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Reconsidering nearshoring to avoid global crisis impacts: Application and calculation of the total cost of ownership for specific scenarios

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ABSTRACT

With the 2020 emergence of the COVID-19 pandemic, many production companies have reinforced the rethinking their strategies of production location. In the 1980’s and 1990’s, one has witnessed a substantial shift of production activities. Increasing production activities led to increasing wage levels and land rents in developing countries since. COVID-19 may be a trigger that will reinforce the nearshoring process. This paper develops and applies a framework with a quantitative and a qualitative part, so as to verify how a selected nearshoring candidate country performs. The quantitative part relies on a chain cost calculation model, while the qualitative part uses appreciations given by the decision maker to ‘time’, ‘value’ and ‘cost’. The framework is applied to a case with production located in China. In doing so, it is important to determine which sector one belongs to, since different characteristics will play a different role depending on the sector. Furthermore, transport costs typically do not have the biggest share in total supply costs, but may be decisive as they determine also the lead time and hence the costs related to stocks. Finally, it turns out that qualitative decision factors – rather linked to perception and personal preferences – do not always match economic outcomes.

1. Introduction

In the 1980’s and 1990’s, one has witnessed a substantial shift of production activities. In a first move, the shift was away from the company to another company in its relative neighbourhood. That shift was then called ‘outsourcing’. In a further step, the shift was away from developed countries to developing ones, called ‘offshoring’. First companies to step in were American. European companies were rather reluctant at first, until they saw the benefits that outsourcing brought to their US competitors. At first also, mainly low-quality production was outsourced. Later on, companies discovered that the target countries also amply hosted more experienced and better-qualified workers. As an illustration, Appendix A presents a SWOT for China as an offshoring production location.

Strengths, Weaknesses, Opportunities and Threats.

It is true that still in 2020, the developed countries remain the biggest markets in terms of purchasing power. However, thanks among others to the production activities that have been delocated towards developing countries, some of them, like China for instance, have seen their share in global welfare strongly increase. The chain reaction initiated by the delocation continued though: increasing production activities and welfare led to increasing wage levels and land rents in developing countries. This in turn more recently led production companies to start considering for their manufacturing activities a move back towards the developed countries many of them once had left. The concept of nearshoring was born. There was also a market need for that reverse move: reaction speed to comply with ever-increasing complexity of consumer requests, including e-commerce. Customers more and more want their ordered products to be tailor-made and delivered quickly.

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Furthermore, here was also a big push to minimize inventory (not least because styles and models demanded change so quickly) which is easier when producers are located close to consumers. Finally, President Trump’s trade barrier policies and China’s ‘eye-for-an-eye’ responses have done much to promote near/on-shoring.

So, COVID-19 was not the real cause of the louder talk that in 2020 started in industries globally on nearshoring. In the past decade, there was already a slow but gradual shift toward intra-continental trade instead of cross-continental trade. At best, COVID-19 is a trigger that will re-inforce this process. Companies that are not yet applying a real nearshoring strategy, are at least considering it.

There is however one element that with a crisis with the global magnitude of COVID-19 comes to the fore strongly and adds to all the above motives in favor of nearshoring: supply chain and production control. Given the strong dependence on overseas areas for the production of a large number of products, also ‘essential’ ones (food, medicine, protective wear, replacement components for essential equipment, etc.), many current supply chain setups have proven to be very vulnerable. First, as the COVID epidemic started in China, and most of its factories had to close down for at least two months, the source of production obviously dried up. Add to that the closure of most port activities in China for at least a while, which implied that neither finished products that were still on stock in China for sales, nor raw materials needed for production that was still open, could leave respectively enter the country. Obviously, this created serious disruptions in product inflows in most other markets in the world.

Because of not being able to enter Chinese ports, or at least because of not having cargo to transport from there, which of course is the payload that the shipping companies live from, many shipping companies decided to reduce the number of calls or even (temporarily) abandoned certain loops. They did that in an effort not to burn scarce capital in sailings that did not pay (enough). This obviously further blocked the production activities that were still going on in China and prevented them from easily exporting.

Then came a next phase of COVID-19, with its spread around the planet, it becoming a real pandemic. That meant that also the target markets for Chinese and other exports started to get seriously affected, with a similar pattern as in China: company closures, meaning that local production activities requesting inputs from overseas, stalled; shop closures, so that also demand for many products dropped; only essential activities remaining open, with in particular medical services, where demand started booming to the extreme. Most ports kept running more or less as usual, but became stock areas for containers with intermediate and finished products that started coming again from China, where activities had gradually and slowly picked up again. Chinese manufacturers made every effort to ramp up production so as not to break supply chains, but the break now happened on the receiving side. Production nor demand for non-essential products was present locally. At the same time, local demand for essential products like medicine was overly present, but due to global scarcity, and big needs for these products in China itself, their supply stalled.

