*European Journal of Sustainable Development* (2021), **10**, 4, 155-166 ISSN: 2239-5938
*Doi: 10.14207/ejsd.2021.v10n4p155*

# Lowering Distribution Costs: The Key to Sustainable Health Development?

By Cole Webber[1]

**Abstract**
Recently selected as a winner of the government of Canada's COVID-19: Digital clearinghouse challenge, our background work has uncovered that the cost of distribution can often be significantly higher than the cost of manufacture for high consumable medical supplies, like personal protective equipment (PPE). What's worse, all of these costs are often not realized in suppliers' pricing schedules, as further 'hidden costs 'are incurred when governments procure centrally but use locally, demanding after the fact 'sub distribution'. As the public and private sector alike look to rebuild stockpiles, how can we rethink the supply chain to maintain domestic production without simple subsidization? Conventionally, domestic suppliers have been unable to compete with overseas counterparts on price point. If distribution costs can be lowered, domestic supplies could become *cheaper* overall, more ethical and more sustainable. The key is in circumventing the architecture of a supply chain altogether — which is only as strong as its weakest link — and enabling an adaptive net that can match suppliers and distributors to orderers, enabling centralized procurement and direct, shortest path distribution *at the same time*. This strategy can improve the reliability, efficiency and resiliency of supply chains with impact on health costs.

*Keywords: Lean, Distribution, Healthcare, Sustainable Development, Supply Chain, Supply Chain Management, Information Technology*

## 1. Cross Sector Issues

Lean methodology, originally developed out of Toyota to streamline manufacturing processes, provides a lens to systematically identify and reduce waste. Lean originally identified seven wastes: waiting, over processing, over production, transportation, motion, defects, and extra inventory. An eighth waste of unused employee potential is often used, although it is an addition from the original Toyota method (Andersson et al., 2006).

Inventory is often rightly identified as the 'keystone 'waste in Lean as it can be thought of as a producer of other wastes. One cannot over process, or transport something which is not there. Lean focuses on a total view of the value that a set of processes or organization adds to a customer, through activities like value stream mapping and 'fish boning 'often encouraging 'one piece flow 'or to initiate a process for a customer once it is known what the customer wants. This, in combination with the intense focus on adding value to the customer, can produce a situation in which *any* inventory is thought of as waste. In combination with concepts such as one piece flow, this originated a practice of 'just in time delivery' — to avoid waiting on parts, they are intended to be delivered at the latest

[1]Betterfit Corporation

possible point for integration to a project, so that storage and handling does not have to occur (Davies and Kochhar, 2002). While Lean methodology is intended to induce an organizational level of thinking, what if an organizational level of thinking does not suffice? Complete reliance on 'just in time delivery 'means that each stop at each organization is now entirely reliant on the stop immediately preceding it. If 'just in time 'delivery is too 'just in time', one missed delivery can render the flow failed, with ripples causing ramifications which last weeks or months after the missed delivery.

In a system with only a few stops, these delays may not be so costly or likely, and the tradeoff of the additional processing that they save at each stop, or each organization, may be worth it. However, today we do not have supply chains with only several stops, but possibly hundreds. Confirmed through our workshops with suppliers, this can even be deduced by simple observation of the delays: in a system with three stops, each stop taking two weeks, we would expect the maximum delay of the first stop missing a delivery, and this accruing through all subsequent stops, to be a mere six weeks. What we have seen in the world economy, in even the production of basic goods, is supply and demand issues rippling months or nearly a year past the point of initial closures at early stops, across a range of items: lumber experienced over a five fold increase in price, the price of steel nearly doubled, coffee experienced over a sixty percent price increase. These are 'basic ' goods which do not incorporate the processing needed in a computer or automobile, which we could therefore not expect to be as susceptible to closures in different locations of the world. Complex goods, even those sold by sophisticated companies, experienced the same problems. The global computer chip shortage is well documented, and is causing the price of some computer goods to surge 30% compared to equivalent previous models (Silva, 2021). Automobiles have increased in price 10-53% as the total US inventory has fallen by 42%, with demand still outstripping supply (Krisher, 2021). Strikingly, the worst of all of these issues occurred nearly a year or more past initial closures due to the COVID-19 pandemic: the impacts were not solved but rippled on, and compounded.

