PPA - International automotive supplier productivity benchmark study

Anders Kinnander

Peter Almström

Chalmers University of Technology

IMIT – The Institute for Management of Innovation and Technology

IMIT P: 13 618

Scandinavian Automotive Suppliers

Preface

After nearly 70 completed Productivity Potential Assesment studies (PPA) in Sweden there was an apparent need too put the Swedish result into an international context. This study was made possible by the support of Tillväxtverket (the Swedish Agency for Economic and Regional Growth) and FKG (the Scandinavia Automotive Supplier Association). Tillväxtverket provided a grant through IMIT (the Institute for Management of Innovation and Technology at Chalmers University of Technology) to make five studies of foreign suppliers. However we ended up doing seven studies in total.

The initial problem we had to solve was to come into contact with appropriate companies to analyze. Sören Gustafsson at MVV International AB organized the Slovakian and South African contacts. The WZL (Werkzeugmaschinenlabor) at the University of Aachen helped with the German contacts and we found the Polish contacts through FKG.

It has been very interesting to do these studies, Sören's help in doing the shop floor part of the studies has been invaluable. His expert analysis of the shop floor at the companies were highly appreciated and opened up the door to a confidence-building dialogue. The polish studies were performed by Håkan Karlsson and Mats Widing at Condustria Industrial Management AB. We are very grateful for the help from these organizations and individuals.

In retrospect there has been reported interest from U.S., Italy, and Norway to participate in the survey. Unfortunetly we could not accommodate them in this study, but they are on a waiting list for a possible continuation.

We hope that this will be the basis for an internationally standardized way to evaluate the performance of manufacturing companies.

February 2010,

Anders Kinnander, Professor, Chalmers tekniska högskola

Peter Almström, Doktor, Chalmers tekniska högskola

Abstract

If Sweden should maintain and develop their automotive industry it needs to have a higher productivity than so called low-cost countries and one that is at least equivalent to that of other high-cost countries.

The studies conducted abroad in this project indicate that the utilization of manufacturing resources is significantly higher compared to Sweden at the same time as the quality level is better and inventory turnover is greater. This leads to a significantly higher productivity compared to the Swedish subcontractors average productivity values. However, it should be empasized that some of these foreign companies are world class and can therefore not be said to represent foreign suppliers in general. These companies are nevertheless indicative as to what level that is achievable and the productivity levels that probably will be necessary to be competitive in the near future. The studied companies' technical level is the same level as the Swedish.

All but two of the studied companies based their work standards on the MTM-system (Method Time Measurement) and properly performed time studies. The most successful companies also applied teamwork and worked according to lean-principles. It appears that a balance between all of the methodologies and philosophies developed in the field of production from Taylor through self controlled-teams to lean, is the way to achieve world class excellence in manufacturing.

For Sweden to be able to assert itself as a leading automotive industry country we must strive for excellence in all aspects of car production.We must continue to compare ourselves with the best in the world and continue to try to outdo them. The need to continually develop and polish the production, does not only apply to suppliers but also the other companies. If they can not handle the productivity development the requirment of subcontractors will disappear.

The study has shown that the PPA method works well also abroad, although the lack of translation into different languages has put some practical limitations.

Table of content

1 Background

Since 2005 about 70 The Productivity Potential Assessment (PPA) studies have in total been conducted which has reluted in a significant experience in assesing manufacturing companies and a unique knowledge about the productivity potential.

A series of PPA studies of Swedish suppliers to the automotive industry has been presented in the report "Analysis of productivity potential in the suppliers of the Swedish automotive industry", NUTEK R 2008:52 in swedish. The report shows the areas in which suppliers are good and also in which areas they can improve. To be concise, the Swedish sub-contractors are good at flexability, but worse in the productivity area. This is an advantage when the products vary, but a disadvantage when high volumes of production need to be reached. It was unknown how the Swedish suppliers would cope in an international comparision which is why this project was started. All companies that participated in the study are guaranteed complete anonymity, which has been a precondition for doing the studies.

The present study is done in six randomly selected sub-suppliers in the automotive industry in Germany, Poland, Slovakia and South Africa. The selection was based on a mix of previous contacts and contacts of third parties. The research can obviously not be considered a complete study of the competitiveness of all subcontractors, but for Sweden. Instead, this should be seen as a number of samples that can possible lead to further investigations.

After the project was decided a survey has been reported that was carried out by FKG and Tillväxtverket called "Expensive to buy cheap". It shows that Swedish suppliers are competitive in producing many components even compared to China. That conclusion makes a good motivation for continuing the productivity improvement effort.

