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# SUPPLIER NETWORK RELOCATION IN A CAPITAL-INTENSIVE CONTEXT: A LONGITUDINAL CASE STUDY

Pamela Danese, Andrea Vinelli

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3 **SUPPLIER NETWORK RELOCATION IN A CAPITAL-INTENSIVE CONTEXT: A**  
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5 **LONGITUDINAL CASE STUDY**  
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12 Prof. Pamela Danese

13 Department of Management and Engineering

14 University of Padova

15 Stradella S. Nicola, 3

16 36100 Vicenza - Italy

17 Tel +39 0444 998789 – Fax +39 0444 998888

18 E-mail: [pamela.danese@unipd.it](mailto:pamela.danese@unipd.it)

19 Prof. Andrea Vinelli

20 Department of Management and Engineering

21 University of Padova

22 Stradella S. Nicola, 3

23 36100 Vicenza - Italy

24 Tel +39 0444 998740 – Fax +39 0444 998888

25 E-mail: [vino@gest.unipd.it](mailto:vino@gest.unipd.it)

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50 **Corresponding author:** Pamela Danese  
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## Supplier network relocation in a capital-intensive context:

### A longitudinal case study

#### Abstract

The problem of delocalisation has assumed enormous importance over the last years, given the ever increasing number of firms who turn to it in order to improve their competitive performance. This type of intervention has an impact that extends throughout the whole supplier network of those firms that delocalise. The originality of this research in comparison with the numerous studies on this subject lies in analysis of the supplier network relocation of a firm that has delocalised the production plant and operates in a *capital-intensive* context. The use of the *action research* method has enabled us to carry out fieldwork, by conducting a longitudinal case study, on what problems can occur, what solutions can be adopted, and what contingent factors are critical for the realisation of a supplier network delocalisation project in a particular context, such as a capital-intensive context.

**Keywords:** Supplier network delocalisation, Automotive industry, Action research, Longitudinal case study, Supply chain management, Global network

## 1. Introduction

In an international economic context in which the emerging Asian countries, in particular China and India, indisputably have an ever heavier influence on market equilibriums, numerous firms are embarking upon delocalisation strategies, in a bid to recover competitiveness in costs and penetrate the Asian market (Wu 2006).

Over the last decade, *international manufacturing* (IM) and *sourcing* (IS) strategies have been the subject of numerous studies.

IM concerns moving production facilities offshore through foreign direct investments, joint ventures with foreign producers, or other mechanisms (Dornier *et al.* 1998). Many studies on IM focus on manufacturing network design, investigating location decisions and international manufacturing configurations (Shi and Gregory 1998). With regard to location decisions, several authors point out that, over recent years, multinational corporations have invested overseas by initiating start-ups, entering into joint ventures, or acquiring existing organizations (Ferdows 1997, West and Bengtsson 2006). International manufacturing network design can lead to different international manufacturing configurations, depending on the network architecture (see De Meyer and Vereecke 1994, Dornier *et al.* 1998) and the different strategic roles played by factories in the network (Ferdows 1997).

Often IM interventions entail the necessity of reconfiguring the firm's upstream network, leading for example, to the development of a new local supplier network around the production plants delocalised offshore (Camuffo *et al.* 2006). Although this is a very significant problem from a managerial point of view, the literature on IM chiefly concentrates on the delocalisation of production plants. However, the subject of the development and management of international supplier networks is central to IS literature (Murray *et al.* 1995).

Recent years have witnessed a renewed growing excitement and top management attention on this subject in consequence of the decline in competitiveness of many Western firms that consider IS a solution to this problem (Trent and Monczka 2002). Most IS initiatives arise as a response to

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3 increasing global competition, in order to find suppliers offering the lowest unit prices (Alguire *et*  
4 *al.* 1994, Murray 2001, Trent and Monczka 2002). Besides cost reductions, however, several  
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7 scholars (see Bozarth *et al.* 1998, Fraering and Prasad 1999, Chan *et al.* 2007) state that other key  
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10 motivations can lead to IS initiatives, such as greater access to new process/product technologies  
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12 and competences, greater ability to introduce competition to the domestic supply base, and greater  
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14 opportunity to penetrate new markets.

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17 Many studies on IS subject aim to individualise several reference models for the planning and  
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19 management of international supplier networks (Monczka and Trent 1991, 1992, Chadwick and  
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21 Rajagopal 1995, Bozarth *et al.* 1998, Liu and McGoldrick 1996, McIvor 2000).

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24 The American scholar Amy Zeng (2003), after a careful revision of numerous articles on IS and a  
25  
26 series of interviews with experts, proposes a general model for the realisation of an IS project, based  
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28 on five phases. The first three concern the planning of the intervention and include: (1) the  
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30 preliminary analysis of the context in which the firm operates, in order to understand what  
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32 opportunities could be exploited by applying an IS strategy; (2) the analysis and planning of the  
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34 intervention, which includes the definition of the selection criteria for the suppliers and the  
35  
36 cost/benefit analysis of the project; and (3) the selection and development of the suppliers, which  
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38 aims to choose new suppliers and define purchase prices and the level of service that the suppliers  
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40 themselves must guarantee. The last two phases of the realisation of an IS project concern the  
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42 management of the relations with the suppliers, namely coordination with the new suppliers to  
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44 satisfy purchasing requests, and the measurement and monitoring of supplier performance.

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47 Many tools can be used to support the IS planning phase. These include the Kraljic Matrix (1983),  
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49 or the Total Cost of Ownership (Ellram 2006) which are used to understand which components  
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51 need to be purchased at global level, or from which country to procure supplies (see Van Weele and  
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53 Rozemeijers 1996). Moreover, studies on procurement strategies provide the mechanisms through  
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55 which the relationships between the buying and supplying organisations can be managed (Bozarth  
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60 *et al.* 1998).

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3 However the problem of how to manage the transition phase from one supplier network located in a  
4 certain country to a new supplier network located elsewhere has not been explored; an important  
5 question in the event that a production delocalisation project also requires the delocalisation of the  
6 upstream network.  
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12 The problem of relocating the supplier network is particularly critical in a *capital-intensive* context.  
13 In this case, the levels of service in terms of quality and punctuality of supply must necessarily be  
14 very high, as capital-intensive production plants are by nature more sensitive to variations in quality  
15 and punctuality of supply compared to human resources. Tolerance errors in component  
16 specifications and delays by suppliers can cause plant stoppages. It is therefore not possible to  
17 accept that, during the transition phase from one supplier network located in a certain country to  
18 another, delays, interruptions or quality problems occur in the procurement of components.  
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29 Lastly, it is interesting to note that, even if the subject-matter of the studies conducted on IM/IS to  
30 date are chiefly firms operating in *labour-intensive* sectors – such as textiles, footwear, toys etc. –  
31 or, in any case, firms that do not use highly automated production plants (Camuffo *et al.* 2006,  
32 Nassimbeni and Sartor 2006), such field of research proves restrictive. Delocalisation increasingly  
33 represents a phenomenon that also involves other types of enterprises, such as those operating in  
34 capital-intensive sectors, that aim to recover lost competitiveness, due to the increase of Western  
35 costs, or to open an interesting outlet in a fast growing market (J.D.Power-LMC 2005).  
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48 In light of these considerations, this study analyses the implementation of a supplier network  
49 delocalisation project in a context characterised by a capital-intensive production system. In  
50 particular, the use of the *action research* methodology has enabled us to carry out fieldwork, by  
51 conducting a longitudinal study, on the transition phase from a supplier network located in a certain  
52 country to a new supplier network located in a low-cost country, during its realisation.  
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59 The research was developed in collaboration with FIAMM s.p.a., world leader in the horns sector,  
60 which has recently delocalised the French production plant, which assembled four families of

