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Operational speed - an opportunity for Finnish paper industry

ABSTRACT

Based on statistical evidence it is argued that the paper and pulp industry is, in general terms, much slower in its operational procedures when compared with other industries. Industries in which there is intense global competition, like the automotive and electronics industries, show a strong correlation between operational speed and productivity. However, this relationship is far from being linear, as speeding up the material flows seem to have a delayed, but, after a threshold point, significant impact on overall efficiency. Differences between national paper industries exist, and the analysis indicates that the Finnish paper industry is a particularly poor performer from the point of view of efficiency and operational speed. Still, Finland's main competitors are not doing much better. The main objective of this article is to show that true competence in operational skills needed to control manufacturing and logistic processes has not yet really been acquired in the paper and pulp industry. Competition based on raw material prices and production volumes will eventually come to an end, and the winners will be those with the most efficient and expeditious supply chain processes. Finnish paper mills still have the opportunity to achieve a competitive advantage over their rivals by speeding up their supply chain processes.

TIIVISTELMÄ

Hyödyntäen laajaa tilastollista aineistoa artikkelissa osoitetaan, että paperi- ja selluteollisuus on yleisesti ottaen operatiivisessa toiminnassa hidas verrattuna muihin teollisuudenaloihin. Kiivaan ja globaalin kilpailun omaavat alat, kuten auto- ja elektroniikkateollisuus, indikoivat voimmakkaasta korrellaatiosta toiminnan nopeuden ja tuottavuuden välillä. Tämä suhde ei kuitenkaan ole lineaarinen, vaan ilmentää hyppäyksellistä vuorovaikutusta näiden kahden operatiivisen suureen välillä. Materiaalivirtojen ja vaihto-omaisuuden kierron parantamisella on viivyttelevä vaikutus tuottavuuteen, sillä nopeuden parantaminen puolella ei vielä välttämättä sanottavasti vaikuta tuottavuuteen. Vasta saavutettuaan tietyn operatiivisen toiminnan tason, tehtaan sisällä syntyy kertaluokkaa olevan tuottavuuden kohoaminen. Eri valtioiden ja markkina-alueiden välillä näyttää olevan pieniä eroavaisuuksia, kuitenkin siten, että Suomen paperi- ja selluteollisuuden toiminnallinen nopeus on keskitasoa huonompaa. Kuitenkaan keskeisiin kilpailijoihin verrattuna erot eivät ole kovinkaan suuria. Artikkelin pääviesti onkin siinä, että todellinen kilpailu siitä kuka tekee tehokkaimmin operatiivisessa ja logistisessa mielessä paperia ei ole vielä alkanut. Ennen pitkään loppuva raaka-aine- ja volyymiperusteinen kilpailu kaivaa esille todelliset voittajat, joilla on korkea tuottavuus ja toiminnallinen nopeus. Tämän ymmärtäminen mahdollisuutena voi pitkällä aikavälillä nostaa suomalaisen paperiteollisuuden ensimmäisenä maailmanluokan tasolle.

Introducing the approach

Mass customisation, just-in-time, business process reengineering, global sourcing, total quality management, benchmarking and many other industrial management hypes basically strive towards a common goal: to improve productivity. Yet, the term productivity has a multitude of definitions. To an economist, productivity might be measured by gross domestic product (GDP) per capita, while to a biologist it may refer to an organism's ability to use solar energy. When industrial managers are asked to define productivity, the result is again many definitions depending on the type of the manufacturing system and the product in question. Typical measures are production in units, litres, kilos or cubic meters per time, energy or raw-material unit. Thus, the universal formula for productivity is simply output per input.