2 International PPA studies

The studies have been carried out the same way as in Sweden according to the PPA concept. Data from the foreign suppliers are collected under the same conditions as for the Swedish and are therefore comparable. The work environment analysis was performed in a simplified way in the international studies due to the requirements of direct conversations with the employees. This has not been possible due to language barriers. In the studies information about the production conditions in each country has been noted from the interviewed production managers. These are reported in the appropriate part of the report but have not been verified against any official views or statistics since that is not part of the project framework. Their perceptions may thus be seen as an expression of how they perceive the production conditions of the respective companies and their behavior in strategic issues.

The studies were carried out during November and December 2009 and in January 2010.

2.1 Company types

Three of the companies in the studies were part of a multinational groups focused on the passenger car manufacturing industry. These were Just-in-time (JIT) sequence suppliers, which means that they are closly situated to the OEM final assembly plant and the production flow is synchronized with the final assembly line. Three of the companies were oriented towards heavy vehicles manufacturing. One of these was part of a small international company and the rest were independent producers. The number of employees at each company varied between 70 and 700. All companies did manual The work mainly assembly work, but four of the companies also had extensive machining. All businesses were hard hit by the crisis with the exception of one which had expanded when the customer introduced a new model.

2.2 South Africa

South Africa has been producing cars since 1947. It was Ford who first established production in South Africa. Today around 600 000 cars are produced, most of which are sold in South Africa and surrounding countries. South Africa does not have their own car brand but there are some models made for the international brands. Roger Pitot, director of the South African equivalent of the FKG group, said that they have problems with high port charges and poor reliability of energy supply.

The level of the investigated the two suppliers varied considerably. From world-class to a very low level. At the first company, they emphasized the difficulties in managing the diverse ethnic groups in the workshop organization. It was stressed that they had to be tough leaders and micro-manage the workers because they were not expected to be able to cooperate or take their own initiatives. The opinion of the manager was that the workers were untrustworthy and had no solidarity towards the company. This information was contradicted entirely by the second company, which held team work high and saw no problems with cooperating across ethnic boundaries. One problem pointed out was what is called ”brain drain”, which means that many young people leave South Africa for a better career elsewhere. This problem was probably exaggerated given the poor status the manufacturing industry has among young engineers. The managers at the second company believed that to increase the attractiveness of the industry would probably solve some of the problem.

2.3 Slovakia

Slovakia has become a major vehicle-producing country that produces about 600 000 cars per year. They do not produce trucks or buses only passenger cars. They are one of the world's top countries in number of cars produced per capita. VW, Porsche, Audi and KIA are produced in the Slovakia.

The automotive industry's development started in the early 1990s, when Volkswagen established a car manufacturing factory near Bratislava. Since then, Volkswagen, is the country's leading export commodity. This has attracted other companies to invest in the market with the result that the country's growth in the component industry has grown strongly. Currently there are 241 supplier of motor vehicles in central and western parts of Slovakia.

Flexibility, highly qualified personnel, flexible trade unions, and good tax reform are some of the reasons that attracted car companies to invest in the country.

In Slovakia, the crisis has taken a heavy toll.

2.4 Poland

There are 600 suppliers to the automotive industry in Poland, half of these companies are joint ventures with foreign companies. The industry accounts for ten percent of the manufacturing sector in Poland, the segments of production of motors and metal parts is the biggest.

The main OEMs in Poland are Fiat and Volkswagen, closely followed by GM, Ford and Toyota. Today Poland produces over 600 000 cars per year. Demand for new cars are still low in Poland due to large import of used cars. This means that most of the cars produced in Poland are exported.

2.5 Germany

Nikolaus Otto invented the four-stroke engine in the 1870s in Germany. Germany is known for several brands such as Porsche, Mercedes, Audi, Volkswagen, BMW, Opel and Ford.

Today, Germany has 29% of the European passenger car market. Germany is in third place among the greatest car producing countries in the world. They produce six million cars per year and approximately every seventh university student begin a career in the automotive industry after graduation.

The car companies make high demands on subcontractors for high flexibility and high technology development ability in addition to competitive costs. Examples of major suppliers are Bosch and ZF, Zahnradfabrik Fredrichhafen. Most of the other subcontractors are SMEs. Germany is experiencing strong competition from low cost countries such as Poland, the Czech Republic and China. Because of this strong competition investments are made to increase productivity through research and development. There is a clearly outspoken goal to keep jobs in automotive industry, which is quite unlike the situation in Sweden.

3 Productivity potential assessment

The Productivity Potential Assessment (PPA) studies of the Swedish manufacturing industry have been going on since 2005. In total, over 60 studies have been carried out in Swedish manufacturing industry and the results have been systematically recorded in a database. The PPA method was designed to provide an objective benchmark of companies within different branches of the manufacturing industry. The studies this far has mainly focused on Swedish suppliers to the automotive industry.

The PPA method was developed at Chalmers University of Technology. Each study is carried out by two certified analysts during one day at each factory or workplace. The procedure is standardized and a comprehensive set of parameters and measures are collected at each site. The core of the method is measurement of actual utilization of operators and machines at shop-floor level. A short description of PPA is found on the next page.

