Integration of production and logistics—in principle, in practice and in education

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Received 31 March 1998; accepted 4 August 1999

Abstract

Integration of material processes within and between companies is one of the most fundamental trends in business these days. An integrated view of these processes includes all traditional areas of supplier–buyer relationships and the production of goods and services: generally (and somewhat loosely) speaking, production and logistics. In the paper the issue of integration of production and logistics will be examined from three different but connected points of view. In the first part the conceptual background of the integrated processes will be analyzed, mostly based on the approach of new institutional economics. In the second part an analysis of the actual state and level of integration in practice will be examined, using several recent company surveys. In the third part of the paper a discussion of the current contents of university and management development programs will be given. Finally, conclusions about the connection of handling integration of production and logistics in the three spheres: theory, practice and education will be drawn. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Integration; Logistics; Production; Institutional economics; Education program

1. Introduction

The practice of business has developed tremendously in the second part of the century. This development has transformed the very nature of business activity, the total picture of the business sphere and the social acceptance of businessmen. Interestingly, this development has attracted a less than appropriate interest of academics. This statement is suggested by the naked fact that despite of business becoming probably the most influential sphere of human society in the late 20th century we have very limited results in both the descriptive and the normative theories of business. The results are coming late and mostly fragmented: some parts of business activity have been successfully modelled but (i) theory cannot give an answer to most questions about the present nature of business, (ii) it certainly cannot predict its development. The most theory can do these days is that it explains practical developments, ex post. Even this happens with a rather large time lag. (Just one example: while the practice of MRP has been developed about 30 years ago and the first publications have appeared about its practice more than two decades ago (its practical “bible”, Orlicky’s work was published in 1975 [1]) summaries of the until now sporadic theoretical results appear just recently [2].
This paper is focused on a field which has received quite a strong attention in business literature recently: the integration of business activities. More closely, we will deal with the integration of the material sphere of business. A more precise definition of this “material sphere” will be given later – as a first approach we may use the name of two traditional functional areas to describe our subject: production and logistics.

We are basically interested in revealing the connection between the theory and practice of integration. However, it is quite straightforward that the way between theory and practice leads through education, according to the following scheme (Fig. 1)

This paper examines the above connections. First the theoretical background of integrated production/logistics systems on the basis of institutional economics (which is certainly one, though not the only one, of the possible theoretical foundations). We then make an overview of some business issues regarding the integration of the two functions (first on a conceptual level, then using several survey results given in Appendix A). Finally, we give a picture of how the connection of the two functions is handled in education. Some conclusions will close the paper.

2. The institutional economics model

2.1. Conceptual background

The following train of thought is to support the thesis that internal integration of manufacturing and logistics is a necessity under current economic conditions and that it represents a rational answer to the challenges of the environment.

According to Williamson [3], the connection between economic actors can be described by three fundamental characteristics:

1. **Bounded rationality.** This concept was introduced by Simon [4], who states that the behavior of economic agents is “intendedly rational, but only limitedly so”. In practice this means that economic actors do not have full information and clear preferences when making their decisions.

2. **Opportunism,** which means that economic actors follow their self-interest in their decision making, even with a guile, if they find it useful. This in practice means that in the process of economic activity appropriate contracts must exist between the actors and contract enforcement mechanisms must work in order to ensure that economic processes reflect the interest of all actors and result in outcomes which is acceptable for all participants.

3. **Asset specificity,** which means that as Williamson [3, p. 30] puts it “parties engaged in a trade that is supported by nontrivial investments in transaction-specific assets are effectively operating in a bilateral trading relation with one another. Harmonizing the contractual interface that joins the parties, thereby to effect adaptability and promote continuity becomes the source of real economic value”.

Transaction cost economics as the leading stream of institutional economics is basically about finding the conditions for and defining the resulting extent of that harmony. Our contribution in this paper is showing that the basic ideas of transaction cost economics applies both in inter-company relations and within the company and that considerations based on this theory supports the value of integration of production and logistics.