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3 products on automated lines, and its supplier network to India. This has meant organising the  
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5 relocation, not only of the assembly lines, but also of around six hundred components necessary to  
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7 produce the horns, for the production of which approximately one hundred and forty different  
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9 equipments are necessary. The research project was developed over a period of more than 2 years,  
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11 during which researchers had the opportunity to participate in and clinically observe the transfer of  
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13 FIAMM's upstream supply network from France to India.  
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17 This protracted observation and the active participation of the researchers with the project team has  
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19 led to a clearer understanding of what problems can occur, what solutions can be adopted, and what  
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21 contingent factors are critical for the realisation of a supplier network delocalisation project in a  
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23 capital-intensive context.  
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29 The paper is outlined as follows. Section 2 describes the research context, by highlighting the  
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31 changes that have characterised the automotive sector in the last years, and the main elements of  
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33 FIAMM's supply network that have made the relocation of supplier network particularly critical. As  
34  
35 point out by Coughlan and Coughlan (2002), a deep understanding of the context is essential in  
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37 action research studies. Section 3 presents the project implemented by FIAMM; while section 4  
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39 highlights problems that arose during the project and solutions adopted. Finally, section 5  
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41 summarises the main theoretical and managerial contributions of this research and provides some  
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43 indications for future research.  
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## 50 **2. The context**

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52 The delocalisation project realised by the FIAMM Group derived from the strategic decision to  
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54 close the French plant, Klaxon, and develop another production activity in India by means of a joint  
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56 venture with a local horn manufacturer (Minda), creating a new company called Fiamm Minda  
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58 Automotive Limited (FMAL). FIAMM's decision is the result of changes that have characterised  
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3 the automotive sector over recent years and have driven the firm to seek cost advantages both on the  
4 supply as well as the production front, and a new outlet.  
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### 10 *2.1. The automotive sector and FIAMM's performance objectives*

11  
12 FIAMM is world leader in the production and sale of horns. In America, the firm meets most of the  
13 volumes of horns required by major automobile manufacturers such as GM and Ford. In Europe, it  
14 has supplied the principal car manufacturers for years. These manufacturers consider the FIAMM  
15 brand synonymous with quality and service, the two characteristics that the company has always  
16 concentrated on in order to become market leader and weave long-term partnership relations with  
17 customers.  
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27 Over the last decades, the automotive market has been characterised by significant changes, which  
28 have had strong repercussions on the automobile industry and on the whole of its related industries.  
29 Consumption in North America and Western Europe has for some years been stagnating, which for  
30 many car manufacturers has turned into a reduction in sales and, consequently, in the increase of  
31 competition within the sector (J.D.Power-LMC 2005). These dynamics have driven many firms,  
32 customers of FIAMM, to exert strong pressure for the reduction of the purchase price of  
33 components.  
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43 Furthermore, it is necessary to remember that the last years have been characterised by exceptional  
44 growth in the price of raw materials. The source Metalprices (2006) shows that between 2004 and  
45 2006 copper, tungsten and steel have increased by 90%, 325% and 10% respectively. The effect on  
46 FIAMM has been twofold: on the one hand the increase in the price of raw materials has had a very  
47 significant impact on the cost of horns, given that raw materials account for 50% of the cost of the  
48 finished product; on the other these increases have contributed to further increasing the pressure  
49 exerted by car manufacturers in order to obtain a reduction in the purchase prices for the horns, the  
50 latter also obviously suffering from the effects of the rise in the price of raw materials (one only has  
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3 to consider the impact of the cost of steel). This has consequently led to a significant reduction in  
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5 FIAMM's sales margins.  
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8 Lastly, to this one must add the entrance into the market of new aggressive Asian competitors, such  
9  
10 as the Indian company Roots and the Chinese company Shanghai STEC, who sell horns at very  
11  
12 competitive prices. These firms have been able to knock down the barriers to entry made by the  
13  
14 investments in production plants through the realisation of an assembly process which is almost  
15  
16 entirely manual. Even if their performance in terms of quality and service level offered are not  
17  
18 currently regarded as comparable to those of FIAMM, it is only to be expected that in the not too  
19  
20 distant future these firms will become dangerous competitors.  
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24 It emerges, therefore, that over the last years, the objective of reducing the price of its products has  
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26 become a priority for FIAMM. In addition to the price, the firm considers the quality of the product  
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28 and the punctuality of supply as important *order-winners* in order to achieve a competitive  
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30 advantage. The horn is classified as a security device and for this reason it must meet a series of  
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32 strict regulations in terms of sound level, life and reliability. In addition to the regulations dictated  
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34 by the highway code, there are also the strict purchase specifications imposed on FIAMM by car  
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36 manufacturers. The customer demands constant certification of product quality, by means of strict  
37  
38 checks on the finished product, its components and the raw materials used. Car manufacturers insist  
39  
40 on full visibility of FIAMM's sources of supply and on being informed in the event of  
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42 modifications to the product, components or procurement sources.  
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46 The punctuality of supply is also highly critical. The penalties in the event of delays or failure to  
47  
48 supply are very heavy. A non-delivery or delayed delivery can mean that a car manufacturer has to  
49  
50 stop a production line or park the incomplete cars while awaiting the missing components, since, as  
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52 mentioned above, the horn is a security device and no vehicle may be sold without this component.  
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56 On the one hand, therefore, the necessary reduction of costs of the horns has made the relocation of  
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58 part of the production and supplier network to India essential for FIAMM. On the other, however,  
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60 the characteristics of the context in which FIAMM competes have made this intervention

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3 particularly complex, since the delocalisation has had to be realised without compromising the  
4 quality of the horns and the punctuality of supply in any way.  
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## 10 2.2. FIAMM's upstream network and relocation strategy

11 Klaxon, which was closed in consequence of the delocalisation of production to India, purchased all  
12 the components necessary to produce horns (approximately 600 component codes) from a local  
13 network of approximately 40 small firms, many of these had developed precisely thanks to Klaxon.  
14 These suppliers produced the components according to the designs provided by FIAMM, utilising  
15 in total approximately 140 moulds and machinery owned by the latter. FIAMM's first-level  
16 suppliers in turn were supplied with raw materials and semi-finished products mainly by large  
17 multinationals, the relationships with whom and the price negotiations were managed directly by  
18 FIAMM.  
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31 In the French production plant, the horns were assembled on highly-automated lines. These lines  
32 have been relocated to the new production plant, FMAL, in India. The use of automated lines means  
33 suppliers' observance of the punctuality of supply and the quality standards of the components  
34 supplied is essential. Indeed, a delay in the delivery of even one single component means that  
35 FIAMM has to stop the production line. Furthermore, working with automated lines requires careful  
36 checking of the components to be assembled from a dimensional point of view. If the components  
37 do not meet the specifications in terms of tolerance, it is highly unlikely that they will be able to be  
38 assembled correctly by the robots on the line. Therefore, it follows that the supplier must implement  
39 strict quality control and monitor the production process in order to guarantee absolute constancy of  
40 output.  
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54 The use of highly-automated lines ensures that the cost of labour represents only 20% of the cost of  
55 a horn, whereas the cost of components is 65%. These data reflect a production model characterised  
56 by very risky automation and aimed at reducing the processing costs. This model unites the  
57 principal actors in the horn sector, namely FIAMM, Bosch and Denso; and, at the same time,  
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3 greatly differentiates these firms from the new Asian competitors, which rely on an almost entirely  
4 manual production process. The high incidence of the cost of components suggests how a careful  
5 management of the supplier network is essential for FIAMM if it wishes to reduce the costs of the  
6 product.  
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12 As demonstrated in the previous paragraph, the dynamics which have characterised the automotive  
13 sector over the last years have made it necessary for FIAMM to adopt a cost reduction policy. The  
14 reduction of costs, however, is not the only reason that has driven FIAMM to delocalise production  
15 and relocate the supplier network to India. Unlike the North American and European markets, those  
16 in South America and Asia are in sharp growth and represent markets undergoing frenzied  
17 expansion. One only need consider that India alone in the first half of 2005 witnessed a 13%  
18 increase in car sales (J.D.Power-LMC 2005). This tendency, together with the opportunities to  
19 reduce the costs of production offered by these countries, has led to the migration of plants and  
20 production volumes of the principal car manufacturers towards China and India. In 2005 in Asia the  
21 production of vehicles increased by 1.4 million units, and by 2020 it is expected that nearly 60% of  
22 vehicles will be assembled in this country. In this sense, China and India represent an attractive  
23 market for FIAMM.  
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### 43 **3. The implementation of relocation project**