From the alternative point of view, we should perhaps be surprised that complex companies were unable to head off their supply chain bets. From a mathematical or technological perspective, more manipulatable variables in a managed scenario should offer the opportunity for more stability in the outcomes, for the same basic reason that 1 times 4 is 4 but 2 times 2 is also 4: there are multiple ways that each variable can be manipulated to produce the same or similar outcomes. The observation that entire high tech sectors have been unable to head off these supply chain issues indicates the dearth of supply chain management solutions — both technological and methodological — currently on the market.

The simplest solution would seem to be to keep an excess of inventory at each stop, so that if a 'just in time 'delivery is missed, one still has the ability to continue on operations. However, this brings with it the waste of inventory: the waste of the items compounding into other wastes, such as handling, transportation and over processing, and the excess investment needed to maintain — and manage — inventory hoards. Yet beyond one organization there are even more wastes. There is only so much inventory available at any given time, and an even smaller 'hoard 'at every stop — amongst dozens or hundreds — sharply diminishes what is available to the end customer, and even to other organizations in the structure. As we saw with personal protective equipment (PPE) and other medical

supplies early on in the pandemic, multiple players vying for stockpiles can rapidly create a surge in prices. In our workshops in one Canadian province alone, frontline healthcare workers reported prices surging as high as five times their normal costs, and demand still overtaking supply. They knew this because they also frequently reported needing to purchase their own PPE, as the supply from their health region had at times completely broken down. In the first few months of the pandemic, PPE prices in the US surged over 1000% (Diaz et al., 2020). These situations of multiple organizations vying for increased excess and buffer inventory amounts creates a kind of prisoner's dilemma, in which it is in every one organizations' best interests to try to keep buying more before the price surges even higher. Yet since every organization is doing this, the price continues to surge — and more and more is stockpiled in unseen corners, taking away from what may ultimately be used by those most in need: the ones still waiting on just in time deliveries, or the ultimate end consumers, usually unable to leverage large buying power to compete. The problems are not solved, but are made worse by the initial reactions to the problems.

In conventional times, inventory as the keystone Lean waste is a logical and tough trade off. There are arguments for keeping it and disposing of it, both valid. More inventory produces more down the line waste. Less inventory increases the risk from mounting failed or delayed 'just in time 'deliveries.

This makes the real argument: how much to keep? This pits Lean practitioners in a constant balancing act of trying to determine the 'proper 'amount of inventory to carry. To be sure, excess inventory, not simply inventory, is the waste. But what exactly is excess?

## 2. A 9th Lean Waste: The Stop

What if the cause of these failings was not just the inventory amount: the lack thereof, or the over presence of it? Just before the pandemic, over 57 million now coveted N95 masks expired in stockpiles in Canada (Dhanraj, 2020) (Leo, 2020), reminding us of the waste of hoarding. The real waste is not in having it or not, but in not using it: the same point where the real risk in either strategy regarding inventory emanates from as well; That inventory will not be there to use, or that one will not use it fast enough. If the *flow* is broken, both too much and too little inventory is a waste. The real waste, when dealing with these problems, is not the *inventory*, but the *flow* to keep it moving, and specifically when this flow has the opportunity to be broken: the *stops*. A systems level of thinking is demanded, one which can identify wastes not within organizations but between them. Distribution stops have a different relationship to risk than inventory. They do not represent a simple trade off. They can provide value, to be sure, but that value is subject to — always — drastically increasing risk.