We have now got an opportunity to make an international benchmark study through financial support from the Swedish Agency for Economic and Regional Growth (*Swe: Tillväxtverket*). We will make at least 5 studies at different suppliers to the automotive industry in different European countries. All costs are covered in the project; the companies participating in the studies will only have to set off 2-3 man-days for preparation and participation at the day of the study. *All information collected is treated confidentially and the results will be presented as averages where no individual company's figures may be identified.* The studies will be carried out by researchers from Chalmers together with experienced certified consultants. The studied workplace should be a manufacturing line or cell producing metal or plastic components. The manual work study will include 3-6 machine operators at the selected workplace. The workplace is selected by the company and should be a bottle-neck for an important product flow.

The result from each study is immediately fed back to the company at the day of the study in an oral presentation and discussion, as well as in a written report later on. The whole study will be analyzed and documented in a project report that will be available to the participating companies. The participating companies will get the possibility to compare themselves with other suppliers to the automotive industry in a new and unique way and get a list of areas with a potential for improvements.

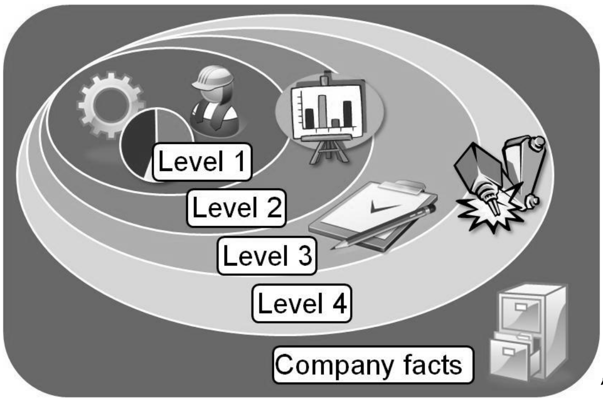
A basic assumption is that productivity can be improved through improvement of the method (M), improving the performance (P), and improving the utilization (U). The relation can be expressed as equation 1:

Productivity = M×P×U

Method improvement is the most important factor where, for example, using an automatic lathe over a manual lathe increases productivity tenfold. The performance factor is equivalent to speed, i.e. working faster, and the utilization factor determines how well the intended method is carried out. For the PPA method the focus is on the utilization factor, the utilization of the labour force compared to the intended method of for example an assembly operation, and the utilization of machines compared to an ideal state with no stops and 100% flawless products.

The parameters forming the PPA method are divided into different levels (see figure 1). Level 1 is the core of the method, constituting two parameters for measuring efficiency in manual work and machine work respectively. Manual work is studied through a work sampling study performed in a standardized way where the operators' working time is divided into value adding, supporting and not value adding activities. The machine utilization is measured through the Overall Equipment Effectiveness (OEE) figure. The necessary OEE-data is collected and calculated from the company's own data.

The level 2 parameters affect productivity at corporate level, like inventory turnover and scrap rate.



,

The parameters at level 3 are measures of the company's and its management's ability to run and develop the production while maintaining a sound work environment. The first part of level 3 measures the level of production engineering, which is defined as the number of "yes" answers from a list of 40 questions. The questions are sorted into 11 topics:

1. Strategy - goals	5. Cleanliness and order	9. Calculations
2. Work methods	6. Material handling	10. Planning
3. Maintenance	7. Change over	11. Quality
4. Competence	8. Continuous improvements	

Altogether the 40 questions evaluate how close the manufacturing unit is to what the research team at Chalmers University of Technology considers being an ideal state of production engineering.

The second part of level 3 concerns work environment. Values for short-term absence, long term sick absence and personnel turn over rate are collected. Three parameters are assessed using three different sets of questions: physical work environment, workload ergonomics, and psychosocial work environment.

The potential of improving productivity by improving the “M” factor of equation 1 is illustrated by level 4. However, PPA does not include a formal measure for method improvement since the measure needed is very different depending on the particular situation. Company facts are collected to facilitate comparison of result from other PPA studies and to be able to sort the database.

Full description of the method in Swedish and some articles in English is found at www.ppaonline.se.

3.1 PPA parameters

Parameters at level one is the true productivity potential of a selected workshop section. For the manual tasks the productivity is measured using a simplified work sampling study. In the simplified work sampling study all activities are divided into three categories: value-added, supporting or non value-added. This classification is standardized in the methodology, but an adjustment must be done in each company.

By default, all activities included in the normal operating cycle are seen as value-adding, for example load and unload, and any post-processing operations for the machine and all the work at the assembly work for the operators. Supporting activities is material handling outside the workplace, set-up work, maintenance work, cleaning, quality control and reporting. Non value-adding is typical disturbance management, waiting, personal time, paid breaks, and more. A small proportion of non value-adding time must always be accepted for personal time and time for recovery, depending on how physically exhausting the work is and what is agreed at the company.