Hence, it is clear that current international supply chain settings are extremely vulnerable, and therefore prone to high uncertainty, both from the demand and supply side. COVID-19 was also not the first, but most certainly the largest, test for the globalized production and supply system, since neither the 2008 financial-economic crisis, nor SARS, nor other crises were of similar magnitude. Its global occurrence, and especially the duration over which it may show impacts, will undoubtedly mean a strategic rethinking of parts of or entire supply chains. Nearshoring will be an essential element of that.

Another remarkable impact of COVID-19 is that it directly led, for the first time in decades, to shipping companies laying-up capacity, thereby leading to strong increases in shipping rates. In the past, without this external trigger, and purely depending on voluntary co-operation among the shipping companies that never materialized due to lack of trust and game theory applying, such rate increase has always proven impossible. The rate increase also brings the freight rates closer to the true social costs of shipping, thereby contributing also to mitigating environmental problems that were waiting for a solution for decades: making users aware of the true cost of shipping. And of course, this again re-inforces the revival of nearshoring.

Typical nearshoring candidate countries for the US are Mexico, Brazil and other Central- and South-American countries. For Europe, Central- and Eastern-European countries qualify. The question then is which will be the exact new location: will it be the original ‘mother’ country, or some neighbouring country with similar characteristics, or which is at least geographically closer to the developed countries market. Developed countries surely have a number of assets in that respect, since next to a large market, they typically also offer well-established logistics systems and infrastructures. Witness the scores many of them obtain in for instance the Logistics Performance Index by the World Bank.4

There is however not so much scientific insight into which are the factors that typically play in such nearshoring decision. At best, one gets survey-based views on what factors are at play (Müller-Dauppiert, 2016). Even less, there are instruments that allow quantifying the costs and benefits of different nearshoring locations. If available, these often focus on one or a limited objective, for instance wage costs (Bock, 2008; Panova & Hilletoft, 2017) or customer relationship (Slepnev et al., 2013). Moreover, the good logistics distribution systems that developed countries have might work in favor or against attracting nearshoring candidates: having good seaports, airports and hinterland connections for instance may lead to a country becoming a production hub, but it may also mean that just more finished products can more easily be imported. This paper makes an effort to shed light into the issue on judging on a specific nearshoring candidate location. This is important, as nearshoring undoubtedly is going to fundamentally alter the structure of global supply chains, re-inforced by the COVID-19 crisis as it seems.

The paper is structured as follows. Section 2 provides a review of literature concerning nearshoring, its motives, and its application domains. Section 3 presents the cases to which the evaluation of the qualities as a nearshoring location is applied. Section 4 presents the approach for the evaluation. Section 5 shows the results of applying the approach to the selected cases. Finally, section 5 draws overarching conclusions.

2. Literature review

This section first defines the concepts of ‘outsourcing’, ‘offshoring’, ‘nearshoring’ and ‘onshoring’. Next, it looks into features, drivers, barriers and risks to outsourcing and nearshoring. Finally, it presents candidate sectors for outsourcing and nearshoring.

2.1. Concepts and definitions

‘Outsourcing’ is defined as “an operational shift of a process that first was organized and managed internally, towards an external party. At this transfer, a long-lasting contract is in place.” (Quelin & Duhamel, 2003). Outsourcing also entails a substantial, mutual transfer of information, co-ordination and trust (Erber & Sayed-Almed, 2005).

Ellram et al. (2013) define ‘offshoring’ as ‘the locating of a manufacturing facility outside of the company’s headquarters region’. ‘Nearshoring’ is defined as ‘sourcing work to a foreign, lower-wage country that is relatively close in distance and/or in time zone. The customer expects to benefit from one or more of the following constructs of proximity: geographic, temporal, cultural, linguistic, economic, political and historical linkages’ (Autesserre, 2012). ‘Onshoring’ finally is defined as “manufacturers returning part or all of their foreign production to domestic facilities”.

4 See https://lpi.worldbank.org/.
2.2. Features, drivers, barriers and risks

The main feature to determine whether a country or region qualifies as an offshoring or nearshoring location, is distance. Distance not only involves geographical distance, but also three other dimensions: cultural, administrative and economic (Table 1). Trade-offs between the various dimensions often need to be made: it can be acceptable only to save on the economic dimension if the sum of losses on the other dimensions jointly is not higher.

Table 2 summarizes the candidate-domains for outsourcing, the motives, the barriers and the risks. Time over, also other domains than the below ones have been identified as candidates for outsourcing. In fact, all processes that are not differentiators of a company can in theory be outsourced. It should also be noted that hundreds of other risks can occur, which should be evaluated on a case-by-case basis.

Simchi-Levi (2012) notes that during the preceding two decades, the nature of risks has significantly changed:

- Costs of energy and labour in developing countries have increased, which has reduced the cost difference with producing at home.
- The level of automation has increased, which reduces the importance of labour in total costs.
- Risks in supply chains have increased: through globalization, effects of any crisis spread out globally very quickly.

Positive motives for reshoring and negative ones for offshoring are found to be the ones of Table 3 for the US, ranked from high to low importance. For Europe, similar motives are identified in Table 4.