Not too long ago, the elusive measurement of input per output has made it possible for economists to show that Finland is more productive than Japan and Germany. Of course, this may be the case in a nation that is generating the same output, i.e. GDP, with half the previously employed workforce, the rest now being unemployed. This means that we have to be very careful on how we measure productivity. For the present purpose we define productivity of an entity as its efficiency to exploit its resources to achieve value added.

efficiency = value added / (employment and investment costs) (1)

The resources employed by industry come in two forms, the one being human resources, and the other being machines and equipment. Employment of human resource can be measured by salaries paid and investments in machinery and equipment. By omitting one or the other, one may calculate separately the efficiency for employment and investment. The value added is defined in the following way:

value added = annual turnover - annual purchases (2)

where purchases include everything from stationary to raw materials and electricity. To put it more accurately, *employment and investment efficiency* is used as an indicator of an industry's or firm's ability to compete and allocate its resources effectively. Employment efficiency is defined as the relationship between value added and the total cost of employment in terms of wages, salaries, and related supplements. Investment efficiency is defined as the relationship between value added and capital usage /1/. Capital usage is approximated as the five year average of Gross Capital Formation for machinery and equipment /2/. Index corrections are not used. Efficiencies are calculated on a yearly level. It is assumed that the effects of inflation in value added and costs cancel each other out for each year.

Efficiency is only one facet of the analyses to come. Another operative measure is needed to put everything in perspective. This is the speed, or inventory commitment, of an industrial entity, which is defined in the following way:

inventory commitment = inventory cover in days (3)

The *inventory commitment* of an industry is measured in terms of days of sales committed to production in work-in-process inventory (WIP), finished goods inventory and material stocks. Two assumptions are made in the calculation of the speed of an industry. First, the inventory figures given at the end of the year are assumed to represent the average yearly level. Second, the inventory commitment in production is estimated by assuming that value added is a linear function of production time. Although these are aggregations, with a major sample they provide the analysis with a firm basis for studying the underlying relationship between speed and efficiency.

The data used in the statistical enquiries are industrial statistics collected by the Statistical Office of the United Nations Secretariat /3/. The industrial statistics represent whole industries, for example in the automotive industry (UN classification ISIC 3843) both assemblers and components manufacturers are included, i.e. the data can be seen as representative of the supply network of the automotive industry in different countries. The situation is the same with the paper and pulp industry (ISIC 3411), which comprises the whole raw material chain between forest and the paper mill, but no activities after the mill. The only drawback of these statistics is their delayed update, meaning that the analyses concern mainly the situation during end of the 1980's and the early 1990's. By regarding the results more as a phenomenon, and not as the present status, one may obtain a deeper understanding of industrial competence.

In the following, the speed threshold phenomenon between productivity and speed is discussed first, as it sets the underlying hypothesis for the paper. Next, the results of the analyses concerning the pulp and paper industry are displayed. Finally, the conclusions and implications of the results are considered.

Speed threshold - the hypothesis

Productivity differences are commonly used as a measure of competitive strength in the manufacturing industry, where the normal definition of the productivity is the ratio between the input of resources and the output of goods and services. Porter /4/ regards productivity as the only meaningful concept of competitiveness at the national and industrial levels. On the other hand, advocates of the operational speed school say that a focus on time in operations development allows for more flexibility without the need for more resources /5/. This creates an avenue for value added growth by directing efforts to transform removed slack into improved customer satisfaction. What, then, does the correlation between productivity and operational speed look like?

Starting with the automotive industry, which is probably the most competitive market in the world, clear indications on the existence of a speed threshold can be found (Fig. 1). Above the threshold, improved speed results in improved efficiency. Substantial improvements in speed in the Finnish automotive industry are not followed by sustained improvements in efficiency. In the British automotive industry the improvement in efficiency is only a slow return to the initial level. The much faster US automotive industry, on the other hand, has improved in speed and efficiency simultaneously. The improvement in efficiency is a result of both lower employment and investment costs in relation to value added. It should be noted that an efficiency measure of less than 1.0 means that the industry is consuming more value than it produces. A healthy manufacturing industry measures 1.8 or more.