44 The objective of supplier network delocalisation concerned the development of a new supplier  
45 network that could supply the Indian production plant, FMAL. Since, the old suppliers of Klaxon  
46 used a series of equipment and moulds owned by FIAMM to produce their components, this has  
47 meant initially arranging a procedure that would enable the firm to decide which moulds and  
48 equipment it would be worthwhile to relocate, and in the event of relocation, the shipment priority  
49 of the equipment.  
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3 The first step for the construction of this procedure was the individualisation of the criteria that  
4 would enable the firm to divide the components into classes with such characteristics that justify, or  
5 not, the relocation of the equipment, or a different priority in the relocation. The criteria used were:  
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- 10 (1) the annual purchase value of the components, calculated as purchase price of the component  
11 multiplied by the annual quantity purchased (expressed in Euros);  
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- 14 (2) the complexity of the process technologies.  
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### 20 3.1 ABC classification by annual purchase value

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22 The analysis of the annual purchase value of the components allowed three classes of components  
23 to be identified (Figure 1):  
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- 26 • Class A: components each weighing between 5% and 1% on the total purchase value. These  
27 components together represent 55% of the total annual purchase value.  
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- 30 • Class B: components each weighing between 1% and 0.2% on the total purchase value; in  
31 total they represent 28% of the annual purchase value.  
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- 34 • Class C: components each weighing less than 0.2% and represent the remaining 17% of the  
35 total annual purchase value.  
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43 Insert Figure 1 about here  
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48 The components in class A were a priority for the firm in terms of supply delocalisation to India,  
49 since if the high annual purchase value depended on a high price of the component, it was probable  
50 that the saving opportunities, by producing that component in India, would be considerable. If,  
51 however, the high purchase value derived from a consistent annual purchase volume, by  
52 immediately delocalising supply to India, FIAMM, besides being able to benefit from a saving due  
53 to the reduction of the purchase cost, would also be able to considerably reduce the expenses due to  
54 international transport between Europe and India. In the transition period during which the new  
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3 Indian plant was already operational but the supplier network not entirely relocated, components,  
4 obviously, continued to come from European suppliers, with a consequent increase in transport  
5 costs. This increase is particularly relevant if the volumes of goods to be shipped are high.  
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10 Class A is formed of approximately 20 purchase codes. Class B by approximately 70, for the most  
11 part brackets and connectors, which represent the components of the horn that are customised  
12 according to customer requirements and for this reason show lower purchase volumes. Lastly, class  
13 C contained the remaining 500 purchase codes approximately, including parts with low added value  
14 (screws, washers, nuts etc.), and components related to special series or products produced in small  
15 volumes.  
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### 27 *3.2 Classification by complexity of the process technologies*

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29 Once the classes are defined by purchase value, it was considered appropriate to also analyse the  
30 process technologies linked to the production of each component. In this phase, in collaboration  
31 with the Indian project team, the firm tried to understand which technologies were “transferable” or  
32 not and, among those that could be transferred, those that would be easiest to transfer to Indian  
33 suppliers, since no particular expertise was required for their functioning and maintenance or, the  
34 Indian suppliers had already acquired the necessary experience for their use.  
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43 The technologies were classified into three classes:

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45 • Non-transferable technologies: this class included very complex technologies, such as co-  
46 moulding for the connectors, or cold stamping. They were not transferable because their use  
47 and maintenance required a great deal of experience and expertise which the Indian  
48 technicians did not have.  
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- 53 • Critical technologies: included those technologies considered transferable to India, but  
54 which in any case necessitated a transfer of knowledge to Indian suppliers, and those  
55 technologies that could be substituted by other alternative technologies already familiar to  
56 the Indian suppliers. For example, Indian suppliers’ knowledge of the moulding process of  
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3 plastic materials for the realisation of the trumpet was considered inadequate. It was  
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5 considered, however, that it could be considerably improved thanks to the training of the  
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7 supplier's personnel *in loco*. Whereas, the transfer press stamping for the realisation of the  
8  
9 horn housing, was too complex for the Indian suppliers in terms of technological knowledge  
10  
11 of the necessary machines and moulds. However the alternative, proposed by an Indian  
12  
13 supplier, consisting in the use of manual tool was considered acceptable, a solution which is  
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15 technologically less advanced and efficient due to a greater quantity of wastage, but which,  
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17 being compatible with the level of knowledge of the technology of the Indian supplier,  
18  
19 permitted the local procurement of the part.  
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- 24 • Non-critical technologies: this last class included simple technologies, such as steel strip  
25 stamping for the production of the brackets, the high resistance steel stamping for springs  
26  
27 and breakers and, also several plastic moulding processes for the production of connectors.  
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### 34 *3.3 Definition of the transfer lot*

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36 By considering the ABC classification by annual purchase value and the classification by  
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38 production process complexity together it was possible to define a procedure for the definition of  
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40 the "transfer lots" that would lead to the reconstruction of the French supplier network in India. In  
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42 other words the objective was to decide which lots of equipment to relocate and with what priority  
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44 (figure 2).  
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57 Insert Figure 2 about here

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### 3.4 Technical and logistical aspects connected to relocation

Transfer lots defined according to procedure of figure 2 were subsequently analysed by the engineering function in order to consider the technical aspects connected with the equipment and the components.

First, this function estimated the residual “life” of each component, namely the possibility that substantial modifications would shortly be made to it, or substitutions with alternative components.

This check is fundamental since there is no sense investing in the relocation of equipment to produce parts that do not have production prospects of greater than 6 months.

In addition, with regard to the components to be relocated, engineering function was asked to quantify a “technical” safety stock ( $S_{\text{technical}}$ ), with the aim of safeguarding against any problems that could occur upon restarting the equipment in India. This safety stock was a function of the complexity of the equipment’s resetting and functioning and varied from between 0 and 4 weeks.

Lastly, the list of components to be relocated was reviewed by logistics function, in order to establish the transfer date of the equipment, so as to avoid any production stoppages during the transfer of the equipment itself.

It was essential firstly to calculate the current stock of components within the supplier network ( $S_{\text{supplier network}}$ ). To accurately calculate this stock it was necessary to know:

- the stock of components at the French supplier ( $S_{\text{F-supplier}}$ );
- the stock of components at the warehouse of FIAMM’s French plant ( $S_{\text{F-FIAMM}}$ );
- the stock of components at the warehouse of the Indian plant, FMAL ( $S_{\text{I-FMAL}}$ );
- the stock of components in transit from France to India ( $S_{\text{in transit}}$ );
- the average weekly requirements of components ( $R_{\text{week}}$  – obtained by multiplying the planned orders of finished products by the quantity of component used).

Therefore we have:

$$S_{\text{supplier network}} = S_{\text{F-supplier}} + S_{\text{F-FIAMM}} + S_{\text{I-FMAL}} + S_{\text{in transit}}$$

This stock expressed in weeks ( $S_{weeks}$ ) is calculated as follows:

$$S_{weeks} = S_{supplier\ network} / R_{week}$$

In order to continuously supply the Indian plant FMAL with the necessary components it was essential that the stock ( $S_{weeks}$ ) be greater or equal to the time necessary to send the equipment, restart it and obtain the validation of the components from the car manufacturers. During this time interval, no new components could be produced and therefore the Indian plant had to utilise the stocks accumulated within the supplier network. As illustrated in the Gantt diagram of the supplier network delocalisation project (figure 3), we can observe that this period was on average approximately 6 weeks (steps 11 and 12 in the figure). Naturally it could vary depending on the necessary technical safety stock ( $S_{technical}$ ), the estimated time necessary for the components' approval by the car manufacturers ( $T_{validation}$ ), and the time for the transfer of the equipment ( $T_{transfer}$ ). It was decided to transfer the equipment by air, rather than by ship, in order to contain the stock to be accumulated before the transfer:

$$S_{weeks} \geq (S_{technical} + T_{validation} + T_{transfer}) = 6 \text{ weeks on average}$$

The date for the end of production in France and the shipping of the equipment had therefore to be set bearing in mind that, if the stock within the supplier network was less than ( $S_{technical} + T_{validation} + T_{transfer}$ ), the French supplier had to have time to produce the necessary stock.

This time obviously depended on the production capacity of the supplier, but on average, as illustrated in figure 3, it was 3 weeks. If, however, for one component:

$$S_{weeks} \geq (S_{technical} + T_{validation} + T_{transfer}), \text{ then the equipment necessary to produce it could be sent to}$$

India immediately.