In his seminal article Ronald Coase [5], the founding father of transaction cost economics clearly describes that businessmen have the double function of reacting to market changes and rearranging the allocation of resources, i.e. that extra-and intra-company changes are to be handled jointly. In business, this practically leads to the continuous revision of the make or buy decisions.
These days we experience two parallel phenomena. The increasing role of enterprise networks stems from the increased complexity of the economy and the increased capital requirements for innovation, which is a condition of staying in competition. We can say that today in most of the essential markets competition goes on not between firms but between networks. So companies on most markets must be stable members of some of the networks if they want to survive. Another relevant phenomenon is that the role of asset specificity is greater in innovation (R&D capacity) than in current production and supply activities. In this latter field increased flexibility leads to the permanent “threat” to any function/activity within a company of being outsourced, which on the one hand is a strong incentive to all involved to perform appropriately, on the other hand connects internal and external integration.

2.2. The conceptual model in a business framework

Current business trends in the world economy especially the ever fiercer competition for the satisfaction of the ever increasing demandiveness of customers (in price, quality, speed, reliability, flexibility and customer service) leads to the requirement that economic actors continuously increase efficiency and effectivity of operations, resulting in ever greater profitability, which is equivalent with the requirement of increasing the speed of return of investments.

One of the most important components of the speed of return of investments is the total throughput time from the rise to the satisfaction of demand. Economic agents start to invest into a specific process when demand arises (or, alternatively dedicate some of their earlier investments, like machine capacity, to this particular process – this is the point when asset specificity becomes fully apparent) and they can expect the customer to pay when they deliver. Of course, many business conditions influence the actual move of money – however the realization of the material processes (the throughput) is a necessary contribution to collecting income. Our view of the integrated connection of the material flows connected to the resulting physical and information processes can be seen in Fig. 2. The smooth realization of these processes is therefore a crucial component of higher profitability. There is no surprise in this statement, but it is

(or, in business terms, the extent of outsourcing) which means a continuous revision of the boundaries of the firm in different directions.
a useful starting point in revealing the theoretical background to integration. One of the central issues of transaction cost economics is vertical integration. The theory describes the characteristics of forward and backward integration, discussing basically the formation of the boundaries of the firm. Its theses help substantially in understanding the background of the supply chain concept [6], when applied to inter-company integration. Here we extend this thinking to intra-company integration.

Fig. 3 is a way of representing some of the fundamental ideas of transaction cost economics. Williamson [3, p. 33] calls it “A Simple Contracting Scheme”, which is a starting point for analyzing the contractual problems stemming from the joint appearance of the three fundamental components of business activity described above (bounded rationality, opportunism and asset specificity). The letter k denotes the degree of asset specificity, s is the degree of safeguard measures against opportunism and p is the acceptable reward for some business activity (it can be the price of a good or service resulting from the activity).

If there is no asset specificity (k = 0), which means that outsourcing is completely flexible, we get to node A obtaining a market price. If k > 0, in case of the need of using some specialized assets (which takes the form of non-general purpose machinery, specific skills of workers, dedicated financial assets or inventories of specific materials or parts), there are two further possibilities. If there is no safeguard against unilaterally terminating the activity to which assets are specifically connected, we get to node B, obtaining a reward ̄p. If a safeguard is applied the risk of interrupted activity decreases (or, if s is very high, disappears), so the reward is certainly lower: ̄p > ̂p. The difference depends on the value of s.

The following remarks can be made on the above analysis.

- The possibility of outsourcing is a safeguard against opportunistic behavior of the internal partners within the firm.
- The issues of internal and external integration cannot be separated. Decisions on technology (k), contractual governance structures (s) and price (p) must be decided simultaneously.
- Internal integration basically means making the internal operation smoother which is equivalent with decreasing the “internal” transaction costs.
- It can be expected (appropriate governance structures can make it sure) that internal safeguards are cheaper than external ones. It means that if there is a smoother, more integrated connection between two activities, it is more probable to do it internally than externally.
- Since (̄p|s = 0) > (̂p|s > 0), the maximum value of safeguard s_{max} = (̄p − ̂p). It can be determined how much we should “pay” for it. The safeguard being the harmonization of two (or more) functions, its value depends on the potential benefits from integration, which in turn depend on the factors determining the possible ways of integration. These factors provide the conditions under which the firm’s management has to harmonize the operation of the integrated functions, depend basically on the common and conflicting features of the functions involved. These features will determine, how costly safeguard measures should be introduced in order to decrease or eliminate opportunistic behavior (i.e. to create mutual interest) of the internal partners (in our case production and logistics). Let us see now what are the common and conflicting features of these two functions.