A threshold is more clearly suggested in the automotive industry when for each year the efficiency and inventory commitment points are connected (Fig. 2). South Korea is left out of the figure since the lower efficiency is clearly a result of surging employment costs. The UK industry is left out because the efficiency improvement appears to be, at least partly, a recovery from the sharp decline at the beginning of the period. The lack of substantial efficiency improvements in Finland, despite the reduced inventory commitment, implies a speed threshold. It is proposed that the efficiency level in the Finnish industry is stable because inventory commitment is above the threshold for efficiency benefits during the whole period studied.

Case study research suggests that the relationship between productivity and speed is more complex than indicated by a straightforward “the faster the more efficient“ relationship /6, 1/. In a study of production dynamics control in different industries /7/ it was shown that a more efficient allocation of resources is possible with greater synchronization of dependent activities and a smaller accumulation of needs in the supply chain. According to this, there should be a clear difference between the effect of reduced inventory commitment in slow and fast industries. Significant benefits from speeding up should be clearly more evident when speed is high enough to allow production to be synchronized with actual consumption. Other studies strongly support these findings /8, 9, 10/.

In other industries, no effort has yet been made to explore the effect of speed thoroughly. However, a study /11/ concluded that throughput time reduction is the only statistically significant way to improve the productivity of manufacturing firms irrespective of nationality or type of industry. An other study /12/ shows in an in-depth investigation of 12 factories from the high tech, process and fabrication industries that the positive effect of cutting WIP inventories on total factor productivity is much greater than can be explained by reductions in working capital alone. On the other hand, it seems that product variety and efficiency are difficult to achieve simultaneously. Results from the analysis of the Profit Impact of Market Strategy study /13/ indicate that customization of products in general has a negative effect on profitability. This is supported by a study /14/ of the UK metal component manufacturing industry, where make to order production was found to have an unfavorable impact on profitability.

To summarize the above analysis, one may formulate the following hypothesis: In order to improve performance by speeding up operations, inventory commitment needs to be reduced to a point where it diminishes operational uncertainty and enables better controllability, which, in turn, results in significant productivity improvement.

Paper industry

In the paper industry, the effect of speeding up is less clear (Fig. 3). The striking difference between the automotive industry and the paper industry is in the durability of efficiency improvements. Once the threshold has been achieved in the automotive industry, performance remains at the high efficiency level, while in the paper industry this is not so clear. The analysis of the automotive industry shows that the speed threshold for substantial efficiency benefits has been passed in several countries. In the paper industry, the supply chain is still too slow to show substantial benefits from increased operational speed, i.e. the real threshold of operational performance has not yet been reached. High efficiencies are extremely vulnerable and improvements are not sustained.

Differencies can also be seen at national levels, as Table 1 indicates. Japan and USA have achieved the high efficiency level in their operations. Perhaps it should be repeated that the information analyzed concerns only operations before and at the mill, i.e. the supply chain from paper mill to the end customer is not included. This means that the relatively poor performance of the Finnish paper industry cannot be explained by its remote geographical location from its main markets. If this were added to the analysis, the situation would be much worse for Finland, and even better for those operating within their main market areas. As earlier studies /15/ indicate, the logistic networks between Finnish paper mills and their customers have a significant improvement potential.

During the ten-year period 1979 to 1989, the correlation between speed and productivity is not strong, yet it is still significant (the binomial parameter p testing for no linear correlation in the data of all six countries in the period 1979-89 is 0.0001). The country data gives no clear relationships, except in certain market areas, namely Japan and the USA, where the relationship is strong. The far right column of Table 1 depicts the situation according to that prevailing in 1989. Here, the data clearly shows that the faster industries outperform the slower ones. Table 1 also shows the relationship between the two input efficiencies. The middle column shows that increased investment bears only a weak correlation with improved employment efficiency.

The average speed of the global paper and pulp industry is slower than in other industries. A more detailed analysis /1/ among several industries indicates that productivity starts its rapid increase when the magic threshold of 30 to 40 days from supplier to consumer has been broken. Clearly, the paper and pulp industry has not yet done this, and it is exactly this which, in the long run, will determine the selection of competitive companies. Fig. 4 summarizes everything by showing each and every measure and their development between certain countries.