Applying the above drivers to Europe, Prologis (2017) mentions that their research points into the direction of increasing attractiveness within the European logistics landscape of nearshoring locations in Central- and Eastern-Europe. An important factor there is the availability of flexible and relatively cheap labour. The ability to recruit low-wage labour onshore and nearshore in dual labour markets is clearly important. Overall, the below reasons are mentioned by Simchi-Levi (2012) as reasons for nearshoring:

- Shorter time to market
- Cost savings
- Product quality
- Increased control
- Avoiding hidden supply chain management costs
- Protecting IP

For Europe in particular, also the fact plays that most Central- and Eastern-European countries belong to the European Common market, which implies that no trade barriers nor tariffs apply. Furthermore, there is the element of migrant labour.

2.3. Candidate sectors for outsourcing

With respect to the various sectors in the economy, McKinsey (2012) distinguishes among five of them, based on their different scores on a number of characteristics relevant for nearshoring, as shown in Table 5. Each ‘sector’ comprises a number of specific products.

With the information from this section, the general observations can now be translated into a real-life case analysis.

3. Selected nearshoring case for analysis

In order to quantify for a concrete case the importance of the various nearshoring decision criteria, and to determine which are the countries that are of most interest, a suitable case needs to be selected. The selected case is that of Belgium. This section determines a number of scenarios of future nearshoring development for Belgium. As part of this, the candidate countries for nearshoring are selected. This is done with the help of a nearshoring-oriented SWOT for each of the selected countries. As a production location, each of the selected countries has its strengths, weaknesses, opportunities and threats. These are summarized in Appendix A, based on a workshop with industry experts.

The selected reference scenario is one where a shipper based in Belgium gets its goods for the West-European market developed in China (Fig. 1). It calls for traditional logistics service provision for its transport and distribution, involving deep sea shipping for final products between China and one of the Flemish seaports, and sourcing of raw materials and semi-finished products from abroad to China via sea also.

The first alternative geographical scenario considers North-Macedonia as a production location. Raw materials and semi-finished products get sourced into that country via a combination of land and sea, whereas final products travel from there to the West-European market either via short sea shipping or via land (rail or truck) (Fig. 2).

The second alternative geographical scenario considers Poland as a production location. Raw materials and semi-finished products get sourced into that country via land and/or sea, whereas final products travel from there to the West-European market either via short sea shipping or via land (rail or truck) (Fig. 2).

Section 4 develops the methodology that will be applied to those scenarios for analyzing their economic viability.

4. Model approach

For the purposes of the analysis in this paper, a comparative instrument is developed and applied. It involves both a quantitative part, called a Total Cost of Ownership instrument, and a qualitative part, with a perception-based analysis. Both are clarified in this section.

4.1. Total cost of ownership model

The first element of the Total Cost of Ownership (TCO) are the transport costs. For simulating those transport costs, firstly, a chain cost model is used. A start is taken from the model developed by van Hassel et al. (2016), which allows calculating the generalized chain cost from a selected point of origin, via a predefined container loop to a destination point. The model contains different aggregated hinterlands that are connected via a route along ports (bold lines in Fig. 5). The aggregated hinterlands are defined as a summation of different smaller geographical areas. Each aggregated hinterland is served by at least one and usually by several ports. Each port is built up of a set of terminals, all of which have their own set of characteristics. From each port terminal, the hinterland connections via road, rail and inland waterways (if applicable) to all the disaggregated hinterland regions are incorporated into the model.

The chain cost model by van Hassel et al. (2016) can also be used for pure land transport operations, in case no maritime transport is involved, since it contains the land modes anyway.

For making real-life and real-time decisions by chain users, ideally, one would use prices (freight rates\(^5\)) rather than operational costs, thereby assuming that the chain user, typically the shipper or

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\(^5\) The workshop was held at VIL with representatives from Ahlers, DHL, DSV, Group Gheys, Port of Antwerp, Barco and Philips, who further acted as advisory board to the research.

\(^6\) Freight price in maritime transport = base freight price + terminal handling charges + bunker adjustment factor + currency adjustment factor + other add-on costs (about 50 other charges, representing on average about 10% of the base freight price).
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forwarders, will not by itself execute the transport operation, but rather contract that out. However, prices are very volatile, given their dependency on both market demand and supply conditions. Moreover, validation by Neyens et al. (2016) and by the advisory group of companies has shown that average prices over a certain period of time are very close to costs. That is also in line with the general perception that profit margins in the transport sector are usually very small. Therefore, the use of transport costs rather than prices in this paper is justified, since we do not look at real-time decisions, but rather the overall and longer-term tendency of which transport mode is most interesting from an economic point of view.

Since the chain cost model is only dealing with maritime transport chains, for the purposes of this paper, it is complemented with price values for air transport. Those were taken from IATA, as the yields reported by airlines. To match full chains, the land transport costs calculated with the chain cost model by van Hassel et al. (2016) can be added to the reported yields.