As new stops are linearly added, the chance that a failure will occur at any one point increases cumulatively, since it must rely on successful delivery form the previous stop. If each stop has a 5% chance of something going wrong, the third stop carries with it not a 5% chance of failure, but a 15% chance of failure, as it must rely on the previous two making successful deliveries to carry out its actions normally. In addition to accumulating the chance of total failure across the number of stops, the average downtime is increased as each new stop is added as well. Imagine we have three equal stops, each posing a possible delay of two weeks. The first stop failing could produce a six week delay, as it

© 2021 The Author. Journal Compilation © 2021 European Center of Sustainable Development.

ripples through the other stops of the supply chain, the second four weeks, the last two weeks. This makes the *average* failure in such a system 'cost 'four weeks. If we add one more stop taking another two weeks, everything is shifted. The first can now cause a delay of up to eight weeks, the second six weeks, the third four weeks and the last two weeks. Our average possible delay is increased to five weeks, and will increase further with each new stop added. As we are increasing the time of the average delay, we are also increasing the chance that said delay will occur, meaning that the total risk and cost posed is increasing exponentially.

This is not just transportation, as transportation can occur within a localized set of facilities. Looking at transportation does not capture the true cost and risk of each discrete stop. Each stop that an item has to make in a flow adds another point of possible failure: like inventory, it adds even further wastes than the ones already discussed. Each distribution point 'stop 'carries with it another location at which to cause mishandling, over processing, and material waste, in addition to inherently carrying some amount of inventory and demanding transportation.

While a certain number of stops is essential to the production of any complex good or service, each stop should be seen as inherently high cost. Not only is identifying this discretely a new waste, but it may take the crown as a 'keystone 'waste from inventory, as its nature is to produce a relationship that is not a balancing act, but one which produces increasingly higher cost and risk. Where inventory *can* produce higher wastes, each stop *does*, and has the ability to produce exponentially higher wastes and risks at that, rather than mitigating them as in the case of inventory — if it can be selected in the (near impossible') right 'amount.

Many of the complex goods and services we enjoy today would not be possible without many stops. Yet each stop adds increasing risk. It should be attempted to eliminate them wherever possible. Where not possible, it should be attempted to 'collapse 'them: not cutting an operation out of the loop, but simplifying that operation into others, or simplifying these stops internally within any organization.

## 3. Invisible Costs

These stops can occur both between organizations, and within them. If they are occurring within organizations, they can contribute to increasingly higher distribution costs that are not realized at the time of purchase from the seller. Critically, in healthcare, these costs often go unaccounted for, and, not being recognized, are taken out of resources allocated and intended for providing actual care.

After conducting workshops with suppliers, industry professionals and healthcare workers, we estimate that the average shipment of high consumable medical supplies makes at least five stops in its route from manufacturer to ultimate frontline user in Canada. This represents the average condition, with the strain placed on the supply chain actually increasing the number of stops and decreasing the percentage of product available to the frontline in the manner discussed above. Frontline workers repeatedly reported making their own trips to procure their own supplies, when supply lines from health regions, provinces and the federal government — all of which take part in procurement — had failed. Stops often occur not just between manufacturer, distributor and purchaser, but

across multiple points *within* these organizations. To leverage their buying power, large organizations often procure larger volumes, which they usually ask be delivered to centralized locations for down the line 'sub distribution'. This adds further costs as warehouses must be procured which do not contribute to the purchasing organizations ' central mandate, and further logistics must be managed and stops executed to get product to those who can ultimately use it. This chain becomes longer and more convoluted the further away the purchasing organization is removed from the frontline user, which in healthcare is a problem that may extend into the future. In Canada, healthcare is a provincial mandate, with several provinces having single unified health regions but most delegating the task to even further distributed networks of multiple health regions per province. During the pandemic, the federal government became the largest purchaser of medical supplies and personal protective equipment, yet was unable to actually use these items for healthcare purposes at the federal level; they had to be sub-distributed to frontline locations of care, at added cost to the government beyond that which they paid for the items and central deliveries. In our investigations, these sub distribution actions are most often not accounted for in government purchasing information and reports. A strategy to buy centrally carries with it the seeming advantage of being able to leverage buying power to achieve discount pricing. This strategy was recently lauded by even Canada's Auditor General (Hogan, 2021). We have seen even more signals that the Federal Government of Canada intends to extend this practice into the future, with recent tenders looking for products in the hundreds of millions of units and billions of dollars, yet once more asking for delivery to centralized federal warehouses (Government of Canada, 2020) (Hogan, 2021) (Public Services and Procurement Canada, 2021). These volume discounts can be quickly eaten away by the true and unrealized costs of getting the products to where they can be used. No matter how centralized procurement becomes, use must ultimately be local and on the frontline. Worse still, the cost is most often 'shifted 'to frontline workers, who must manage increasingly complex processes to request and receive the materials they need, eating into the time they spend providing actual care.