The analysis realised by logistics function enabled a final transfer schedule to be drawn up, which for each component considered transferable (also as a result of the engineering function's evaluation) reported, in addition to the technical safety stock, the total stock within the supplier

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3 network, the date set for the end of production in France, the date of shipping of the relative  
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5 equipment and the estimated date for the restart of production with this equipment in India.  
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10 Insert Figure 3 about here

11 \*\*\*\*\*

#### 12 13 14 15 16 17 **4. Problems discovered and solutions adopted**

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19 During the implementation of the delocalisation project numerous unexpected problems emerged  
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21 which risked compromising the outcome of the project itself.  
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##### 25 26 27 *4.1 Checking the stock in transit and planning the requirements of components*

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29 As emphasised in the previous section, for deciding when to transfer the equipment, it was  
30  
31 necessary to know the average weekly requirements of components, the stocks at French suppliers,  
32  
33 at the French FIAMM warehouse, the stocks in India and those in transit. Initially it was considered  
34  
35 that finding these data would not have been difficult. The firm, having the ERP SAP/R3 system that  
36  
37 was integrated between the various European plants, could have the information relating to the  
38  
39 stocks at suppliers' factories and the FIAMM warehouses in Europe both quickly and reliably.  
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41 However, it proved very difficult to obtain reliable information concerning the stocks of  
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43 components in transit and those at the Indian plant, since, at this plant no information system  
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45 existed to check the stocks and the planning and control of production.  
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50  
51 In practice the only way to verify the actual date of reception of the goods in India was by means of  
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53 notification from the Indian planners, a method which intrinsically did not give the European  
54  
55 planners the precision necessary to assess the stocks in the FMAL plant. Moreover, since not even  
56  
57 the collections from the warehouse were registered in an information system, it was impossible to  
58  
59 assess the exact stocks of components in the FMAL plant. Inventories in the warehouse in India  
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were checked periodically and manually, with notifications on the physical stocks to Europe by

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3 MS-Excel spreadsheets. The fact that the updating operations on the stocks were not managed in  
4  
5 *real time* created considerable variances between the stocks visualised on the terminal in Italy and  
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7 those effectively present at each moment in the plant in India.  
8  
9

10 As regards the stocks in transit, these had to be estimated by considering what had been shipped and  
11  
12 the arrivals of goods communicated by the Indian planners. The total quantity of goods shipped  
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14 could be calculated by checking shipments registered on the ERP system.  
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17 However, given the high number of component codes that were transferred periodically, the  
18  
19 complexity of the management of a stock control and production planning system of this type  
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21 appears evident.  
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24 In addition to this, the definition of the weekly requirements of components proved very  
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26 problematic. On the one hand it proved impossible to refer to the historical production data in order  
27  
28 to calculate the requirements. This was because the last months of production by the French  
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30 suppliers showed production volumes that had been corrupted by the need to build up a stock of  
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32 components necessary for the transfer of the equipment. On the other, considering the historical  
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34 data prior to the start of the creation of this stock constituted a great risk of error, since the mix of  
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36 products realised by FIAMM and therefore also the components required vary significantly over  
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38 time.  
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43 The project team therefore decided that the only way to calculate the requirements of components  
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45 was to base them on the future purchase orders communicated by the car manufacturers. However,  
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47 the agreements between FIAMM and the car manufacturers provided for visibility on the orders of  
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49 just three months, which was no longer adequate given the expansion of the procurement and  
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51 delivery lead times, caused by the new, though transitory, structure of FIAMM's supply network  
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53 (figure 4). Until the components were purchased in India and the attainment of the quality standards  
54  
55 was guaranteed, they would have to be sent by ship by French suppliers to the FMAL plant in India  
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57 (delivery time: 2 months), while the horns produced by FMAL would have to be sent back, once  
58  
59 produced, to France for checking and then shipping to customer. In practice, the component  
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3 requirements would have to be planned based on customer orders, only if the orders were  
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5 communicated 5 months in advance.  
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12 Insert Figure 4 about here

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20 The lack of reliability of the stocks registered in the information system and the difficulty in  
21 defining component requirements represented a strong limitation to the accurate management of the  
22 first transfer lots of equipment.  
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26 To calculate more accurately the actual level of stock necessary before transferring the equipment  
27 (i.e.  $S_{\text{supplier network}}/R_{\text{week}}$ ), several corrective actions were adopted. Firstly, it was decided to  
28 temporarily introduce a new “virtual” category of stock in the information system for the  
29 management of the stocks in transit. The shipments of components from France, registered as stocks  
30 in that category, were automatically added to the stock available at the FMAL plant on the  
31 estimated date of arrival in India, in this way bypassing the phase regarding the communication to  
32 Italy of the arrival of materials in India. Naturally this was only a temporary solution to the problem  
33 which did not entirely resolve the question of stock control in India. The most important initiative  
34 concerned the decision to speed up the process of SAP/R3 implementation in India, by dedicating  
35 several resources specialised to the project and training the Indian resources who would be using  
36 the software.  
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52 Moreover, as regards the planning of the requirements, a fundamental step was contacting the car  
53 manufacturers in order to obtain a broader visibility of the purchase orders (at least 6 months).  
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#### 4.2 Collection and coding of the information on components and equipment

The collection of data regarding the components and equipment represented a critical phase in the implementation of the project.

The collection of such data essentially had a double purpose. On the one hand the data were necessary to plan and manage the relocation process (for example defining the priority of shipment of the transfer lots and creating the documentation that would accompany the crates), and on the other making explicit the knowledge concerning the components and equipment was essential to enable the new Indian suppliers and colleagues from the FMAL plant to operate.

The responsibility of collecting and coding the data was initially entrusted to the managers of the Klaxon plant, who should have retrieved the information necessary for the relocation, within the firm and collaborating with the French suppliers. In addition to having greater experience of the products and processes involved, they also had, as regards workload, more free time, since the activities concerning ordinary management of the plant had decreased. This choice however caused a series of problems of a psychological, relational and motivational nature which absolutely could not be ignored.

The colleagues in Klaxon, in most cases, often turned out to be understandably reluctant to collaborate, since they were aware that the project in progress, to which they were asked to participate, was the same that would take away a lot of their jobs. In the same way, the French suppliers, who soon would have seen their turnover considerably reduced due to the closure of Klaxon, did not completely collaborate; they provided partial data on the equipment in their possession and the process technology, information which was absolutely essential to restart production in India.

Therefore, very soon it was decided to transfer the responsibility of collecting the data to the managers of the Italian FIAMM plant, which was already working on the project. The leader of the Italian project team, as project manager, also had full authority over the resources of the Klaxon plant.

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3 The members of the Italian team, with great effort and in collaboration with their French colleagues,  
4 started to collect a series of information on the quality specifications of the components, the  
5 application of the process technologies, equipment maintenance, the tests to be carried out on the  
6 components etc. This knowledge, in most cases, belonged to few experts, while the relative  
7 documentation was inadequate. Moreover, this documentation was in French, since Klaxon was  
8 originally a French company later acquired by the FIAMM Group.  
9

10  
11 Considering these problems and given the need that the data on the components and equipment be  
12 shared between the company functions (see the previous section), before long it became necessary  
13 to code and classify the information in a database that would collect the enormous amount of  
14 information gathered and allow it to be used by means of a standard language and shared  
15 conventions. Practically all the information collected from the different functional areas flowed into  
16 this database (such as for example: the equipment value, the product family to which the component  
17 belonged, the current supplier, the annual volume, the standard price etc).  
18

19  
20 Furthermore, in order to facilitate consultation, the components were classified into nine macro-  
21 groups, each one included those components produced using the same technology (steel strip  
22 stamping for example). Each macro-group was divided in turn into sub-groups, each contained a  
23 certain type of component. For example the “steel strip stamping macro-group” included the sub-  
24 groups: “horn housing”, “compression chamber disc”, “membrane”, “breaker” and “spring”.  
25