Another important element of the generalized cost, next to the operational transport cost, is the transport lead time. Its absolute value as well as its variance have a strong influence on stocks that need to be kept. The transport lead time for the entire transport chain is therefore incorporated in the maritime chain cost model. This means that the transport lead time from a hinterland region (including a dwell time at an inland terminal for rail or IWT) to a port, the dwell time of container at a deepsea port, the maritime transport and the reverse port and land transport lead times at the destination hinterland are taken into account. This means that a change in a loop structure will impact on the generalized cost of the total logistics chain (including the transport time). In this research, a change in cyclical stocks is not taken into account, since these are too product-specific: they are assumed constant. However, safety stocks are taken account of. For air transport, as no model is available, stock costs are assumed to represent 10% of the production costs, multiplied by the lead time of the air part.

Table 1
Distance dimensions in outsourcing and nearshoring.

| Parameter                  | Definition                                                                 |
|----------------------------|-----------------------------------------------------------------------------|
| Distance parameter         | Measures the physical distance between locations.                          |
| Cultural                   | Reflects cultural and social differences.                                   |
| Administrative             | Encompasses administrative factors.                                         |
| Legislative                | Captures legislative aspects.                                               |
| Physical                   | Includes physical dimensions such as road and rail networks.               |
| Difference in consumer income | Examines economic differences across countries.                           |
| Environmental              | Considers environmental factors.                                            |
| Social                     | Incorporates social factors.                                                |
| Hidden costs               | Accounts for hidden costs in the supply chain.                             |

Source: own composition based on Ghemawat, 2001.

Table 2
Candidate-domains for outsourcing, the motives, the barriers and the risks.

| Candidate-domains | Motives | Barriers | Risks |
|-------------------|---------|----------|-------|
| - Management of a sub-task | Costs | Management (control and risk) | Import duties |
| - Operational processes | Human resources | Out-of-stock issues | Transport: time |
| - Back office processes | Behavior | Transport cost | Political stability |

Source: own composition based on Block, 2007; Roza et al., 2011; Lewin & Volberda, 2011; Worley, 2011; Judl, Koskela and Thomas, 2011; Carmel & Abbott, 2007; Ghemawat, 2001; Auteserre, 2012.

Table 3
Positive motives for reshoring and negative motives for offshoring in the US.

| Positive motives for reshoring | Negative motives for offshoring |
|-------------------------------|--------------------------------|
| 1 Government support          | 1 Lead time                    |
| 2 Skilled working population  | 2 Lead time                    |
| 3 Image/brand                 | 3 Freight prices               |
| 4 Automation                  | 4 Increasing wages             |
| 5 Market proximity            | 5 Total cost                   |
| 6 Synergies with ecosystems   | 6 Stock                        |
| 7 Product redesign            | 7 Delivery                     |
| 8 Energy price                | 8 IP                           |
| 9 Higher productivity         | 9 Delivery                     |
| 10 Process improvements       | 10 Communication               |

Source: Reshorenow, 2015

Table 4
Positive motives for reshoring and negative motives for offshoring in Europe.

| Positive motives for reshoring | Negative motives for offshoring |
|-------------------------------|--------------------------------|
| 1 Skilled working population  | 1 Lead time                    |
| 2 Image/brand                 | 2 Quality                      |
| 3 Government support          | 3 Increasing wages             |
| 4 Automation                  | 4 Freight prices               |
| 5 Energy price                | 5 Total cost                   |
| 6 Product redesign            | 6 Stock                        |
| 7 Higher productivity         | 7 Risk of chain interruption    |
| 8 R&D                         | 8 Delivery                     |
| 9 Process improvements        | 9 Communication                |
| 10 Synergies with ecosystems  | 10 Communication               |

Source: AlixPartners, 2015
development activities in function of products. Material costs refer to raw or intermediate products needed for production. Wages refer to costs for employees or independent sub-contractors, directly linked to production. Energy costs encompass all costs for energy consumed during production. Manufacturing costs finally contain all other costs directly or indirectly linked to production, including overhead, administration, buildings, etc.

A final cost category is linked to risk, due to unexpected events. For instance, in case of a stock rupture due to unexpected demand increase, air transport might be required as a fast remedy. In our model, risk is not considered separately, next to the part already taken into account by the stock costs as linked to the transport mix.

### 4.2. Qualitative decision factors

Since not all industry decisions, also on production location, are taken fully rationally and with unequivocal information, also a number of qualitative, perception-based decision factors are considered, next to the TCO of the preceding section: ‘time’, ‘value’ and ‘cost’.

Those refer to the sentiment by industry decision makers on factors like political stability, the ‘ease’ of investing in a certain country, the local availability of skilled labour, etc. These are factors of which information is often not well known, or hard to measure and hence compare.

‘Value’ is then defined as ‘opportunity’: what is the value added and/or sales increase by producing in a certain country. ‘Value’ is closely linked to ‘time’ also: if the cycle between product development and delivery is shortened, how much value can be added by being able to more quickly adjust to changing market demand and requests?