Overall Equipment Efficiency (OEE) is the metrics which is used to determine the machine efficiency. It is defined as the ratio of the value-added time spent in the machine to produce quality approved products and the total planned production time. OEE is calculated by using the company's own figures for the stop times, production results and quality outcomes. To be able to get an OEE number it is required that the company has a follow-up of disturbances and set-ups.

Performance parameters on level two is typical parameters that most companies follow up. They are: Inventory turnover, delivery accuracy, the scrap rate and the customer customer complaints rate. All parameters of level two indicates whether the company it is productive. Additional parameters which indicate the company's ability to operate and develop its production in an efficient manner are included in level three. This level includes the assessment of its production engineering skills through a list of 40 yes or no - questions, and an assessment of the work environment. The assessment of work environment involvs ergonomics, physical environment and psychosocial work environment. These assessments are made using checklists based on observations and interviews. A number of quantitative parameters related to the work environment are collected, such as absenteeism and staff turnover.

Level four handles method improvements. Method improvements are often the biggest improvement opportunity but is at the same time difficult to measure in a way that is comparable between different companies. Although it can not be measured an experienced assessor can conduct a discussion with the company about its potentials and methodological improvements. In addition to the parameters that indicate productive potential, data is gathered that allows different types of comparisons and classifications of the company. Company facts also includes data from financial statements, such as turnover and number of employees.

3.2 Work Process

Some of the parameters of the PPA is of assessment character. This puts high requirements on the PPA analyst and therefore everyone who is certified to perform the method are experienced production techniquans. Certification is obtained by passing a four-day course covering both theory and practice, which includes two complete trials.

The PPA study is conducted in one day by two certified analysts. The study starts with the PPA analysts together with senior management come to agreement with the company on an appropriate section to study. The section should ideally be a bottleneck in the work flow. One of the certified analysts conducts the interview with senior management, the management then gives the analyst a guide tour through the plant. The analyst also assesses the technical level of production and calculates OEE figures from the company's figures. While this takes place analyst two conducts the work sampling study, which is made of 480 readings in approximately 4 hours. During the work sampling study the analyst also makes an assessment of the work environment. In the afternoon direct feedback is given to the senior management and a discussion about the productivity potential can take place. The company will receive a written report with all parameters and a comparison between companies, along with a more qualitative analysis with suggestions for improvement.

4 Quantitative results and comparisons

Seven PPA studies were carried out. One in Slovakia, two in Poland, two in South Africa and two in Germany. In order to compare results from these studies with the earlier study of Swedish suppliers to the automotive industry, we divided the companies and the studied sections in the following sub-categories:

Category A: Just-In-Time (JIT) sequencing supplier in the tier one of passenger cars. The studied work places was basically manual installation, but the degree of automation were high, especially for companies 5, the input machines are often the bottleneck.

Category B: The others are classified as normal in the PPA-studies and are put into two sub-categories based on degree of automation manual labor (assembly) and semi-or fully automatic work.

As shown in Table 1 just one of the studied sections in this study was semi-automatically, the others studied in the production section was manual assembly.

Table 1: Categorization of studies

Company	Category	Level of automation
Company 1 Slovakia	Category B	Manual
Company 2 Poland assembly	Category B	Manual
Company 2 Polen machine shop	Category B	Semi-automatic
Company 3 South Africa	Category B	Manual
Company 4 South Africa	Category A	Manual
Company 5 Germany	Category A	Manual
Company 6 Germany	Category A	Manual

4.1 Quantitative comparison Category A (JIT suppliers)

Just-In-Time or In-sequence (sequence), suppliers are situated all over the world. They are geographically located close to the car manufacturers' final assembly plant to allow the sequential delivery of client-driven components. Typical components are bumper parts, dashboards, seats, etcetera. Competition is fierce and there are a limited number of suppliers operating worldwide and specializing in certain types of components. These suppliers may set up a JIT supply plant anywhere in the world and then copy the production style from a "mother plant". This category of suppliers and factories are in a class of their own in terms of productivity and production technology development level. Therefore this category is reported separately and compared with a selection of four Swedish suppliers. These Swedish suppliers is part of international groups.

Table 2: Results for foreign JIT suppliers, compared with Swedish.