In workshops with frontline workers from Alberta Health Services (AHS), we broke down the steps needed for those on the frontline to request and ultimately receive materials to their health unit. We found that the actual realized process could take dozens of steps, including time-consuming steps like 'ad-hoc 'conversations and phone calls; that, even if in stock at one of the central regional warehouses, delivery could take a week or more; and that delivery of critical supplies often failed. Delivery from the region to the hospital units failed so frequently that multiple workers from different hospital locations reported having large volumes of taxi tokens on hand, to send needed materials back and forth between hospitals in the back seat, often 'just in time 'for an operation. Each worker who raised this point claimed that the frequency of this occurrence was multiple times a week, diminished only by further asking ambulances to transport materials to other hospitals just before they left on a call. What unaccounted for costs to care — or even lives and wellbeing — are being added by potentially delaying ambulances?

Determined through these workshops, these factors, among others, result in an average of 28% of frontline care workers' time being spent on administrative duties. Compared to AHS's annual budget (Ernst & Young, 2019), this represents an approximate annual cost of $1.9 billion CAD in lost care time. Put another way, this is equivalent to an annual cost

© 2021 The Author. Journal Compilation © 2021 European Center of Sustainable Development.

of 36 million hours, or 17,300 FTEs, for this one health region. While this represents all administrative duties, dealing with ordering is one of the most significant components, and this represents just a fraction of the added costs of further 'sub-distribution'. Not recognizing are the costs realized by the federal and provincial government in the process, or the costs of actually moving the product around — only the costs on one end of dealing with such an ad-hoc system, composed of multiple levels of purchasing. Even looking at these costs alone, the pricing discounts achieved by buying centrally must surely be outstripped.

The avoidable costs of actually delivering the product to the organization from the supplier end, while hard to calculate, must be immense. In consultation with suppliers, some provided us with pricing schedules and cost estimates. We also undertook workshops to identify the costs in running a manufacturing operation, and received quotes from suppliers of equipment, raw materials and leases for the space required. Though companies are usually wary to share information like specific margins, we were able to develop a good picture of the market for consumable medical materials. We estimated the actual cost of manufacture for various kinds of medical masks as a mere 10-15% of the total cost often given to buyers. Yet most companies reported fears of going under, operating on razor thin margins; the remaining 85% was not contributing directly to profit. Depending on how the costs are viewed, the vast majority of the remainder can be considered distribution: especially if we identify distribution from a systemic point of view, counting the overhead costs of processing at additional stops. Products are most often moved multiple times, each stop offering a point where more overhead, more processing, and more waste costs can be accrued. As mentioned, the concept of the stop as a waste does not involve mere transportation costs, if the whole stop can ultimately be avoided, though even the transportation costs involved in one average trip were estimated to possibly outstrip the cost of production. Multiple trips have a further compounding effect on transportation costs alone, as the costs from couriers are greater if a distance is reached in two trips than in one, meaning that, even if the same distance is ultimately achieved, a stop is a significant added cost. Considering these costs once an item has been delivered to an organization, if the organization must sub-distribute, these can rapidly match or exceed the cost of the item at only a few further stops, though these costs are rendered essentially invisible within internal distribution systems where costs are often not tracked per item, but as a separate department. If an item was able to be delivered once to where it was needed, these costs could ultimately disappear.