To score the three decision factors ‘cost’, ‘value’ and ‘time’, a list of 22 questions in total is used, based on the Global Innovation Index and the Global Competitiveness Report. Each question answers part of one of the three above decision factors. The 22 questions are found in Appendix B, and all ask for the importance the decision maker attaches to one specific qualitative sub-factor each. To each question, a score can be given on a Likert scale from 1 to 5. That score for each question is

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**Table 5**

| Sector | Global innovation for local markets | Regional processing | Energy-/raw material intensive goods | Global technologies/innovators | Labour-intensive trading goods |
|---|---|---|---|---|---|
| Sub-sector | Chemicals, motorized and other vehicles, machines | Rubber and plastics, finished metal products, food and drinks, tobacco, printing | Wood, refined petrol and coke, paper, minerals, base metals | Office equipment, semiconductors, electronics | Textile, furniture, toys |
| Industry share (%) | 34 | 28 | 22 | 9 | 7 |
| Characteristic scores (1 = not important, 2 = slightly important, 3 = important, 4 = very important) | 3.4 | 2 | 1.6 | 4 | 2 |
| R&D intensity | 1.6 | 3.5 | 2.4 | 1.66 | 4 |
| Labour intensity | 1.8 | 2.25 | 3.4 | 3.33 | 1.5 |
| Capital intensity | 2 | 2.75 | 4 | 1 | 2.5 |
| Energy intensity | 3 | 1 | 1.6 | 4 | 4 |
| Trade intensity | 2.8 | 2 | 1.2 | 4 | 3 |

Source: own composition based on McKinsey (2012).
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subsequently multiplied by the country score given by the Global Innovation Index to each selected country. That means that the cost in this qualitative part of the analysis will not be equal to the TCO value obtained in section 4.1, as for consistency with ‘value’ and ‘time’, the Global Innovation Index scores will be used for ‘cost’ too. Totalling the obtained products per element leads to a score per element for each country.

The decision maker is also asked to attach a weight to all three decision factors ‘cost’, ‘value’ and ‘time’. In that way, a trade-off between ‘cost’, ‘value’ and ‘time’ is made. Multiplying the above country scores per decision factor with the respective weight decision factors then leads to a weighted overall score for the selected country for the qualitative part.

The combined quantitative – qualitative instrument will be applied in section 5 to the selected case scenarios from section 3.

5. Application of the instrument to selected case scenarios

To apply the developed instrument, first the quantitative TCO part is calculated. Next, the qualitative part is elaborated. Finally, an overall assessment is made based on both results.

5.1. Total cost of ownership calculation

In our analysis, we consider chains to go from the production site as the origin, to the final distribution center of the shipper. We do not consider the last mile to the retailer or the private customer.

A number of inputs are needed for the TCO model application. Final destination of the goods is assumed to be Kortrijk (Belgium). With respect to transport, it is assumed that 30 container shipments per year are needed. The current transport mix is taken to be 90% maritime and 10% rail, which implies no usage of road nor air. Furthermore, two alternative transport mixes are also considered, as in Table 6, given that origin and destination are closer to each other and on the same continent in the alternative geographical scenarios.

It is furthermore assumed that the chosen sector belongs to ‘Global innovation for local markets’, as typified by McKinsey (2012). Production costs are assumed equal to €5,000,000 for the reference scenario. R&D, materials, energy and manufacturing are considered fixed, no matter the scenario. That implies that total production costs in alternative geographical scenarios will only vary because the wage costs do vary. For the variation in wage costs, Eurostat data are used.

Based on McKinsey (2012), each of the components from the preceding paragraph is assumed to represent a fixed % of the total production costs for a given case and scenario, as shown in Table 7 for the reference scenario China, based on validation with the advisory board.

The results of the calculation for ‘Global innovation for local markets’ with the above-mentioned inputs can be found in Table 9. What

Fig. 2. Alternative geographical scenario 1: North-Macedonia.

Fig. 3. Alternative geographical scenario 2: Poland.

Fig. 4. Alternative geographical scenario 3: Benelux.

10 This sector was chosen, given the largest % among all sectors of total industry it represents, see Table 5.

11 Materials and energy costs may vary within countries and due to market conditions over time, but the average picture shown by McKinsey and confirmed by the advisory board is that the presumption of overall fixedness is correct.
can be observed, is first of all that production costs make up by far the largest part in the TCO, no matter the scenario. Next, it can be seen that from the perspective of transport costs, air is always the most expensive option, with maritime, rail or road being the cheaper one, depending on the scenario. In some scenarios, some transport modes are excluded: road transport from China to Europe obviously is not possible, and similarly, maritime and air are considered not possible when the

![Fig. 5. Structure of the chain cost model.](source)

**Table 6**

| Mode    | Alternative transport mix 1 (%) | Alternative transport mix 2 (%) |
|---------|---------------------------------|---------------------------------|
| Maritime| 10                              | 0                               |
| Rail    | 20                              | 30                              |
| Road    | 50                              | 70                              |
| Air     | 20                              | 0                               |

Source: own composition based on McKinsey (2012).