26  
27 The sections and information that the database should contain were defined during the development  
28 of the project. For example, during the delocalisation process, the need emerged to carry out  
29 modifications to several components, in terms of raw materials or treatments, because they were  
30 more easily available in India. The various functions did not align with each other on how to  
31 manage this problem, not understanding initially its importance, and consequently significant  
32 problems regarding component codes arose. In particular, in several cases once a component was  
33 modified so too was the component code, while in others the code stayed the same. Although it is  
34 clear that the modification of the code is essential to verify the causes of any non-conformities in  
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3 the finished products, nevertheless, in a process of supplier network delocalisation this is not  
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5 sufficient. It is also essential to maintain a connection between the original component code and that  
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7 of the modified component, namely highlight which components derived from the modification of  
8  
9 others and can be used as substitutes. When requirements of the component are calculated on the  
10  
11 basis of bill of materials containing the new component code, it can result that in the warehouse  
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13 there is not sufficient quantity of the component, when there may still be considerable stocks of the  
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15 original component sent from France. Therefore it was decided to always modify the component  
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17 code in the event of modifications to the raw materials or treatments, but to register in the database,  
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19 alongside this code, any substitute components sent from France.  
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#### 27 *4.3 Monitoring the progress of the project*

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29 Once the transfer of the equipment lots was started, monitoring the progress of the supplier network  
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31 delocalisation project turned out to be a significant problem. This is easily understood if one  
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33 considers that each transfer lot corresponded to a considerable number of activities to be carried out  
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35 – 13 steps (figure 3) – and the different transfer lots were managed in parallel. They differ only in a  
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37 week or two from each other.  
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41 Given the complexity of the project, the team soon realised that it was impossible to monitor the  
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43 project's progress and the achievement of the objectives just by meetings with suppliers and Indian  
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45 colleagues, or informal control procedures of the progress made in the different activities. On the  
46  
47 other hand losing control of the delocalisation process could mean causing production stoppages  
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49 and therefore delays in the supply to car manufacturers.  
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53 The project team therefore decided to develop and apply appropriate monitoring instruments, that  
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55 would highlight the variances between what was planned and what was realised and any anomalies  
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57 during the delocalisation process.  
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3 Important control instruments used were “localisation curves” (figures 5 and 6). These were applied  
4  
5 both to verify the achievement of the project objectives and to highlight any inefficiencies in the  
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7 transfer process.  
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14 Insert Figure 5 about here

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20 Insert Figure 6 about here

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29 Figure 5 shows a localisation curve, which indicates for each month the percentage of the purchase  
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31 value localised in India compared to the total purchase value of that month.  
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34 The “aggregate” localisation curve in figure 6 indicates the percentage of the purchase value  
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36 localised in India compared to the value of the purchases realised since January.  
37

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39 Both curves provide interesting information about the project. In particular, the first curve indicates  
40  
41 the level of localisation attained month by month. In December 2005 for example, FIAMM had  
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43 reached a level of localisation equal to 45% (see figure 5 – ‘real curve’). The aggregate curve,  
44  
45 instead, by indicating the percentage of the purchase value realised in India since the beginning of  
46  
47 the year, gives an idea of the benefit, in terms of saving, obtained thanks to the localisation project.  
48  
49 From figure 6, for example, one can infer that 29% of FIAMM’s annual purchase value in 2005 was  
50  
51 related to purchases made in India (see figure 6 – ‘real curve’).  
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54  
55 Localisation curves are among the most well-known instruments for the management of a  
56  
57 delocalisation process. Nevertheless, the application of these curves in the FIAMM project was  
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59 peculiar, in that the curves have been adapted to the monitoring needs and to the problems that  
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emerged during the project’s implementation. In particular, three types of localisation curves were

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3 created. In addition to the planned curve, in figures 5 and 6, the real project curve and the  
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5 theoretical one have been shown. Both curves show the progress over time of the percentage of  
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7 purchase value localised in India. However, in the case of the real curve, a component is considered  
8  
9 localised when it starts to be effectively purchased from the new supplier. In the case of the  
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11 theoretical curve, instead, a component is considered localised when the Indian supplier is ready to  
12  
13 produce and all the approvals have been obtained from the customer. This moment often did not  
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15 correspond to the instant in which the firm started purchasing from the new supplier, due to the  
16  
17 presence of substantial quantities of components in stock, deriving from an imprecise planning of  
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19 the stock to be accumulated before beginning equipment transfer. The variance between the  
20  
21 theoretical curve and the real curve therefore represents the impact that the problems related to the  
22  
23 calculation of stock within supplier network ( $S_{\text{supplier network}}$ ) and component requirements, discussed  
24  
25 above, had on the project performance. This was therefore a useful method to understand if these  
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27 problems had been resolved over time and to have an idea of what percentage of purchase value  
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29 could not be localised due to excessive stocks within the supplier network.  
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## 39 5. DISCUSSION AND CONCLUSIONS

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41 By using data from a longitudinal case study, this research analyses the implementation of a  
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43 supplier network delocalisation project in a context characterised by a capital-intensive production  
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45 system. The project, developed in collaboration with FIAMM, has led to interesting results both  
46  
47 from an academic as well as managerial point of view.  
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51 From an academic point of view, the principal contribution of this research consists in the analysis  
52  
53 of those aspects which result critical during the relocation of a supplier network from one country to  
54  
55 another, in a capital-intensive context. The literature on IS does not investigate the problem of how  
56  
57 to manage such a relocation. Furthermore, the studies on IM and IS concentrate their attention on  
58  
59 either labour-intensive firms (in the textiles industry, for example) or on cases in which  
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delocalisation does not concern highly automated production units (Camuffo *et al.* 2006,

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2  
3 Nassimbeni and Sartor 2006). This research, instead, offers an in-depth analysis of the  
4  
5 implementation of a supplier network delocalisation project in a firm, FIAMM, that has decided to  
6  
7 relocate its French plant, responsible for the production of horns, and its supplier network from  
8  
9 France to India. The horns are produced on highly automated lines, while the upstream network is  
10  
11 composed of suppliers that produce components using expensive moulds and equipment and  
12  
13 advanced technologies.  
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17 Reasoning about contextual factors, procedure of relocation followed by FIAMM, problems  
18  
19 occurred, and solutions adopted helped researchers to identify a series of generalisable lessons on  
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21 what elements are critical when supplier network delocalisation is realised in a capital-intensive,  
22  
23 rather than labour-intensive, context.  
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- 26  
27 ▪ Firstly, the FIAMM case has demonstrated that the accurate management of the transition  
28  
29 phase from a supplier network entirely located in a Western country (in this case France) to  
30  
31 a supplier network entirely located in a *low-cost* country is one of the most important  
32  
33 aspects for the success of a delocalisation project in a capital-intensive context (see figure  
34  
35 4). The management of the transition phase from one supplier network to another is  
36  
37 obviously important also in a labour-intensive context, since, during that phase, the suppliers  
38  
39 must be trained, and the supply of components and products from the low-cost country must  
40  
41 be gradually increased, and reduced in the country in which the supplier network was  
42  
43 originally situated. Nevertheless, the capital-intensive context offers a further element of  
44  
45 complexity. As the components are produced by costly and technologically advanced  
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47 equipment (often owned by the customer or personalised according to his requirements), it is  
48  
49 not convenient to buy or reconstruct such equipment in the low-cost countries. They have to  
50  
51 be transferred. Since in a capital-intensive context no delays in the supply of components are  
52  
53 permitted, as this would entail stopping the plants, the challenge lies in organising the  
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55 transfer of an often high number of machines without compromising the supply of the  
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57 components to the production plant.  
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- A second critical element is represented by the necessity of controlling the flows of materials and stocks of components by means of careful production planning during the transition phase from one supplier network to another. As emerges in figure 4, during this phase, the flow of materials is much more complex, as in fact the transitory supplier network includes a greater number of tiers and therefore also warehouses. This problem also exists in labour-intensive contexts, however the complexity in a capital-intensive context is much greater. This is essentially due to two reasons. Firstly, when the supply of components obtained by complex treatments and technologies is delocalised, many of these components must be re-coded since they are realised in low-cost countries with different raw materials, treatments or technologies. To correctly manage production planning, particular attention must be paid to these re-coded components, so that the stocks of the component code prior to the modification are exhausted. To this aim, even if the information system elaborates the requirements of the new component code, it is necessary to monitor also the stock of the original component. Therefore it is fundamental to maintain a link between the code of the original component and that of the modified one. Secondly, when the equipment for the production of a component starts to be transferred to the supplier in the low-cost country, for a certain period, the production of that component is interrupted. Therefore it is essential to accumulate a certain quantity of component stocks before starting to transfer the equipment. This stock must be calculated with extreme accuracy in order to avoid any plant stoppages, or the excessive accumulation of stocks, that would delay the delocalisation of supply. Such considerations do not count for the labour-intensive context, since, in this case, the component codes are not re-coded and the production equipment is not transferred and, therefore, there is no need for any stock to be accumulated.
  - A further critical aspect is linked to the difficulties that can occur in the transfer of knowledge concerning the components and products that are being delocalised. This transfer of knowledge is an essential element in each delocalisation project, whether in a capital- or

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3 labour-intensive context (Rogers 1983, Kim 1997). In the first case, however, it is  
4 particularly problematic, since the components and products to be transferred are complex  
5 and realised using advanced technologies. Moreover, the knowledge concerning production  
6 processes is often tacit and belongs to few experts. Therefore the information and data to be  
7 transferred must for the most part be gathered from those same people who probably will  
8 lose their jobs due to the delocalisation process. This last problem is even more important in  
9 the supply networks of groups, such as FIAMM, in which each production unit is in charge  
10 of a certain type of product, on which the other production units have no expertise, and  
11 utilises suppliers that typically do not supply the other firms in the group.