The cost of distribution — which we define as the cost accrued through multiple unnecessary stops — could be reasonably seen to take up between 60% and 80% of the supplier's quoted cost on many transactions of highly consumable medical products, like masks or gloves, and the further costs incurred through sub-distribution once delivered to an organization can quickly exceed the price originally paid. In other words, for each product, an organization may be rapidly 'paying 'twice what it thinks it is.

As mentioned, the burden of dealing with further sub-distribution costs often falls to frontline workers. With no additional costs allocated in the system, frontline workers deal with the added complexity at the expense of not dealing with patients, which causes backlogs to 'invisibly 'get longer. Procurement failings may have a large part to play in Canada's ranking in terms of access to care.

These costs are sure to be added to if centralized procurement is in turn ramped up, yet they come at a time when maximizing the amount of resources spent on patient care is a high priority: many experts are estimating that the impact of care deferred during the COVID pandemic may rival or outstrip the impact of the virus itself. Ontario's backlog now sits at over 15 million cases, excluding the cases that already existed before the pandemic (Alberga, 2021) and Alberta has delayed approximately 30% of procedures (Rieger, 2021), with our respondents with scheduling experience estimating the overall backlog in the province has more than doubled since the pandemic began. With Canada ranking near last among developed countries in terms of access to care and procedural wait times before the pandemic, (Dawson, 2020) (Barua & Moir, 2019) (OECD, 2020) these delays threaten to undermine the very foundation and core purpose of the country's healthcare system.

Yet would it be possible to unify the discounts realized through bulk purchasing without the added costs of sub distribution? Even decreasing other costs and wastes, such as the amount of inventory carried?

## 4. A Supply Net

We have identified a series of problems relating to the supply chain:

1. That it is only 'one direction'; just in time deliveries cause each stop to rely on the stop previous.
2. That this in turn creates a system which fails to adapt when problems arise. In fact, problems are further compounded by emergency behaviours.
3. The architecture of a chain in turn causes violent pendulum swings when an error is encountered, with organizations rapidly going from seeing inventory as a waste to trying to hoard as much as possible. This only compounds problems, as those still waiting on just in time deliveries suffer even further delays, which ripple further down the chain, and so on.
4. That each stop poses waste and risk more than the sum of its parts, offering another opportunity for error to occur and therefore compounding the total chance of failure, and offering more opportunity for added waste and further trips to occur.

In such an interrelated system, the lack of ability for one node to get access to what they need can affect dozens or hundreds of others — others which may even be actively buying up inventory needed for the node that they rely on. Even between organizations, this can result in further needed 'sub-distribution', for the down the line organization to share inventory back to their partners that they are waiting on, once more compounding the complexity of logistics.

As the number of stops increases, the amount of material ultimately available at the final use point decreases, even with the same amount of supply available in the total system. This is caused not only by hoarding, but also by increasing complexity of logistics, which means more stops and trips. In addition to more of this supply being taken up by inventory hoarding at every stop, each stop provides a further opportunity for material waste — as we saw with stockpile waste in Canada — and, more than this, as the number of trips between each point increases, the volume of material in transit at any given time increases as well, leaving ultimately a lesser percentage available for 'frontline 'use. Our respondents

© 2021 The Author. Journal Compilation © 2021 European Center of Sustainable Development.

reported the number of trips that each material item took skyrocketing in the beginning of the pandemic, sending items back and forth between hospitals, and other distribution points so they could in turn make good on the demands posed by other frontline locations deemed to be a higher priority. Suppliers also reported being asked to move shipments from one location to another. Even with the same number of distribution points, increasingly complex logistics caused by missed deliveries can lead to more stops between these points.