Company	Stock turnover speed	Delivery accuracy	Scrap rate	Complaint	Value added time	Supporting time	Non value adding time
Company 4 South Africa	34	100%	1,55%	189 ppm	56%	5%	40%
Company 5 Germany	33	99,8%	0,6%	12 ppm	72%	2%	26%
Company 6 Germany	71	100%	0,08%	30 ppm	80%	2%	18%
Average value foreign JIT sup.	46	99,9%	0,74%	77 ppm	69%	3%	28%
Average value Swedish JIT sup.	16,2	98,5%	1,04%	120 ppm	60,2%	25,3%	14,6%

The average of the foreign factories are better than the average of Swedish factories on all points. The Swedish average is based on four PPA-studies. We can establish that the foreign companies that has participated probably are among the best in the world, the two German factories have for example distinguished themselves in the "Factory of the Year" contest in Germany. Company 6 had 36/40 yeses in production technical level, which is the highest value to date. There is very likely some sequence supplier in Sweden that can present similar result as the three JIT suppliers that took part in this study. However, we have not had the opportunity to study (or identify) these companies yet. A qualified guess is that there is maximum ten factories in Sweden that can present result at this high level. Most, if not all, of these ten factories are probably part of an international group based outside of Sweden.

4.1.1 Inventory turnover

Stock turnover rate is a measurement that indicates how effectively the flow of material is organized in the production. It indicates how many times per year the whole stock is turned over. Average for the three foreign factories is well above average compared to similar plants in Sweden. However, there could be a swedish plant where we have not conducted a study who could have the same high stock turnover. The value of Company 6 is especially impressive since the production was specialized for the assembly of a certain type of products but these products were manufactured in a wide variety of variants and they contained hundreds of different components. The average value for Swedish JIT suppliers is about 16 times / year. The maximum value of the Swedish studies, from all types of manufacturing companies, is 52 times/ year, which was a plastics company manufacturing standardized products in a process step (injection molding).

4.1.2 Delivery accuracy

A 100% delivery accuracy is expected in a JIT supplier company anything else is unacceptable. A fine clause in the contract with the customer decide what the supplier must pay for every minute that the customer's assembly line is delayed as a result of late delivery.

4.1.3 Scrap rates

Scrap rate is directly productive potential. The loss is especially great when it occurs late in the flow, when the product has been added more value. Company 6 had an excellent value, 0.08% on this parameter, which represents less than one tenth of the Swedish average.

4.1.4 Customer customer complaints

The quality requirements the customer put on suppliers of JIT-products are enormously high. In principle the customers require zero defects, but in practice the target is set lower. Customer complaints are measured as the number of defects per million units shipped (ie parts per million, ppm). The two German suppliers stand out with two extremely low values. It should be stressed that the two German companies supplied products which are mostly not visible to the end customer, which in practice mean that minor injuries such as scratches and dirt particles will not result in customer complaints .

Components which are visible to the end customer tend to get more customer complaints . Two of a total of four Swedish suppliers in the control group had components of the latter type.

4.1.5 Utilization rate in the manual work

A difference between the international and the Swedish companies in the work sampling study was that the three foreign plants in the study had indirect staff who took care of most of the materials handling, while in Sweden the fitters themselves collected materials and threw away packaging. The supporting portion of time is thus significantly lower for the foreign factories. The high proportion of non-value added time to Company 4 was largely the result of imbalances in the flow that arose because the fitting was carried out in batches rather than as a whole flow as planned. Companies 5 and 6 had a higher proportion of non value-adding time than the Swedish average. Company 5 had a high non-value-added part because of waiting in the assembly, which occurred when operators were waiting for the automation device, ie. imbalances. Company 6 had a big disturbance during the day of the work sampling study. The disturbance was not representative of a normal day, and thefore the study results has been reduced by 3 percentage points from 21% to 18% in the non value added time (based on the company's own measured average failure percentage was 10% and the disturbance that occurred lasted half an hour , which represents 13% of the study time).

4.2 Quantitative comaparison Category B

The vehicle component suppliers outside of the category of JIT suppliers (Category A) are generally not as far advanced in production technology and exhibits as a result of this even worse value of the various result parameters. In the automation level of manual work thera are three trials in the project (Table 3) while for semi-automatic production, we had only one study (Table 4)

Table 3: Comparison between manual assembly of three countries and an average of the Swedish automotive component suppliers.

Company	Stock turnover speed	Delivery accuracy	Scrap rates	Customer complaints	Value added time	Supportin time	Non value added time
Company 1 Slovakia	2,25	96%	N/A	57 ppm	78%	6%	16%
Company 2 Poland assembly	2.8	93%	0,2%	13 ppm	76%	15%	9%
Company 3 South Africa	12	100%	N/A	200 ppm	35%	16%	49%
Average value foreign automotive suppliers	5,7	96,3%	0,2%	90 ppm	63%	12%	25%
Average value Swedish automotive suppliers	8,6	88,2	1,5%	500 ppm	61,0%	17,7%	21,3%

Table 4: Comparison between a semi-automatic production in Poland and an average of the Swedish automotive component supplier

Company	Stock turnover speed	Delivery accuracy	Scrap rate	Customer complaints	Value adding	Supporting	Non value adding	OEE
Company 2 Poland machine shop	2.8	93%	0,2%	13 ppm	61%	31%	8%	N/A
Average value Swedish sup.	11,0	82,5%	1,4%	4700 ppm	45%	23%	32%	57%

There was a big difference between businesses in category B. In contrast to category A firms are not the same global competitive position and all the companies were primarily suppliers to heavy vehicles.