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▪ Lastly, the monitoring activity over the whole delocalisation process of the supplier network is particularly critical in capital-intensive contexts, compared to labour-intensive contexts. Any delays or inefficiencies in one of the process steps (figure 3) could stop the automated production lines of the firm and those of its customers. In the case of labour-intensive contexts, the fact that “old” suppliers are still able to continue to supply the components, should problems occur during the realisation of the new supplier network, represents a security. This is not possible in a capital-intensive context, as the old suppliers stop producing when the equipment starts to be transferred.

From a managerial point of view, this research has important practical implications for managers that operate in contexts similar to that in which FIAMM operates.

Firstly, the detailed description of the procedure for the transfer of equipment contained in this article could be very useful for other managers who intends to delocalise the supplier network. In particular, from the case study it emerges that it is necessary to actively involve the various firm functions in the planning of the equipment transfer (in particular the engineering and logistics function, in addition to the purchasing one).

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3 Furthermore, this research individualises a series of problems that can occur during the supplier  
4 network delocalisation process in a capital-intensive context and the ways in which these can be  
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8 dealt with.

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10 For example, to correctly determine the amount of stocks necessary to supply the production plant  
11 during the transfer of the equipment, it is suggested that it is necessary to modify the logic with  
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15 which component requirements are calculated (for example by modifying sales forecast horizon or  
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18 requesting greater visibility on customers' orders) and implementing, since from the beginning of  
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20 the delocalisation project, an information system that guarantees the full visibility on the stocks  
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22 within the supplier network.

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24 Moreover, to facilitate the transfer of knowledge that, as mentioned before, is particularly critical in  
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27 a capital-intensive sector, the FIAMM case suggests that an appropriate subdivision of roles and  
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30 responsibilities during the course of the delocalisation project, and the adoption of instruments  
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32 supporting the collection of data can prove to be essential solutions.

33  
34 Lastly, to facilitate the project monitoring activities, this case indicates that it could be useful to  
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37 design and use instruments that allow to monitor any problems that may occur (for example the  
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40 presence of excessive stocks of components) and what is their impact on the project performance  
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42 (see figures 5 and 6).

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45 We believe that, starting from the results of this research, it could be interesting to conduct further  
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48 longitudinal case studies on the delocalisation of supplier networks in various contexts and sectors,  
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51 in order to investigate the contingent factors that can influence how they should be managed. This  
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54 research demonstrates how several elements in a capital-intensive context can make some aspects of  
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57 delocalisation particularly crucial and emphasises what problems can occur and how they can be  
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60 dealt with in a context of this type. Other critical factors and problems could emerge in other  
contexts.

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**LEGENDS FOR THE FIGURES**

Figure 1 - ABC classification by annual purchase value

Figure 2 – Procedure for defining transfer lots

Figure 3 - Gantt diagram of the delocalisation project

Figure 4 - Supplier network before the delocalisation (a), transitory supplier network (b), supplier network after the delocalisation (c)

Figure 5 - Localisation curve

Figure 6 – Aggregate localisation curve

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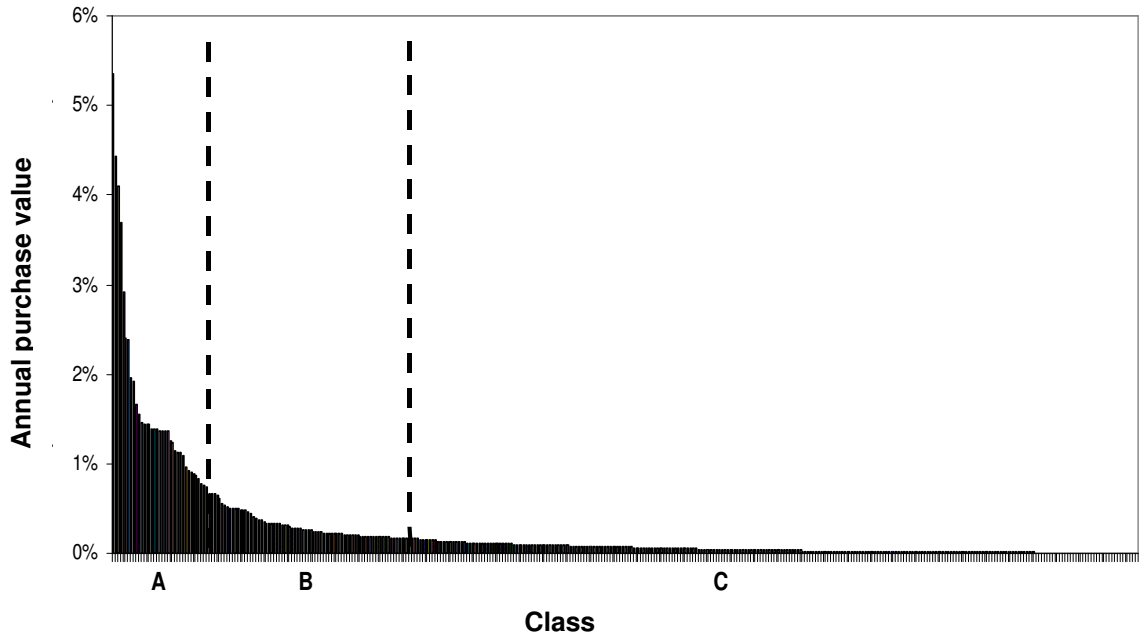