It follows that to solve the problems of such a system, we would need to envision one in which:

1. Movement is adaptive, not one way. Movement can be rerouted easily, with connections between stops not forming a one way chain but more akin to roads that can be driven on or not at any instant, but have the potential to facilitate movement.
2. That this movement is rerouted to deal with problems as they are happening.
3. That hoarding of inventory is prevented even in emergency situations by prioritizing need in terms of down-the-line effects to the ultimate user or customer, and ensuring that these needs are met to keep the movement in progress.
4. That items make as few stops as possible from manufacturer to final use point.

In such a system, an order could come into a centralized digital clearinghouse, be prioritized based on its down the line consequences to the rest of the system and ultimately to the final user, and be matched to the supplier that has the item in stock and is the closest to the ultimate final delivery point. The supplier could then be paid to deliver the item in the proper quantity to the final use point, rather than to a centralized site from which further sub-distribution must occur. If we were matching based at least in part on the supplier's location relative to the final use point, this could ultimately result in less transit distance than through the previous sub distribution strategy, let alone less stops.

These strategies would serve to target and bring down by an order of magnitude both the distribution cost built into suppliers 'prices, as well as distribution costs incurred after the fact by buyers with hierarchal structures. This method targets suppliers 'distribution costs by ensuring that orders are matched to them which involve the lowest overhead for them to fulfill, for instance matching orders to them based on items they already have in stock at low reported costs, at distribution points the nearest to the location of order. In a unified digital clearinghouse, market pricing pressures would further apply, as multiple suppliers would be present on the platform, and, especially for larger organizations, (perceived) price point can ultimately be the deciding factor in purchasing decisions. This means that multiple suppliers would be vying for contracts based on price point. By eliminating the need for suppliers to distribute through multiple points, involving overhead, and matching the one trip made to the nearest combination of supplier and use point, both total overhead and total transit distance can be brought down, lowering distribution costs dramatically — which likely make up a significantly larger portion of total supplier price than manufacturing does, for many items. If these gains were significant enough, we would predict the market to find a new equilibrium at a lower price point that still enables suppliers to have a greater profit per item. On an item with a 60% distribution cost, if overhead could be cut in half by eliminating stops and administrative complexities, this could provide a 30% 'buffer 'to the supplier. The supplier could therefore pass 15% of the gain to the customer by lowering the price, and still realize a 15% increase in per unit

profit.

This system also targets further unnoticed costs of sub-distribution, by seeking to deliver directly to the point of use, bypassing internal sub-distribution that must occur if delivered centrally. The true cost of total distribution is targeted, not only the cost which registers on the supplier's pricing schedule.

Such a system would further enable manufacturers to more easily sell directly to buyers, bypassing distributors that usually take an extensive mark up and add even more stops to the chain. In fact, the market pressures set up through such an adaptive clearinghouse would serve to optimize the true value add posed by distributors, as it would only allow those distributors with markup levels and distribution points that simplified delivery and cost to the final user to compete on price, and therefore ultimately remain. In other words, distributors may fulfill a need by offering more local distribution points than manufacturers, but could only compete on price if they fulfilled this need. Distributors must find the balance of localized delivery points, minimal trips made and price markup to be able to be matched to an order over a manufacturer.

This registers an increase in environmental sustainability as well. Because of Canada's vast geography and distribution of population, our country is one of the most reliant in the world on trucking operations, spending about 1.6 times the per capita annual spend compared to Europe on road freight (Mazareanu, 2020) (Statista Research Department, 2021) even though a majority of freight (in tonne kilometres) is still carried by road in all EU member states except for Latvia and Lithuania (Eurostat, 2020). Even as federal pushes are made for electric vehicles, 33% of Canadian electricity is produced via nonrenewable resources (Government of Canada, 2016). Ultimately significantly lessening the number of trips that even an electric vehicle must make transporting goods can have impact sooner than the initial transition to electrical vehicles itself, especially in remote areas likely to be slow to adopt renewable energy sources or to link up to a centralized electric grid. This is especially true of Western Canada, which has very little hydro generated power or access to hydro power sources, which represents 89% of Canada's total renewable energy production (Government of Canada, 2016).