3. The connection of production and logistics

The identification of separate company functions is a result of the internal distribution of labor, which naturally leads to different contents and
features of the various functions. The smoothness, efficiency and effectiveness of the connections of various functions depend most of all on the relationships between the mentioned contents and features. In case of any two functions there are characteristics of both which help the cooperation of the functions and some others which hinder it. In case of manufacturing and logistics based on actual empirical experiences and on the literature (for some papers specifically handling manufacturing and logistics integration see [7–12], we advance the following common and conflicting features as most important ones:

3.1. Common features

- Both functions focus on the “real” sphere. Both have activities which belong to or lead to the monetary and the information sphere of company operation, but the essence of the two functions is that they arrange moving, storing and transforming goods.
- Both functions must be operational at the end of the day. Of course there are a lot of strategic contexts, long-term effects, etc. involved – but the activities of both functions need to be translated to actual day-to-day operations in the material sphere.
- Both have a fairly well-measurable contribution to the profitability of the company (mainly because of their operational features).
- For fulfilling their tasks, both functions must have a short-term feedback (and of course a long-term one, as well – however, the distinct feature here is the critical nature of the short-term feedback).

3.2. Conflicting focuses of production and logistics

There are a number of conflicting areas of the two functions which must be handled when trying to establish an integrated (or at least smooth) connection. These are especially important for us when we discuss integration, which in this context means the organic handling of these conflicts. These conflicts stem from the very nature of the functions and under normal conditions they are the basis of self-interest seeking (opportunistic behavior) of the parties involved. By normal conditions here we mean that the parties work for the same purpose, i.e. company success but they deem to achieve it in different ways. The most important conflicting features in our view are the following:

- Both production and logistics add value to the product, but in different spheres: production adds use-value while logistics adds place value and time-value (i.e. makes the item available for use at appropriate time and place).
- Production focuses on operations which usually means manipulating the item at a given place while logistics is interested in moving it towards further steps of transformation or to the final customer.
- As a consequence of the type of value they add, from the many different possible criteria which can be used for evaluating the effectivity of the functions, production usually advances quality while logistics emphasizes costs (and prices).
- Attention in production turns first of all to the technology (which actually produces the use value) while logistics is oriented more to the products it has to handle (both in case of inputs and outputs).
- Production sub-functions are usually concentrated in the organization, while logistics sub-functions are spread over. This often goes together with a higher position of the head of the production function, than of the logistics head.
- As for the organizational contacts to other functions, the most important orientative function for production is usually marketing, while for logistics usually production itself plays the most influencing role.

We have called the differences between the two function as conflicting focuses – those familiar with practical operation of any company can give a large number of examples. The main issue from our point of view is that it is the very role of integration to provide a framework for handling these conflicts in a way which ensures the most effective contacts of the functions, the fastest flow of goods towards the final customer, ensuring the fastest return of capital invested – basically we can say that for minimizing frictions in the operation of
the system. Since an appropriate measure of friction is exactly transaction cost, that is what we want to minimize.

Now we have seen that, according to theory, production and logistics should be, and can be, integrated in real-life company operations. Let us see now what we can see from global surveys: are the two functions really integrated in practice?

4. Integration of production and logistics – what do we see from the international surveys?

First of all it has to be confessed that we were rather disappointed when doing this part of the research. We had several surveys at hand both in production and logistics (see the complete list given in Appendix A), and I planned to have a meaningful comparison of them. However, it turned out that only anecdotal conclusions can be drawn: statistical evaluation is impossible because of the inconsistency of the various surveys. In some cases even the definition of data or the position of respondents were not given. In other cases many details were clarified, only the concept of the author(s) regarding the factors of influence or the contents of the data were different. So we only made a contents analysis of the various papers – even from this we managed to get some interesting conclusions.

The issues of the production – logistics interface have been examined through the comparison of performance measures of the two functions. Performance measures can be supposed to reflect preferred managerial behavior, so their harmony (or conflict) may be a good indicator of integration.