A closer look at national differences in speed (Fig. 4a) indicates that Finland is the second slowest in the sample. Yet this has not always been the case, because at the beginning of the 1980's Finland was the fastest. The operational speed of the supply chain up to the mill (note: not up until consumer, which from the mill takes on average 60 - 70 days /15/) was close to 40 days. From there on Finland has steadily developed in the wrong direction, and is now close to 75 days' tardiness. In the meanwhile, some of the competitors have improved their performance, especially the UK. However, the underlying message of Fig. 4a is that none of the sample countries have clearly separated from the others, and, in particular, no supply chain is close to the speed threshold. The fastest supply chains are approaching 40 days in the chain up to the mill, but none is close to the threshold when the consumer is included. Several surveys /16, 17/ indicate that there is significant time slack embedded in the operations of the Finnish paper mill, and that the means to improve operational speed are very practical and appealing to common sense.

In employment efficiency (Fig. 4b) Finland is the worst case, as it has been for most of the period studied here. Korea, Japan and the USA have similar and very high employment efficiencies, although for different purposes, as the labor costs tend to vary significantly among these nations. What ails the Finnish mills? Despite, or perhaps due to, the high level of automation in the production process, the white-collar staff cannot compete with the others in term of efficiency. This is a question is not only of the level of salaries and social security paid, but also of how many people are needed to maintain the hierarchical and bureaucratic organizations, which add no direct value to the end product.

Ranta et al. /18/ have shown that the Finnish paper industry is characterized by its increasingly investment-intensive approach to the development of production processes. This engineering-oriented approach to producing the maximum tonnage in unit time is clearly evident from the statistics (Fig. 4c). The high rate of investment has left a heavy burden by keeping investment efficiency at a low level. While Finland is the worst case, surprisingly Japan also has a relatively low efficiency, albeit 50% better than Finland's. The situation in the mid-1990's indicates that after a few good years the investment has again spiralled in Finland, which may be the right policy, if the cash is appropriately allocated. The UK shows a bizarre trend through its large fluctuations. No explanation for this can be found from the available data.

In terms of total efficiency (Fig. 4d) the whole picture becomes visible: Finland shows a continuous fluctuation between 1 and 1.5. This means that the industry is barely surviving from its own operational and capital costs. A desirable level is somewhere above 1.8, which means that the industry generates enough value added to be able to afford a research and development programme, including human resource development.

Conclusions and strategy

The road to high efficiency is not an easy one. Even a cut of 50% in operational speed may have only a small impact on efficiency. It is not until the world class level in operational performance has been achieved that high returns can be expected. The relationship between speed and productivity seems to be highly non-linear: when a certain threshold has been crossed a productivity jump takes place. According to the analyses, the Finnish pulp and paper industry is slow and has poor employment and investment efficiency, all of which results in poor total productivity. Fortunately, the average performance of the industry in general is rather modest, when compared with that of industries facing fierce global competition together with continuous pressures to innovate and upgrade products. This is exactly what should be realized, i.e. that the real competence-based competition within the paper industry is about to start. Those who outperform others with speed will be the first ones to reap the benefits.

As productivity depends on the value added and operational speed of the mill, work to bring about improvements must start at a very practical level. Action is needed that will have a direct impact on production cycle times, logistic partnering and information flows between mill and market demand. After all, it is the way that things are done altogether rather than separately that counts. Performance in operational speed is the result of teamwork between numerous contributors.