**Table 7**

| Component | Share (%) |
|-----------|-----------|
| R&D       | 4         |
| Materials | 68        |
| Wages     | 5         |
| Energy    | 3         |
| Manufacturing | 20   |

Source: own composition.

**Table 8**

| McKinsey factor | TCO cost component |
|-----------------|--------------------|
| R&D intensity   | R&D                |
| Labour intensity| Wages              |
| Capital intensity| Manufacturing     |
| Energy intensity | Energy            |
| Trade intensity  | No equivalent      |
| Value density    | Materials          |

Source: own composition.

**Table 9**

| TCO calculation results. | China | North-Macedonia | Poland | Benelux |
|--------------------------|-------|-----------------|--------|--------|
| Production costs (€)     |       |                 |        |        |
| R&D                      | 200,000 | 200,000 | 200,000 | 200,000 |
| Materials                | 3,400,000 | 3,400,000 | 3,400,000 | 3,400,000 |
| Wages                    | 250,000 | 174,000 | 394,000 | 1,901,000 |
| Energy                   | 150,000 | 150,000 | 150,000 | 150,000 |
| Manufacturing            | 1,000,000 | 1,000,000 | 1,000,000 | 1,000,000 |
| Total                    | 5,000,000 | 4,924,000 | 5,144,000 | 6,651,000 |
| Transport costs (€)      |       |                 |        |        |
| Maritime                 | 51,063 | 54,531 | 46,334 | N/A    |
| Rail                     | 204,608 | 67,027 | 39,724 | 7587   |
| Road                     | N/A    | 71,687 | 42,316 | 8411   |
| Air                      | 1,996,525 | 370,476 | 272,663 | N/A    |
| Lead time (days)         |       |                 |        |        |
| Maritime                 | 47     | 30   | 24     | N/A    |
| Rail                     | 20     | 14   | 6      | 4      |
| Road                     | N/A    | 2    | 1      | 0      |
| Air                      | 3      | 2    | 2      | N/A    |
| Stock costs (€)          |       |                 |        |        |
| Maritime                 | 500,000 | 399,527 | 356,682 | N/A    |
| Rail                     | 1,277,696 | 271,245 | 185,137 | 146,543 |
| Road                     | 101,445 | 79,990 | 35,039 |        |
| Air                      | 119,774 | 109,492 | 109,913 | 0      |
| Current transport mix cost (€) |       |                 |        |        |
| Maritime                 | 5,551,063 | 5,378,057 | 5,547,016 | N/A    |
| Rail                     | 5,532,304 | 5,262,272 | 5,364,861 | 6,805,130 |
| Road                     | N/A    | 5,097,131 | 5,266,305 | 6,694,449 |
| Air                      | 7,116,300 | 5,403,968 | 5,526,575 | N/A    |
| Current transport mix cost (€) |       |                 |        |        |
| Alternative transport mix |       |                 |        |        |
| 1 cost (€)               | N/A    | 5,219,619 | 5,366,941 | N/A    |
| 2 cost (€)               | N/A    | 5,146,673 | 5,297,072 | 6,727,654 |

Note: When it comes to large countries like China, the US or India, wages vary a lot from region to region. This phenomenon is acknowledged. However, going into this level of detail for this paper would make the comparisons and analysis too complex. Furthermore, in consultation with the advisory board, average values were taken that apply to the regions where the concerned industries are currently located. The values are not official government figures, but real-life figures as experienced by the companies.
Benelux is taken as the origin. Given the respective lead times, stock costs are always cheapest for air transport, always followed by road as the second cheapest. Summing up all cost elements, air is always the most expensive, except for the scenario of Poland, where the current transport mix appears more expensive. Road consistently leads to the cheaper option.

Comparing the various scenarios, the scenario North-Macedonia is consistently the cheaper option overall. Logically, the option Benelux consistently allows for the cheaper transport and stock costs, given the much shorter transport distance, and the consequently shorter lead times. However, its higher wage costs crowd out the cheaper transport and stock costs. For the two scenarios (North-Macedonia and Poland) where both alternative transport mixes can be calculated, the alternative transport mix 2 is always cheaper than the alternative transport mix 1, which in turn is cheaper than the current mix.

5.2. Qualitative decision factors

For the qualitative analysis part of the analysis, Table 10 gives the assumed scores to each of the questions. That table also contains the multiplier of the latter with the input values for each of the question items, as taken from the Global Innovation Index. Each of the latter values constitutes an index in the range 0–100, with a higher value meaning a better score.

The scores of the 22 questions are then grouped per decision factor, and the resulting ranking on each decision factor is shown in Table 11, as well as three alternatives of weighted sums over the three decision factors. Various alternative assumptions are made of the relative importance attached to ‘cost’, ‘value’ and ‘time’, as shown in Table 12.