There is a wide-spread view that the performance of the material sphere can be characterized by five significant performance measures: cost, quality, flexibility, delivery time and customer service. When one compares the various approaches, he/she will find these five as the most frequently advocated ones. Studying the production and the logistics surveys, the following general picture appeared:

1. The surveys support the statement that logistics managers care more about costs than their colleagues in production: they put more emphasis on analyzing costs and put them higher in the hierarchy of performance measures than production people.
2. The opposite seem to hold for quality. It is on the first place in the order of importance in all production surveys, while it gets varying weight in the logistics surveys. A possible reason, however, can be that the definition of quality differs very much from questionnaire to questionnaire.
3. It is logical but worth mentioning that delivery speed is more important for production while reliable delivery is emphasized more by logistics.
4. It came as a surprise that neither logistics nor production advocated flexibility (measured usually by willingness to change volume). Both in the professional and academic literature flexibility has a stable place among the most important performance indicators, but these surveys do not support its importance.
5. The connection between production and sales is much stronger than between production and purchasing. Most of the surveys handle purchasing as of secondary importance, which is remarkable and arguable – for us it means that integrated management of the internal supply chain is more an exception than a rule.

It must be added that according to our investigation, the survey results vary quite wildly among countries which calls for the need of a more detailed examination about the reasons of differences. We show two illustrations: one from logistics and one from production.

The ELA logistics survey provides a wide range of data about logistics costs in various countries. Fig. 4 shows the logistics cost in percentage of sales in several European countries. One can see that the costs in Spain are about twice the costs in Italy, which is certainly a large difference – it is easy to see why a Spanish manager would give a much higher weight to costs than his/her Italian colleague.

The other illustration (Table 1) comes from the International Manufacturing Strategy Survey and gives data about weighting performance measures. Again there are large differences among countries which certainly puts a question mark behind averages one can read in many reports. The surveys we
analyzed provide very little help in understanding the reasons of the large differences.

As a general conclusion from the performance indicators we can say that there seems to be no fundamental conflict between the two functions, but (if we can consider, as we believe, performance measures as indicators of preferred behavior) they are motivated to show rather different behavior. We cannot draw strong conclusions from the surveys about the actual level of integration, but these evidences show that the degree of integration is much lower than one would expect from the literature. Anecdotal information support this statement.

5. Issues of production–logistics integration in education

There are two major forms of education which are of interest for us when studying the appearance of integration in the curriculum: (i) professional education ending with a certificate from some recognized association, federation or society and (ii) university education. By the nature of these different types of education the professional one is usually faster in implementing new developments even if it is often done at a less-organized, less-clarified level and/or without a well-established theoretical background. Universities implement new course materials more slowly but usually provide more embedment and deeper analysis. In the following we examine both forms of education to see how they reflect the importance attributed to integration.

5.1. Integration in professional education

We examine the appearance of integration in professional education through the analysis of the advanced management development programs of three major international organizations in which production and logistics play a crucial role: the European Logistics Association (ELA), the Federation of European Production and Industrial Management Societies (FEPIMS) and the International Federation of Purchasing and Materials Management (IFPMM). (This part of the paper is based on Chikán [13].) Knowing all three organizations quite well we can say that their study programs provide the most up-to-date managerial knowledge available. All three have advanced level qualification programs (slightly different but comparable in style and nature).

The focus of interest and the scope of activity of the three organizations are different but overlapping (see Fig. 5 for illustration). One aspect is common, however: all three claim that they have an integrated view of the material sphere, including external and internal integration.

We have studied the detailed description of the three programs and have come to the following conclusions:
Table 1
Importance of performance measures in production

<table>
<thead>
<tr>
<th>Countries</th>
<th>Austria</th>
<th>Finland</th>
<th>Germany</th>
<th>Italy</th>
<th>Norway</th>
<th>Spain</th>
<th>USA</th>
<th>Largest</th>
<th>Smallest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance measure (Weight 1–5)</td>
<td>Denmark</td>
<td>Great Britain</td>
<td>The Netherlands</td>
<td>Japan</td>
<td>Portugal</td>
<td>Sweden</td>
<td>Hungary</td>
<td>Weight</td>
<td></td>
</tr>
<tr>
<td>Delivery speed</td>
<td>4.22</td>
<td>3.94</td>
<td>4.05</td>
<td>3.89</td>
<td>3.35</td>
<td>4.00</td>
<td>4.07</td>
<td>4.19</td>
<td>4.10</td>
</tr>
<tr>
<td>Communication with partners</td>
<td>4.48</td>
<td>4.11</td>
<td>4.12</td>
<td>4.33</td>
<td>4.17</td>
<td>4.44</td>
<td>3.80</td>
<td>4.46</td>
<td>4.70</td>
</tr>
<tr>
<td>Delivery reliability</td>
<td>3.79</td>
<td>4.29</td>
<td>4.31</td>
<td>4.00</td>
<td>4.26</td>
<td>3.51</td>
<td>4.14</td>
<td>3.96</td>
<td>4.80</td>
</tr>
</tbody>
</table>

