplier has proven mastery of manufacturing processes and no new requirements, error-free quality history for series parts and samples; non-critical product in terms of deadline
- 10 points – for the supplier, the technology/production processes are largely known, requirements are clear. Minimal technical difficulties or confusion with similar parts; non-critical product in terms of deadline
- 30 points – lack of knowledge or technological/manufacturing processes on the part of the supplier/compliance with the requirements is doubtful and/or deadlines are critical for the product

The available **Distance** of the supplier's **Location (LD)** can also be critical in the event of a complaint. Nowadays, the competitive situation in the market has forced companies to prefer cost-effective countries for purchased raw materials and semi-finished products. The price level of other continent suppliers is more advantageous, however, in the case of a customer complaint, if the product has to be replaced and replaced within a short period of time, it can cause even bigger problems. Or, if the supplier requires the support of a quality area, the distance between the company's receiving/using site and the supplier's manufacturing site must always be understood in the assessment.

Evaluation:

- 3 points – access within one day (visit by car is possible without an overnight stay)
- 10 points – transport visit possible with multi-day travel, neighbouring countries (visit without overnight stay is not possible)
- 30 points – carrier can be reached by plane for several days, within the continent
- 100 points – for a multi-day flight by plane, intercontinental distance



Risk assessment Quality / Production

Key indicators		Value	Remarks / justifications
NP	Number of Process steps	3	
M	Manufacturability	3	
Risk factors			
TM	Technology, Manufacturing processes	3	
MP	Material (Production-oriented view)	3	
LD	Location / Distance	10	
VC	Verifiability of Characteristics	3	
		15	

Recommended evaluation: Accepted

Risk group	3
Department responsibile	Date

Fig. 3. Quality and production risks
(*Source*: author)

The **Verifiability (VC)** of the **Characteristics** of the purchased product as prescribed in the drawing and documentation may also present hazards. Measuring and checking the specifications of the purchased product. Depending on how and in what time the given characteristics can be tested, we measured 4 different grades.

- 3 points – a proven method of measurement and control, and not critical to the procurement deadline
- 10 points – the supplier must be trained and adapted to the measurement and control method, it is not critical for the procurement deadline
- 30 points – no method of measurement and control for the specified parameters is available, or if the product is critical for the delivery time
- 100 points – in case of complete lack of measurement of the given values or in case of doubts related to the reliability of the measurement and control method.

Risks in the quality and production area can also be performed using a logarithm-based calculation method, taking into account the number of process steps (FS) and the logarithm of the sum of manufacturability (GY), risk factors such as Technology (TG), Material (AG), Supplier location (HT) multiplied by the sum of the controllability (JE) of the characteristics and rounded to the nearest whole number.

Formula and calculation:

$$\log(NP + M)*(TM + MP + LD + VC)$$

$$\log(NP + M) = \log(3 + 3) = 0{,}778$$

$$(TM + MP + LD + VC) = 3 + 3 + 10 + 3 = 19$$

$$0{,}778*19 = 14{,}782 \approx 15\,\text{point}$$

The limits of the risk group assessment are the same as in the previous sections. The proposed assessment must be justified in case of deviation. Once adopted, the final evaluation follows.

The final assessment is calculated from the values determined by the sub-areas. The risk groups of each area are denoted by abbreviations (Purchasing – P, Product Design/Application Technology-T, Quality/Production – Q) (Fig. 4).

A low category 3 is considered a risk if

$$P3 \text{ or } P2 + T3 + Q3$$

It is considered a medium category 2 risk if

$$P1 + T3 + P3$$

$$P3 \text{ or } P2 + T2 \text{ and/or } Q2$$

$$P1 + T2 \text{ and/or } Q2$$

High, category 1 is considered a risk if

$$P3 \text{ or } P2 \text{ and } P1 + T1 \text{ and/or } Q1$$

A definite decision based on each area recommendation, which can be acceptance or rejection. However, if the competent representative of the individual field refuses to purchase the product in the evaluation, the system will automatically reject the whole project due to the area-specific rejection related to the product. In the comment box, it is possible to identify measures and additional tasks that can reduce the risk in the given area. These can be a supplier audit, run @ rate (which can be used to estimate the number of defects), Advanced Product Quality Planning [15, 16] or other documentation related to the delivery of the product, raw material certificates, machine capability, OEE, etc.

The last part contains the name and contact details of the field, if the person is on leave, the deputy or the telephone number can be included in the comment, if the final approver may have an immediate question.

7. RESULTS

The system development is based on the company's analysis of several years of complaints and minor supplier errors, and in addition it was based on the experience of field specialties groups.

Definite decision based on each board recommendations area	Accepted	Risk 2	Specific classification, based on the calculated risks

Remarks / Justifications

....
....
....
....
....

Approver

Department responsibile	Date

signature

Department	Name	e-mail	remarks
Purchasing			
Product design/ Application Engineer			
Quality			
Production			
Sales			
Project coordinator			

Fig. 4. Final risk evaluation
(*Source*: author)

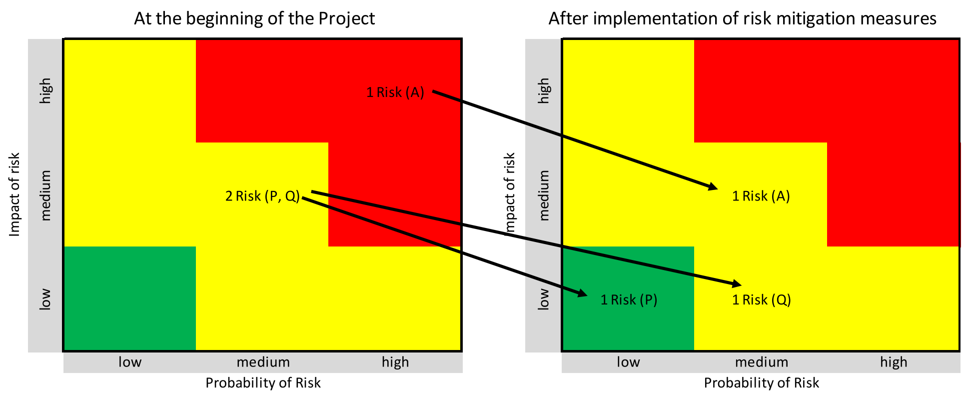


Fig. 5. Risk transformation
(*Source*: author)

At the beginning of the project, the specific risk was identified during the project kick-off discussion and risk mitigation measures were introduced in each area. After the introduction of the defined measures, the risk was significantly reduced by the person in charge of the given area, which strengthened the stability of the project implementation (Fig. 5).

With the development of technology, digitalization and industry 4.0 will come to the forefront of companies. Due to continuous development and change, new directions are emerging. Risk analysis of purchased products is of paramount importance.

For example, IoS (Internet of Services): The key point of the IoS is that the companies sell not simple products anymore, but services embedded in objects since the purchased goods can be continuously developed [17].

In addition to manufacturing companies, procurement analysis, evaluation and ranking of data for service sector companies is becoming more and more common. One of the determining factors in the service industry is trust, which can be measured in an unusual way [18].

8. CONCLUSIONS

The assessment set out in the study can be of help to companies that can introduce and understand the risks and hazards associated with a supplier in a simple way for the introduction of a new project or product and the associated raw materials and semi-finished products. By seeing the critical area in advance, they can proactively prevent the development of subsequent problems and misunderstandings and even complaints.

The most important result is that each specialization can be evaluated electronically, each specialization in its own subject in a few minutes can be transmitted, thus operating as a fast and efficient system.

Other considerations apply in individual industries, such as the procurement of automotive products, oil, gas [19], or food products.

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