Figure 1 - ABC classification by annual purchase value

Review Only

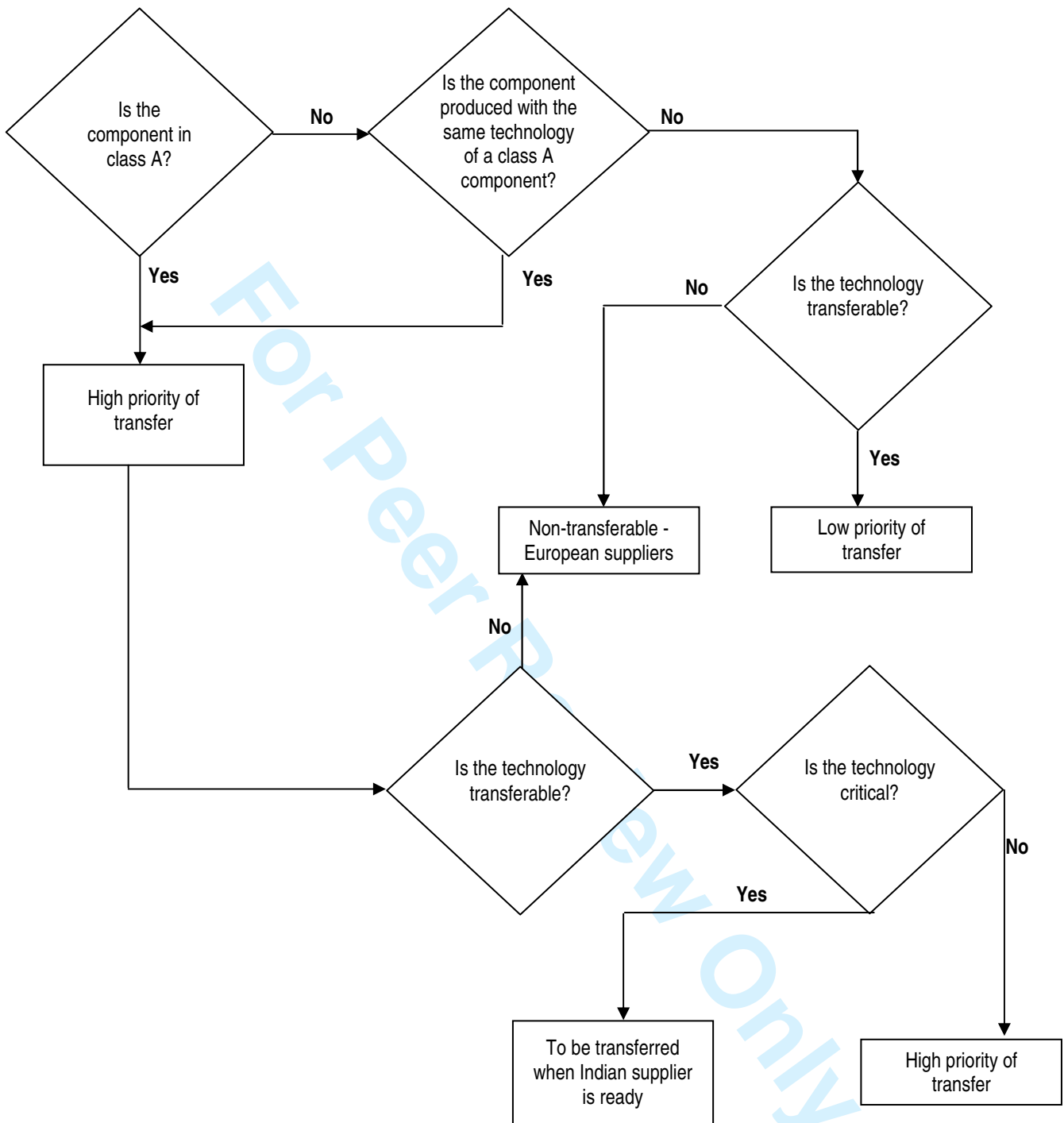


Figure 2 – Procedure for defining transfer lots

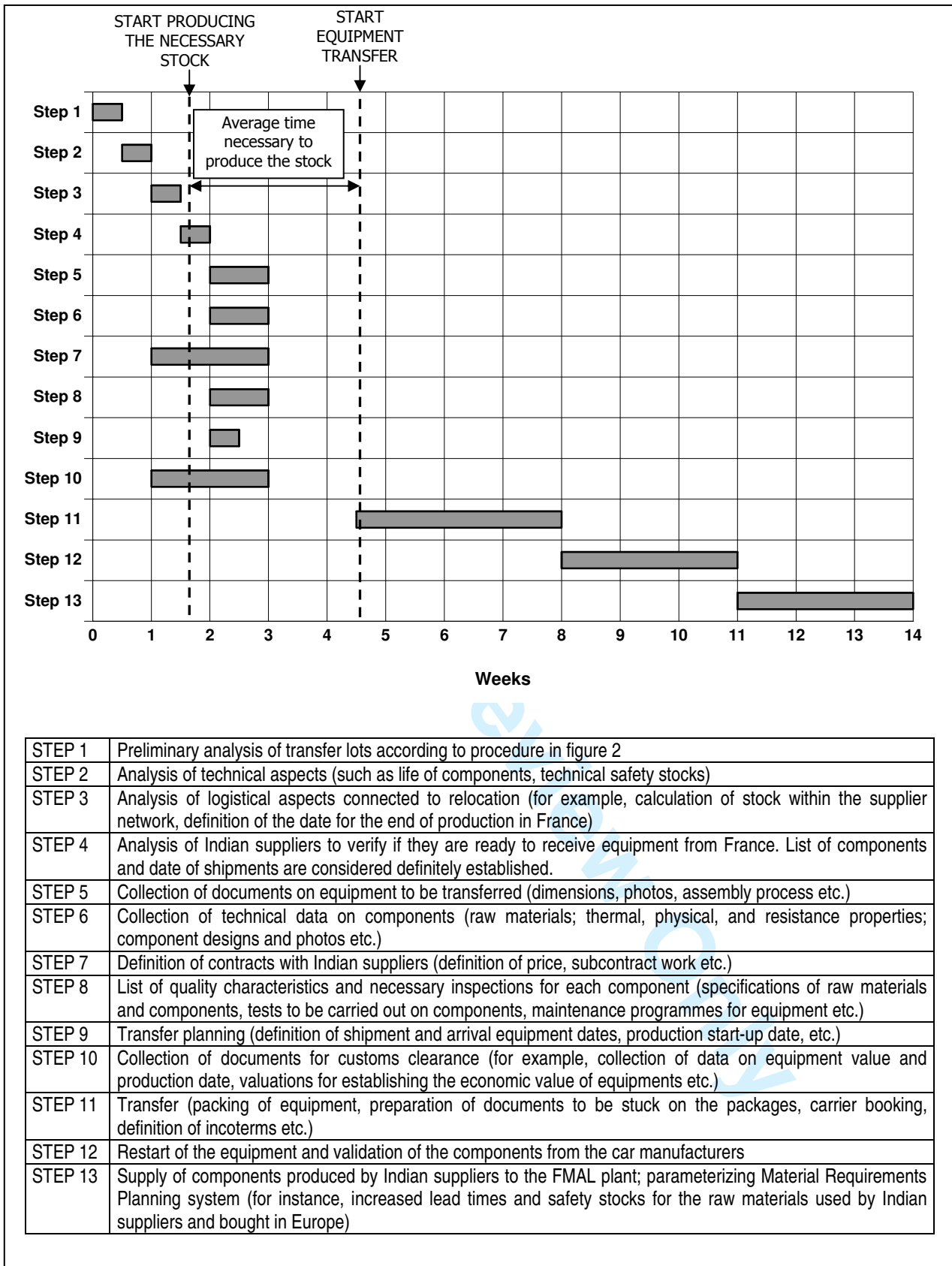
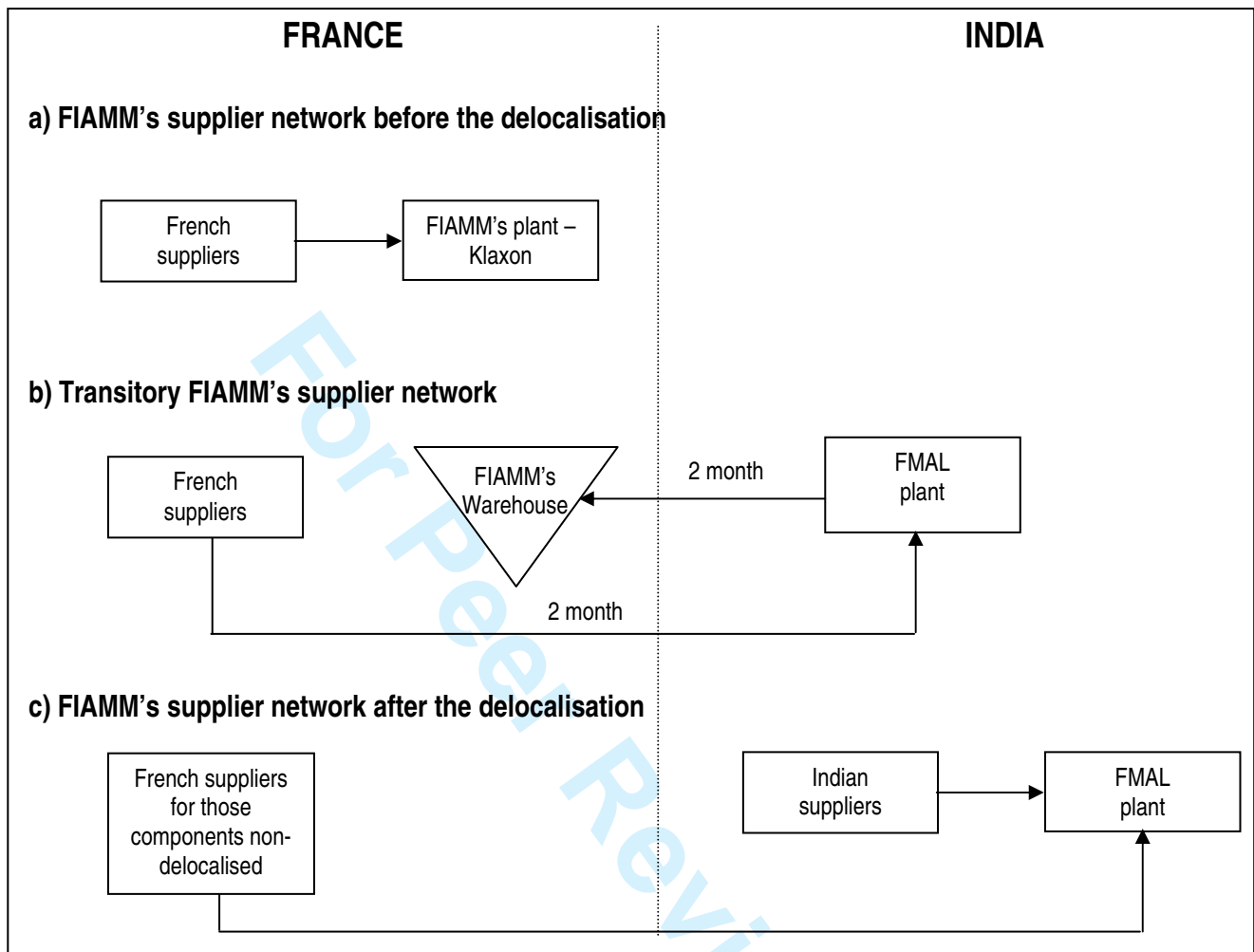