Order of performance measures

| Cost      | 4  | 5  | 5  | 2  | 1  | 4  | 2  | 2  | 4  | 4  | 2  | 5  | 3  | 2  | 3  |
| Delivery speed | 3  | 4  | 4  | 5  | 5  | 3  | 4  | 4  | 5  | 5  | 4  | 4  | 5  | 5  | 5  |
| Communication with partners | 1  | 3  | 3  | 3  | 4  | 1  | 6  | 3  | 2  | 3  | 1  | 1  | 2  | 4  | 2  |
| Quality  | 2  | 1  | 1  | 2  | 2  | 2  | 1  | 1  | 1  | 1  | 1  | 3  | 2  | 1  | 1  |
| Delivery reliability | 5  | 2  | 2  | 4  | 3  | 5  | 3  | 5  | 1  | 2  | 5  | 3  | 4  | 3  | 4  |

Source: IMSS (1994), author’s own calculations
1. Both internal and external integration issues appear in all three programs with basically similar weight. This is illustrated in Table 2, which also provides some interesting insights into other aspects of the structure of the programs. It must be added, however, that the contents analysis of the programs is only a rough indicator of the actual weight of the various parts of the curriculum.

2. The approach of the three programs to integration is different:

- The ELA program handles it mostly as the integration of flows of goods, i.e. as a feature of the technical activities of business (transportation, storing, materials handling, etc). Also, it mostly handles functional connections as direct interfaces, so it provides the linkages which are necessary for integration of production and logistics but talks only little about overall integration issues.

- The program of IFPMM discusses integration as a feature of business processes, mentioning much less about physical flows. The main framework for integration is the supply chain concept, with more emphasis on external than internal integration and focusing on the input side.

- FEPIMS, unlike to the other two organizations, handles integration as an issue separate from handling functional areas. It has chapters called “Integration within the enterprise”, “Supplier interface” and “Customer interface”, which is not such an organic way of discussing integration but helps in calling attention to the subject.

Of course no one can say anything about the quality or ranking of the different approaches briefly described – to rate them would require a much deeper analysis.

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**Table 2**

<table>
<thead>
<tr>
<th>Issues</th>
<th>Organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ELA</td>
</tr>
<tr>
<td>General (strategic) management</td>
<td>22</td>
</tr>
<tr>
<td>Specific functions</td>
<td>32</td>
</tr>
<tr>
<td>Inter-company relations</td>
<td>8</td>
</tr>
<tr>
<td>Internal integration</td>
<td>13</td>
</tr>
<tr>
<td>Economic + legal environment</td>
<td>7</td>
</tr>
<tr>
<td>Management techniques</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

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Fig. 5. The focuses of three international professional organizations.
3. There is very little discussion about the connection of internal and external integration. As we have tried to explain it in the first part of the paper, we believe that there is a very strong connection between the two. This idea is almost completely missing from the programs. Some titles indicate that the authors of the programs considered this issue but it is still far from what we would like to see (all references to this connection are that ELA discusses internal and external integration in the same chapter: “Integrated Goods Flow” and that IFPMM refers to the connection between the supply chain and the value chain concepts).

4. Though the three organizations approach integration with different focus and scope, they all emphasize the importance of the production – logistics integration. However the actual appearance of the issues of interface of these functions is rather seldom mentioned.

5.2. Appearance of integration in the university curriculum

During our investigation about the foundations and spread of integration, we have thoroughly studied the education program of 11 major universities to see how integration is reflected in their production and logistics programs. The study was extended to full graduate and postgraduate programs which are integrated from the educational point of view. They cover usually two years. (We did not deal with individual courses, though we admit it would be interesting also.)