What can be observed from Table 11 is that Belgium is always on top of the ranking, except when only the item ‘cost’ is considered, where North-Macedonia and Poland precede Belgium, mainly due to their lower wage costs, and in the alternative weighting 2, where cost gets a very high importance, making North-Macedonia win.

5.3. Combination of quantitative TCO and qualitative perception factors

By combining the results from section 5.1 (TCO model) with those of section 5.2 (qualitative model), the decision maker can make a reasoned trade-off between the objective TCO and the subjective qualitative decision factors of cost, value and time (Table 13). An example is shown for the three considered transport mixes (current + two alternatives) from section 5.1 for the weighted sum 1 of section 5.2. While Belgium features on top of the qualitative ranking, its TCO is substantially higher than that of North-Macedonia and Poland, although only alternative 3 has a TCO value for Belgium. It will then be up to the decisionmaker to judge what (s)he values most. Especially in a context of COVID, and the uncertainty of what the post-COVID era will look like, with pandemics maybe emerging at a faster pace, or the current pandemic having a longer-lasting impact, the trade-off is crucial for supply chain decision makers. The combination of tools from this paper should help in underbuilding such decisions.

6. Conclusions

The starting point of this paper was the observation that the nearshoring tendency, which emerged around 2010, and which featured steady but modest growth, got strongly re-vived recently by the COVID-19 pandemic. With the help of both a quantitative and a qualitative model, for a number of concrete scenarios, potential nearshoring decisions were judged on their fit with economics and user perception.

First of all, it is important to determine which sector one belongs to, since different characteristics will play a different role depending on the sector, linked among others to the value of the product, the habits and expectations with respect to speed of delivery, the typical location of suppliers and customers, etc.

Next, transport costs typically do not have the biggest share in total supply costs, but may be decisive as they determine also the lead time and hence the costs related to stocks. In general, of the considered modes (maritime, rail, road and air), air seems generally restricted to very high-value products only, or for emergency deliveries. Equally, air and maritime transport do not make sense for some scenarios, especially when the distance is very small.

Finally, it turns out that qualitative decision factors – rather linked to perception and personal preferences – do not always match economic outcomes. Therefore, a trade-off remains needed from the side of the decisions-maker. However, this paper contributed at least by providing an instrument that quantifies to the extent possible and allows the user to make a well-founded decision, especially in a crisis situation, when time is lacking to start developing decision frameworks and determining which data for which variables are relevant.

The applications developed in this paper with the TCO model are not meant to give a complete and exhaustive picture of all factors that need consideration when envisaging near- or offshore. Neither are their calculation results an exact reflection of any company-specific setting, since assumptions are made with respect to commodity- and producer-specific unit values. Rather, the application in this paper is meant to give orders of magnitude of fluctuations in impacts and the role of specific factors in supply chain changes, which were as such also validated by the advisory group member companies. In that sense, further refinement work as well as sensitivity testing of the developed model to other contexts might be desirable.

CREdit authorship contribution statement

Edwin van Hassel: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing.

Thierry Vanelslander: Funding acquisition, Project administration, Supervision, Writing – original draft. Kris Neyens: Conceptualization, Data curation, Writing – review & editing.

Hans Vandeboore: Conceptualization, Data curation, Writing – review & editing. Domine Queid: Conceptualization, Data curation, Writing – review & editing.

Stefan Kellens: Conceptualization, Data curation, Writing – review & editing.
Appendix A. SWOT for offshored production location (China) and candidate nearshoring countries

Table 11
Country rankings based on individual decision factors + weighted sum of decision factors.

| Cost      | Value      | Time      | Weighted sum 1 | Weighted sum 2 | Weighted sum 3 |
|-----------|------------|-----------|----------------|----------------|----------------|
| North-Macedonia | Belgium  | Belgium  | Belgium       | North-Macedonia | Belgium       |
| Poland    | North-Macedonia | Belgium   | North-Macedonia | Belgium       | North-Macedonia |
| Belgium   | China      | Poland    | China         | China         | China         |
| China     | Poland     | China     | China         | Poland        | China         |

Table 12
Weights for qualitative decision factors.

| Alternative 1 | Alternative 2 | Alternative 3 |
|---------------|---------------|---------------|
| Cost          | Value         | Time          |
| 40            | 80            | 10            |
| 30            | 10            | 45            |
| 30            | 10            | 45            |

Table 13
Trade-off between qualitative ranking and corresponding TCO.

| Qualitative ranking | TCO alternative transport mixes (€) |
|---------------------|-------------------------------------|
| Alternative transport mix 1 | Alternative transport mix 2 | Alternative transport mix 3 |
| Belgium N/A | 5,366,479 | 5,219,619 | 5,146,673 |
| North-Macedonia 5,529,201 | 5,366,941 | 5,297,072 |
| Poland 5,549,187 | N/A | N/A |
| China 5,549,187 | N/A | N/A |

Appendix A. SWOT for offshored production location (China) and candidate nearshoring countries

Fig. A1. SWOT China as a production location. Source: own composition.