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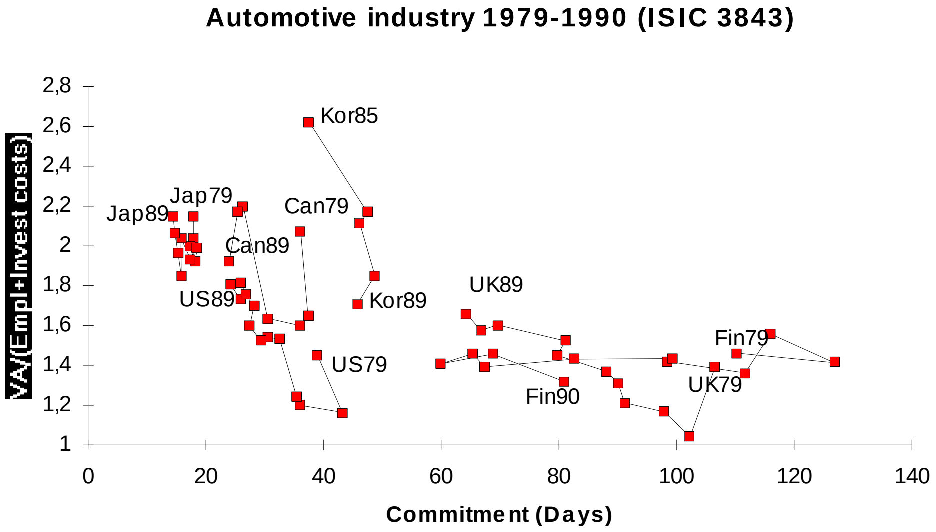


Fig. 1. Speed and combined employment and investment efficiency in the automotive industry /3/.

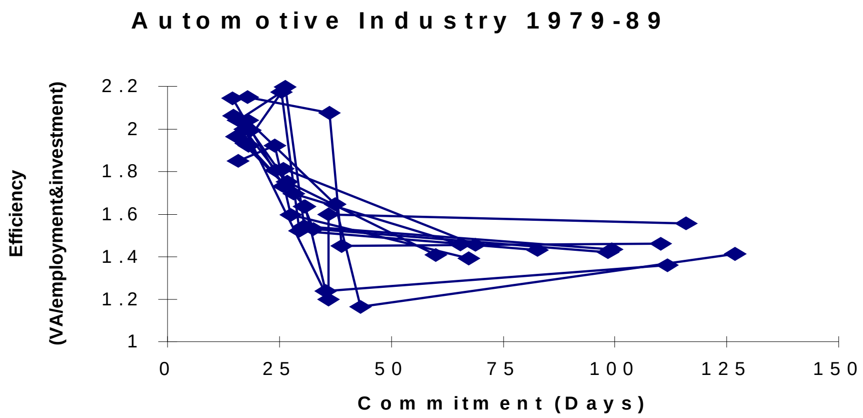


Fig. 2. Is there a speed threshold for realizing the productivity potential of speed in the automotive industry /3/?

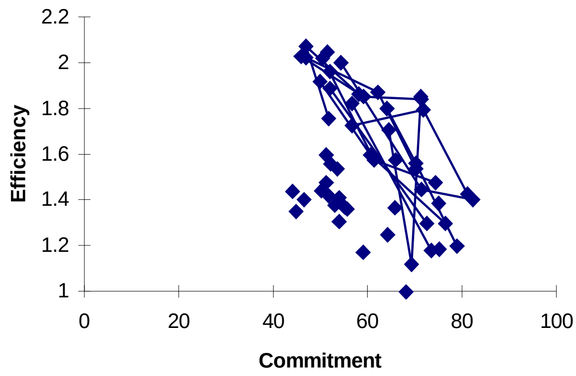


Fig. 3. Efficiency and inventory commitment points connected year by year in the pulp, paper and paperboard (ISIC 3411) industry /3/. The points not connected are the data points for the US and Finland.