According to the model described in Fig. 2, the question confronted with each program was how much do they cover from the following fields:

1. Supplier relations.
2. Purchasing.
3. Production.
4. Distribution.
5. Customer relations.
6. Information.
7. Physical handling.
8. Integration.

It would take very long to detail how we interpreted the above functions and under what kinds of different name they came (like that production, manufacturing and operations where handled as synonyms). Of course this gave a substantial room for subjective judgments but we finally believe that the resulting interpretation and classification of subject areas correspond very well to common sense and everyday intuition of academics dealing with the above areas. Under “supplier relations” and “customer relations” we ment the “policy level” or “strategic” handling of input and output of the firm, while “purchasing” and “distribution” here express the technical (tactical) aspects of input and output. “Production” was interpreted as the transformation of input into output. Information processes and physical handling (transportation, storing, packaging, etc.) are the connected activities as given in Fig. 2. Under “integration” we included those subjects which directly delt with the complex connections of the above areas. The list of higher institutions the program of which were included in the analysis is given in Appendix A.

Not forgetting the limitations of such an analysis (stemming not only from the above-mentioned interpretation issues but also from factors like the different education systems of the countries included or the different character of business and engineering schools), a few interesting conclusions can be drawn.

It is promising that the issue of integration seems to be one of the core issues of teaching about the “material sphere”. However, the interpretation of it varies widely, which reflects the lack of theoretical background behind the concept. Please note that there are important differences between the interpretation of the traditional functions like logistics, purchasing, operations, etc, which in part explain why the integration of these functions has diverse interpretations as well.

There are three programs out of the 11 which handle more or less evenly all the eight areas listed. Partly as a consequence of the different interpretations used, partly because of the different focuses and traditions of the various schools involved, most of the programs have an explicit emphasis on either the input or the output side. “Production” (the transformation process) is included in all.

Interestingly, while the “technical” aspects of input and output (purchasing and distribution) are
included in the programs with the same frequency, the policy issues in the output size are far more integrated into the programs than in the input side. This may be a (natural) consequence of the customer-oriented operation of the firm's activity. However, considering both the theoretical background provided in this paper (the symmetric logic of customer-supplier relations in the economy) and the extensive discussion on supply chains in recent years, it seems that integrating the input side more into this field of education has yet not reached the high level which may be expected in the future.

6. Conclusions

We believe that the confrontation of handling integration of production and logistics in theory, practice and education has been a useful venture, leading to some interesting conclusions as follows:

1. There can be given a theoretical background for integration in transaction cost economics, which (related to current business trends) supports that integration is not only a buzzword of current business literature but a real need of successful operation. However, at the moment there is no really well-developed connection between theoretical and business literature on the subject; the theoretical background is not elaborated yet while business literature exaggerates the appearance of integration in practice. Finally, there seem to be very little connection between the practice and theory of integration.

2. The actual integration of production and logistics in business practice is less frequent and less deep than one would expect having read the literature (see Chikán [14]). However, importantly enough, the conclusions drawn from practice mostly correspond to the theoretical foundations.

3. Education gives a heavy weight to the integration of the two functions, the material sphere of the company – in fact it seems that, strangely perhaps, the practical aspects are more “in place” in education than either in theory or in practice. However, education schemes neither at universities nor at professional education connect practice to theory.

All this means that (i) there is extensive room for further research in the field; (ii) there is a real need for this research and (iii) the focuses and framework of the research can be quite clearly identified.

Appendix A

A.1. Surveys

Logistics

- European Logistics Comparative Costs and Practice (ELA, 1995)
- Logistics Management and Technology (KPMG, 1995)
- Purchasing and Supply Management: Future Directions and Trends (by J.R. Carter and R. Narasimhan, CAPS, 1995)
- Logistics in Europe – the Vision and the Reality (ELC, 1996)
- Towards the 21st Century. Trends and Strategies in European Logistics (ELA, 1997)

Manufacturing

- Manufacturing delivers! But will that be enough? (by A. De Meyer, European Manufacturing Futures Survey, 1994)
- The International Manufacturing Strategies Survey, 1994
- Building the Value Factory: A Progress Report for US Manufacturing (by J.S. Kim and J.G. Miller), Boston University, 1992

A.2. University programs

Universities the production/logistics program of which have been included in the analysis.
References