Figure 3 - Gantt diagram of the delocalisation project



**Figure 4 - Supplier network before the delocalisation (a), transitory supplier network (b), supplier network after the delocalisation (c)**

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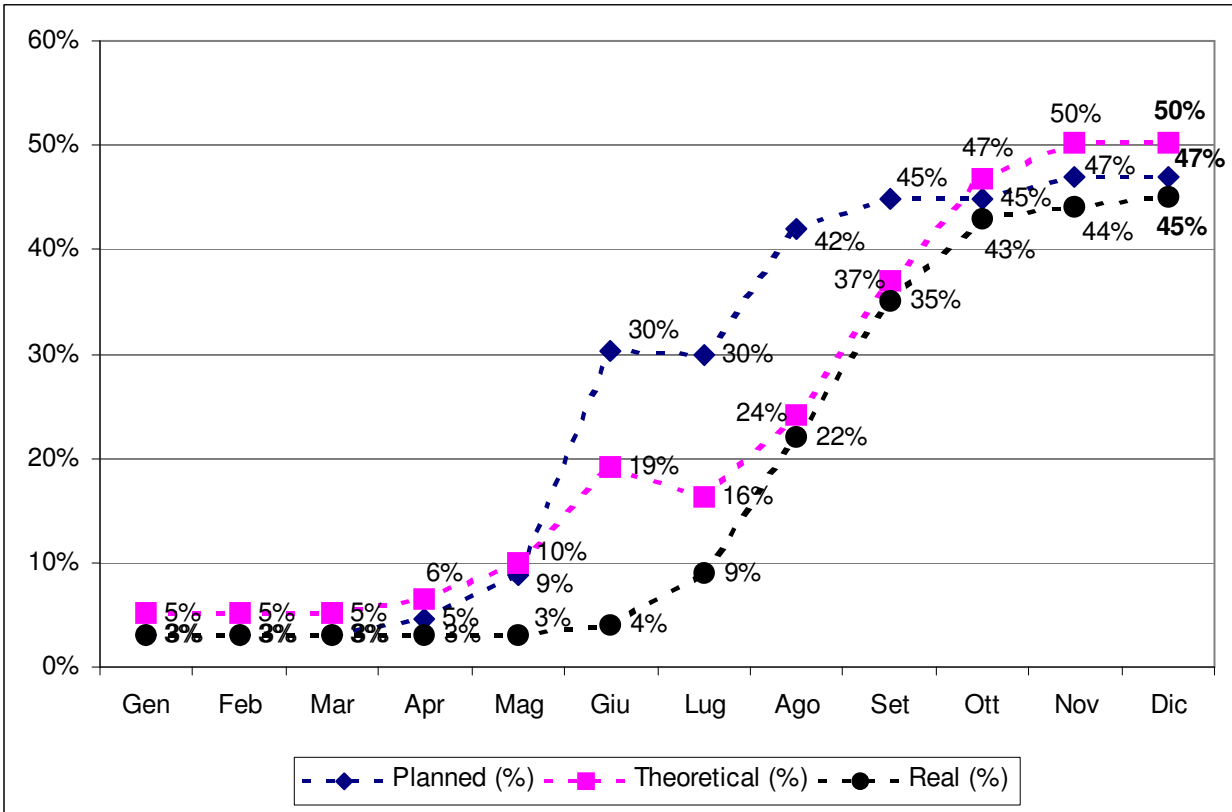


Figure 5 - Localisation curve

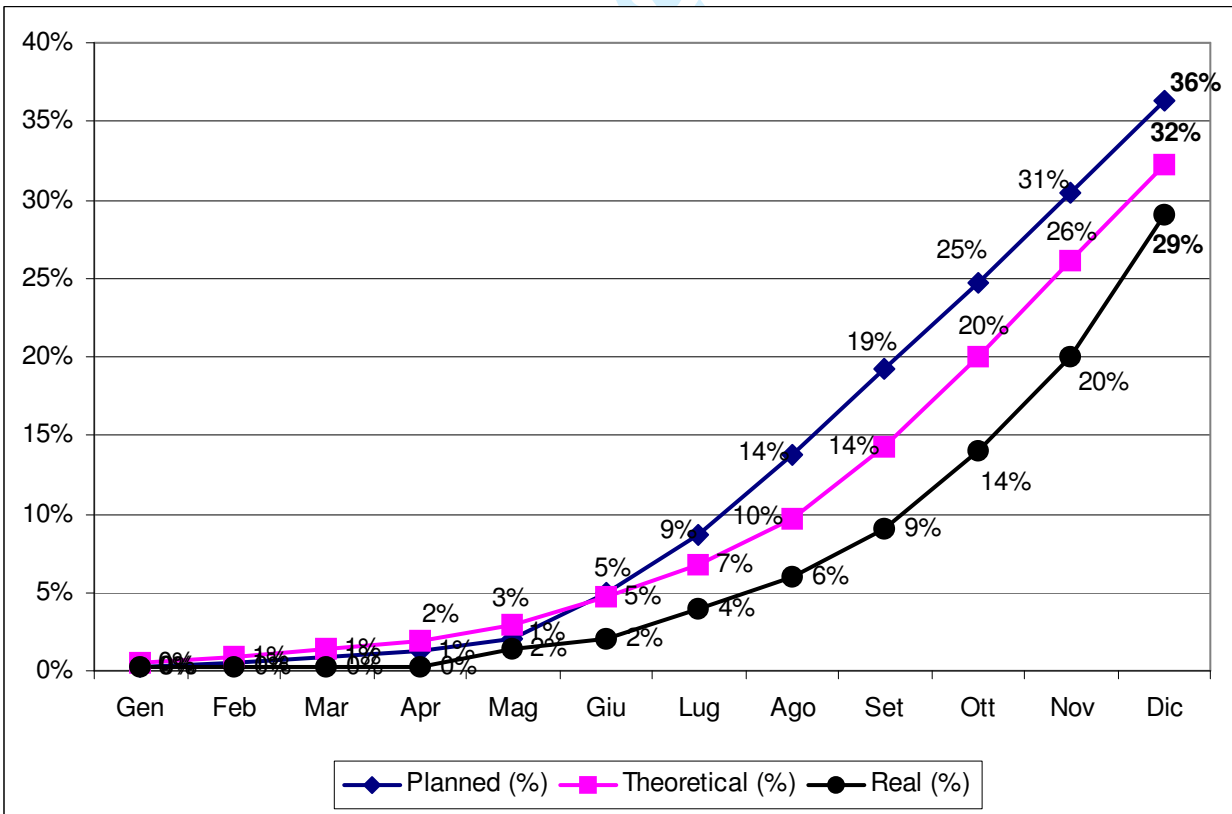


Figure 6 - Aggregate localisation curve