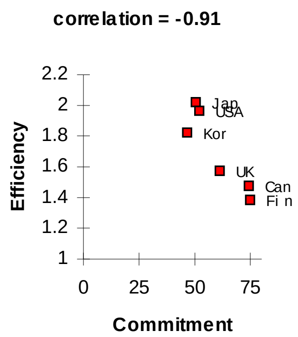
<table>
<tr><th colspan="3">Pulp, paper and paperboard (ISIC 3411)</th></tr>
<tr><th>Inventory commitment & Efficiency 1979-89</th><th>Investment & Employment Efficiency 1979-89</th><th>Inventory commitment & Efficiency in 1989</th></tr>
<tr>
<td>correl. = -0.49
• highly variable speeds and efficiencies among nations
• differences between competent market areas, e.g. USA beats Canada
• compared with other industries the speed levels are modest</td>
<td>correl. = -0.06
• steady heavy rate of investments, which have retarded the overall productivity development
• variable employment efficiencies, depending on the national situation</td>
<td>
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Table 1. Paper and pulp industry and the correlation between different resources and factors and productivity.

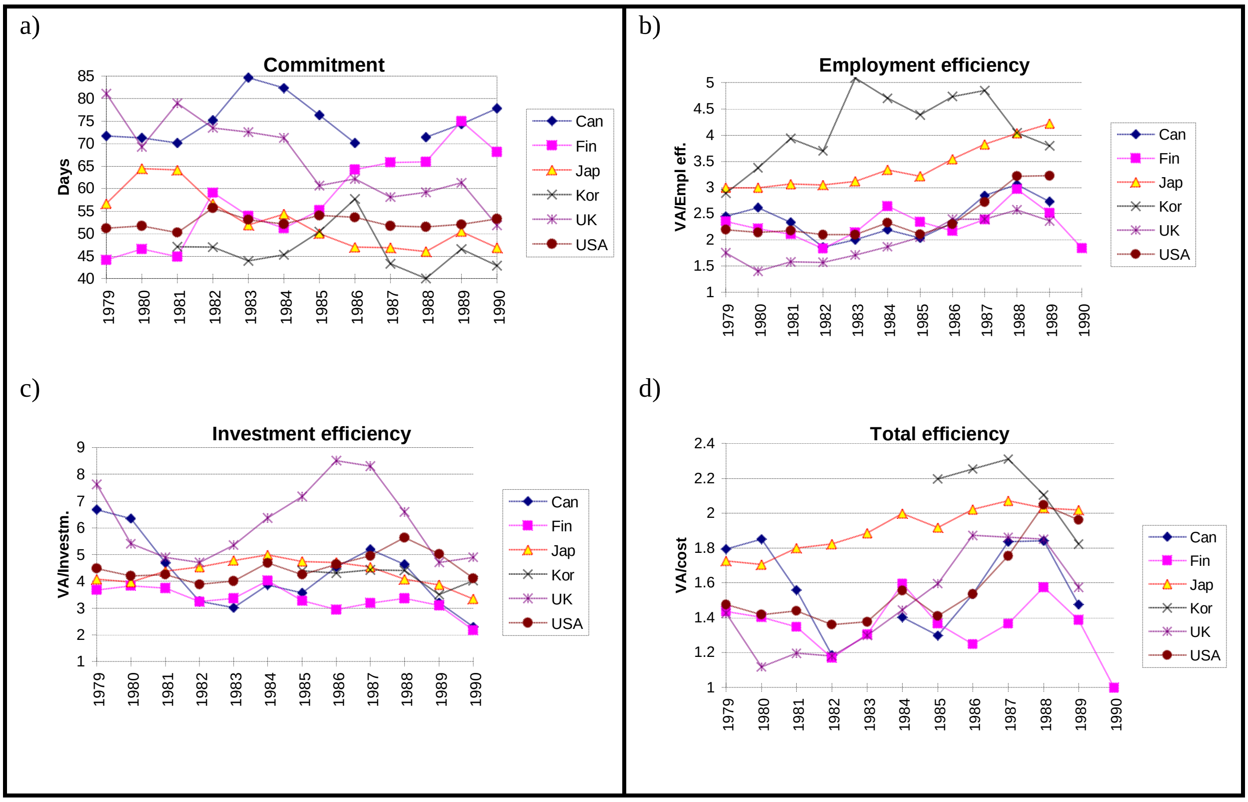

Fig. 4. Various productivity measures among certain countries.