4.2.1 Stock turnover rate

The Polish and the Slovak company had a mixed production of a wide range of products to different customers. Therefore they had a stock turnover that is lower than the Swedish average. There are examples of Swedish companies that have just as low or lower levels, but generally a low level that indicates a lack of awareness within the company about how much it actually costs to have large stocks and buffers. The South African company had a better level, but this was mainly due to that they manufactured standardized products. This company had a very low production engineering level.

4.2.2 Delivery accuracy

For these type of companies delivery accuracy is not as critical as for JIT suppliers. Delivery accuracy has significance for the relationship with clients and the possibilities for potential future business, but has no direct cost impact like they have for category A companies. Delivery accuracy indicates the individual company's ability to plan activities internally. In the current economic downturn, there should not be a problem for most companies to achieve 100% delivery accuracy.

4.2.3 Scrap rates

Scrap rate represents a direct loss of productivity. Company 2 (Poland) had a relatively low scrap rate degree. The Swedish companies scrap rate varied between 1-2%, but there are also examples of lower levels. The Slovak company had a different definition of scrap rates therefore their scrap rate data is not included in this study. The South African company had poor follow-up and could not present a scrap rate number.

4.2.4 Customer complaints

Customer complaints are errors discovered by the customer and have a direct impact on productivity. Customer complaints also influence the relationship with the customer and opportunities for future business. All the international companies had a quality level toward their customers which exceeded the average level of the Swedish companies in the study. Meanwhile, Swedish companies in general have a good quality reputation, which gives an ambivalent picture. The basis of this study is too small to draw any conclusions, but it might indicate that the average Swedish supplier do not live up to their reputation.

4.2.5 Rate of utilization of the manual work

The utilization rate in the manual assembly of company 1 (Slovakia) and company 2 (Poland, assembly) was high and above the Swedish average. Company 2 had very low non-value added time. The South African company stood out in this category with an extremely low value for value-adding time. As mentioned earlier, they had a low level of production technology and the work flow was not effective, resulting in much waiting and disorders. In the second study of the Polish company (company 2 Poland, machine shop), the non value-adding time was also extremely low.

4.2.6 Machine utilization

The only machine service section studied was at company 2 in Poland. This was a sheet metal workshop where they used machine efficiency rates, which they called OEE. They had a different definition of OEE so it was not possible to calculate the OEE according to our definition.

The other companies also had extensive machining in addition to assembly. These companies' gave their own utilization figures for machinery. The figures are probably well-founded but there is no guarantee that they are developed under the strict OEE definition. The figures are reported to get a full illustration of the differences. The conclusion is that machine utilization of these companies on average are much higher than in the earlier study of Swedish suppliers. However, the highest OEE figure recorded in Sweden is 92%.

Table 5: Comparisons between companies listed OEE figures and the Swedish average component vehicle supplier (all companies)

Company	Category	”OEE”
Company 1 Slovakia	Machine shop	74%
Company 2 Poland	Machine shop	N/A
Company 4 South Africa	Machine shop	75%
Company 5 Germany	Machine shop	84%
Company 6 Germany	Machine shop	75%
Average figure suppliers to vehicle industry (OEE figures with correct definition)		60,4%

5 Qualitative analysis and discussion

There are several factors that differ between the suppliers in the countries studied in this project compared to suppliers to the automotive industry in Sweden. Discussed below are a selection of the most important factors.

5.1 Performance and performance wage

It is very important not to confuse the concepts of performance and productivity. High productivity is built up on a base of an efficient working method (short walking distances, balanced automation, etc.), this method should be performed at a high speed (performance), and a large part of the workday should be devoted to the value-added method (high utilization). This can be described by the following formula:

$$\text{Productivity} = \text{Method} \times \text{Performance} \times \text{Utilization}$$

The method can be measured with a productivity measure, e.g. the number of units produced per unit time. Normal performance is defined as 100% MTM speed. The rate is based on a normal individual who can work 8 hours a day throughout his whole career with the same speed and without getting injuries. It is possible to keep a higher pace if you have the correct individual performing the work. The utilization rate can never exceed 100%. For manual work personal time is often regulated by contract to about 9% of the total work time. In practice the utilization figure can not be higher than 91%. PPA measures the utilization rate only, but during a PPA study observations about the performance factor and the method factor are made.

Performance-related wages was applied in many of the foreign study cases. In extreme cases, the workers are paid only for approved produced workpieces. In some cases the performance wage or bonus made up 30% of the salary, which therefore requires that the operators can work in 130% MTM pace. The salary system requires precise time-based measurement, monitoring, and a clear leadership because otherwise a wage-drift can easily occur.