Labour: large pool
Market: very extensive
Wages: relatively low
Expertise: knowledge and expertise clusters

Transit time: long towards Europe
Transport cost: high
Total cost: increasing
Inventory: offshore, floating
Greening: unclear
Labour: large turnover

Consumer market: growing
Logistics network: no country-wide
China + 1: from export-producing to consumption-driven
Outsourcing: possible to even cheaper countries (Bangladesh, Cambodia, Vietnam)

China is n°1 reshoring origin
Wage cost: rising
Local for local: own market
Industrial air and water pollution
Labour conditions: long working days and high pressure
Negative food safety reputation
IP risk

Fig. A2. SWOT North-Macedonia as a production location.

Fiscality: fifth lowest tax rate globally, no import duties
Wage cost: lowest in Europe
Political stability
Free trade agreements: 41 countries
Labour: young + well-trained
Intra: 2 pan-European corridors

Airports: national airports have no direct overseas connections
Environment: no compliance with EU rules on air, water and waste
Slow economic development

EU membership can have benefits for Macedonia
Strongly developing IT sector
28% unemployment, so large and growing talented labour pool
Various industrial clusters + global free zones

Low wages does not mean low quality here
Corruption level lower than in surrounding countries, unfair competition
Unemployment: 28%
Frequent smaller earthquakes
Appendix B. The 22 questions as applied in the Global Innovation Index

| Question number | Question: How important is to your organization in the production country ... | Qualitative decision factor answered |
|-----------------|--------------------------------------------------------------------------------|------------------------------------|
| Q1              | Low labour costs                                                               | COST                               |
| Q2              | Low transport costs                                                             | COST                               |
| Q3              | Good education level                                                            | VALUE                              |
| Q4              | Political stability/absence of terror and violence                              | VALUE                              |
| Q5              | Transparent and stable legislation                                              | VALUE                              |
| Q6              | Efficient and correct government                                               | VALUE                              |
| Q7              | Favourable taxation and fiscal policy                                           | COST                               |
| Q8              | Protection of intellectual property rights                                      | VALUE                              |
| Q9              | Sentivity to fraud/respect of laws                                             | COST                               |
| Q10             | Ecological considerations                                                      | VALUE                              |
| Q11             | Ease of launching new activities                                               | TIME                               |
| Q12             | Sufficient supply of good labour                                               | VALUE                              |
| Q13             | Ease of dismissing staff                                                        | COST                               |
| Q14             | Strong local R&D setting                                                       | VALUE                              |
| Q15             | Strong local supplier network                                                   | TIME                               |
| Q16             | Qualitative local supplier network                                              | VALUE                              |
| Q17             | Good and quick access to ICT infrastructure                                     | TIME                               |
| Q18             | Well-established logistics network                                              | TIME                               |
| Q19             | Ease of access to credit                                                        | TIME                               |
| Q20             | Strong collaboration with research network                                       | VALUE                              |
| Q21             | Competent and well-trained staff                                                | VALUE                              |

Appendix C. Conversion of production costs to other sectors

| Sector                          | Global innovation for local markets | Regional processing | Energy-/raw material intensive goods | Global technologies/innovators | Labour-intensive trading goods |
|---------------------------------|--------------------------------------|----------------------|--------------------------------------|-------------------------------|--------------------------------|
| Share of 'Global innovation for local markets' equivalent (%) | R&D intensity 100 | 59 | 47 | 118 | 59 |
|                                 | Labour intensity 100 | 219 | 150 | 104 | 250 |
|                                 | Capital intensity 100 | 125 | 189 | 185 | 83 |
|                                 | Energy intensity 100 | 138 | 200 | 50 | 125 |
|                                 | Trade intensity 100 | 33 | 53 | 133 | 133 |
|                                 | Value density 100 | 71 | 43 | 143 | 107 |

(continued on next page)
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### Table 1: Application of the % to TCO items for China

| Sector                        | Global innovation for local markets | Regional processing | Energy-/raw material intensive goods | Global technologies/innovators | Labour-intensive trading goods |
|-------------------------------|------------------------------------|---------------------|--------------------------------------|--------------------------------|-------------------------------|
| R&D intensity                 | 200000                             | 117647              | 94118                                | 235294                         | 117647                        |
| Labour intensity              | 250000                             | 546875              | 375000                               | 259750                         | 625000                        |
| Capital intensity             | 340000                             | 425000              | 642222                               | 6290000                        | 2833333                       |
| Energy intensity              | 150000                             | 296250              | 390000                               | 75000                          | 187500                        |
| Trade intensity               | –                                  | –                   | –                                    | –                              | –                             |
| Value density                 | 1000000                            | 714286              | 428571                               | 1428571                        | 1071429                       |
| Total production cost         | 5000000                            | 5835058             | 7619911                              | 8288241                        | 4834909                       |