5.2 Organization and salary systems

Piecework bonus or group bonus directly tied to production result was applied more often, which means in its strictest definition that the worker or the team only get paid on the number of successful produced workpieces. The operator can also in some cases have to pay the workpiece if it is found faulty unless the mistake is due to something outside the workers' control such as material defects. At times with low workload the worker stays home with 50-60% of their salary. In for example Germany and South Africa government insurance cover income loss at lay-offs due to temporary less work load. In Sweden the problem of variation in work load is solved by using temporary staff from staffing companies to out help in busier times. The wage gap on the shop floor internationally is considerably higher than in Sweden. It can differentiate up to 50% in salary between a new employee and a skilled machine operator. Where teamwork is applied, usually in connection with the assembly, the wage distribution is much lower.

There is a strong downward pressure on wages in Germany and one of the surveyed plant managers expect that there may be a question of lowering wages considerably over the next few years. During the good years Volkswagen has accepted 32 hours working week, something they are now trying to change. Generally working hours for the factory worker in Germany is 35-40 hours per week, depending on local agreement. Wages are about 25% higher which, together with the shorter working hours mean that the productivity rate must be about 50% higher to be able to reach Swedish cost level. In the studied German companies productivity was up to 100% higher than the Swedish subcontractors average productivity. This mean they still have a significant productivity advantage.

5.3 Production engineering support

In regards to the studied companies it can be established that the production engineering level in South Africa varied from a very high level to a low level. In both cases, improvements could be made with regard to the arrangement of the assembly lines. In one case, radical improvements and in the second small refinements.

In the other countries visited the production engineering function was well developed.

All of the subcontractors with the exception of two had work study engineers who were trained in either MTM system or the German high-level variant UAS (equivalent to Swedish SAM). Workplaces were planned for maximum productivity and the manual work was standardized with these methods. This ensured an ergonomically correct work environment with possibilities for effective use of resources. In many cases the standard was not followed. In case of absence, training time of new employees and/or the need to catch up after machine downtime, etc they worked more flexible. Because of this the production plant could be run more efficiently than if the standard would have been followed entirely.

One company claimed that they were more efficient than Toyota because of their flexibility, however flexibility requires highly motivated employees. The same company had also left the original concept of lean and shifted to a fully integrated IT solution for production management which meant that they entirely left Kanban cards.

Preparation work and programming of NC machines and other production equipment was completely centralized in all cases.

5.4 Team work

Teamwork is important but it must not lead the company to loose focus on development. Teamwork is a way to polish the company developed production solutions. Unfortunately, you often see workshops in Sweden, which has reduced the production engineering detail work and delegated it to staff. Often the company produces a rough work solution which then the workes are left to optimize. Knowledge and motivation may not be sufficient for this. The result is a poorly designed workplace where ergonomics and productivity are not good enough. In many cases, employees feel strong pressure to increase production outcomes which will worsen the problems if the work is not well structured. In the visited German companies the company developed the best possible solution which was then continually refined by the staff.

There are many possibilities in the potential of team work for foreign suppliers. They are often better staffed on the technical side of production. There is great productivity potential for them in this area.

The specialized functions that many foreign suppliers have can lead to high productivity. A Slovak company let each operator run two NC machines at a time and had seperate staff who serviced the machines with materials and transitions. When it was time for conversion or change of program the machines were stopped one at a time. The operator helped with the conversion but the operators primary mission is to keep the other machine running. This led to a very high machine utilization, but at the cost of more indirect staff.

Another example is from Toyotas tool shop in Toyota city in Japan. The example is not included in this study but is taken from a previous visit. In this work shop the produced wrought iron tools, which were manufactured in one or two copies. The processing was done in four high-speed milling machines served by one operator. The machines were run in three shifts. The need for NC program is extensive with such small range of sizes. Their solution was to have shifts programmers who worked in pairs. The thought-provoking is that they reached a high level of machine utilization in few piece production by using shifts to reinforce high capacity. We have not seen anythig similar in Sweden where in the corresponding production usually run the machines in one shift. It is not unusual for the operator to programme and use the machine control system and the machineis at a stand still during this time.

5.5 Lean production applications

Since there is considerable focus on Lean production in Sweden we will make a few observations how this trend is reflected in the studied companies.

The German companies used lean principles in their production systems. This had no significant role when they presented their production systems. One company claimed that they had developed a production system that was better than Toyota's. They claimed that it had a flexibility that exceeded the strict implementation of standardized work that the Toyota system provide. When disturbances occur the operators themselves balance work on the line to compensate for this. We found this to be correct during the study.

The best companies in the study had a strong focus on traditional production engineering issues. The assembly work is for example designed by work-study engineers. Furthermore, it is not controversial to measure time and study manual work as it is on many Swedish companies.

It seems that a balance between all the methodology developed and philosophies in the field of production from Taylor, through self-controlled team, to lean is the way to achievie world class excellence in manufacturing.

To keep the Swedish manufacturing industry competetive a higher productivity level must be reached than in countries with lower cost and to a level at least equivalent to other high-cost countries. The Swedish average company is not good enough today. In many Swedish interpretation of lean production, the productivity issue has been completely lost. There is a notion that if the company in question just gets “lean enough”, productivity will occur by itself. In reality, the key factor to become more productive is to start measure productivty.

5.6 Strategic development of sub-contractors in high cost countries

One of the leading countries when it comes to developing highly efficient factories appear to be Germany and were first tier sequence suppliers to the passenger car industry. The three best companies in this study was German or had German connections. These companies were world class and one of the companies claimed that they had a higher productivity than Toyota which was not contradicted by the study. These companies were sequence suppliers to automakers.

There is considerable development potential in several of the companies visited in the so-called low-wage countries. The requirements on the Swedish sub-contractors will rise for them to be able keep their market shares. Therefore it is important to exploit the strategic advantages such as proximity to the qualified vehicle manufacturers, which are located in Sweden.

A few of the suppliers were high performing in the same environment as poorly performing suppliers. The way production is carried out are of great importance and is determined only partly by local conditions. A "World Class Manufacturing" can be achieved almost anywhere in the world. Usually it is done by a major subcontractor who establishes themselves together with a fully developed production concept.

There is a widespread perception that the highly automated production facilities should be in countries with high cost level. This is contradicted by the most labor-intensive parts of production, namely the sequence deliveries must be close to the final assembly of cars. A tendency in Germany is to develop manual assembly work by designing the components so that assembly work is minimized while the degree of automation can be increased. One of the German companies emphasized that the high motivation among the German workers makes this possible. Automated facilities are better in low-cost countries because it requires less skill to run these plants and therefore the workers does not have to be as qualified. The approach assumes that technology development is done in countries with high engineering skills, and then implemented at the appropriate location.

The greatest danger for subcontractors in Germany, according to a production manager, is that the vehicle companies productivity is too low. High wages cost coupled with a much lower productivity could ultimately reduce the proportion of car production in Germany which will directly affect the number of subcontractors. Since an increasing share of car production are made in low cost countries both component and sequence manufacturers will continue to grow in these countries.

The observation that the vehicle companies can have a lower productivity than their sub-contractors is something that the PPA studies also have seen in Sweden.

6 Conclusion

This study shows that resource utilization seems to be higher among sub-contractors in the outside world than in Sweden. This does not imply that the cost will always be higher in Sweden since the Swedish companies in general have a lower proportion of overhead costs. It is therefore important to look at the cost of the increased proportion of indirect functions and measure it opposite the utilization factor of production resources. It should be emphasized that this is a comparison between 30 Swedish studies and seven foreign. The statistic base is too small to draw final conclusions. .

Stock turnover rate could be significantly increased among Swedish JIT suppliers.

Quality outcome for Swedish subcontractors compared to the companies in this study is surprisingly low. This should be investigated further.

Many of the principles that guided the development of the engineering organizations in Sweden, objective work team, team work lean, etc. are indicative also among subcontractors in other countries. The difference is that internationally this is implemented in a more disciplined manner with a qualified production engineering management .

With regard to the low-wage countries that have participated in the study it can be concluded that they have good opportunities to improve their competetive position even further assuming they invest in development and develop their leadership.

Multinational first tier sequence suppliers to cars seem to have the highest productivity. They spread production know-how to new countries by applying their principles in all their factories worldwide. and have the opportunity to refine and tune their production systems principles.

Benefits with Swedish sub-contractor industries is high flexibility and low overhead costs. In order to strengthen Swedish competiveness, it is important to reduce costs through increased use of resources. By increasing the resource without a corresponding increase in costs the sub-contractors competiveness would rise significantly.

It would be interesting to extend the study and obtain a more comprehensive benchmarking data. Especially interesting would be to study even more companies in Germany. This study included only JIT suppliers.

Finally, we can establish that the PPA method worked well in an international context, although our material is only translated into English and not any of the other languages represented in the study.

References

Almström, P., and Kinnander, A., (2006). *PPA-metoden - En metod för att bedöma produktivitetspotentialen i verkstadsindustrin*, (In Swedish), Nutek rapport R2006:17, Stockholm.

Kinnander, A. and Almström, P. (2009). Analys av produktivitetspotentialen hos underleverantörer till den svenska fordonsindustrin, (In Swedish), Nutek rapport R2008:52, Stockholm.

Exportrådet, FKG och Tillväxtverket, (2009) Dyrt att köpa billigt - En analys av kostnader för fordonskomponenter i Kina, Ryssland och Rumänien. (In Swedish), Stockholm.