Such a system places a significant importance on supplier location relative to buyers, to fulfill orders with minimal distribution costs and impact both built into the price and incurred by buyers after the fact. As such, we begin optimizing the true problem, the more significant cost of distribution rather than manufacturing. From our analysis discussed previously, labour is the largest cost involved in manufacturing domestically in Canada and, we believe, in most of the developed world. Ethically priced labour cannot compete with the wages paid out by some overseas manufacturers, which results in a drastically reduced price of manufacture for overseas products. If the cost of distribution for both is the same or similar, overseas products, especially those produced in an unsustainable, unethical fashion, beat domestic products on price point and in turn flood the market. However, since a system factoring into account distribution costs relies on relative location to the point of use, distribution costs can be uniquely lowered for domestic suppliers, allowing them to compete on a direct dollar-for-dollar price point, with the additional added benefits of domestic production.

Another dimension of the often unsustainable nature of cheap overseas production is its certification standard. In Canada, the market was quickly flooded with overseas

© 2021 The Author. Journal Compilation © 2021 European Center of Sustainable Development.

manufactured PPE and other medical supplies, for which substantial recalls have been issued by government regulators (Health Canada, 2020). However, this occurred months into the pandemic, after these products have been in the market and in use for an extensive period of time. Where recalls are a reactive approach, allowing pre-approved domestic suppliers to compete on price through the optimization of distribution costs offers a proactive approach, potentially preventing the need to import large, untested quantities in the first place.

This is a stark departure from the early government strategy, which has been to subsidize domestic manufacturing. Operations with little experience — being that the industry was not established — were given large contracts extending into the future, favourable loans or even grants to cover their cost of establishing manufacturing operations (Babych, 2020) (Morrison, 2020). However, this threatens to be an economically unsustainable strategy, as many Canadian suppliers have been unable to compete on price point and have not secured other contracts. By integrating these suppliers together and allowing them to compete on price point by lowering distribution costs, we could give domestic suppliers a unique edge over overseas counterparts, leading to increased financial independence.

Yet, if we are optimizing distribution to the point of use, are we eliminating the ability for large, multi-tiered institutions, be they public or private, to leverage their buying power? Not necessarily. It is through such a centralized clearinghouse strategy that we can enable users to buy centrally yet still distribute locally. Through our workshops, we often found the largest concern of suppliers — and especially manufacturers — is to have guaranteed orders as their product is moving off of the production line. The *size* of the order is often not as much of a concern as the *regularity*, since warehousing supplies and finding buyers takes up a greater cost than allowing it to be shipped as soon as it comes off of the line, in whatever ultimate delineation. Shipping orders of 400 boxes, 100 boxes and 300 boxes poses little difference than an order of 800 boxes, especially if the 800 boxes would otherwise need to be stored. Likewise, we know that large stockpiles of materials have often remained unintegrated with the rest of the supply chain, expiring and going to waste. A primary concern of those having the buying power to procure large stockpiles should clearly be not only securing the amount, but keeping it in use. These two concerns of both supplier and buyer can be unified to create a strategy better for everyone. Large organizations especially have the buying power to 'pre purchase 'capacity from suppliers, to in effect own certain volumes of materials as they are coming off the line. The large organizations can in turn, through a digital clearinghouse, allocate these pre-purchased credits to multiple locations of ordering to be ultimately fulfilled to. This pre-purchased capacity can be purchased from or split between multiple suppliers, and orders can be matched to the nearest supplier in the network capable of fulfilling them, both as inventory amounts are updated by suppliers and as frontline orders come in, all drawing down from the credit purchased by the large organizations. Such a model enables large volume discounts to be negotiated, while still skipping the sub-distribution costs often needed to secure these discounts, which would ultimately eat into them anyway. This further allows suppliers of a smaller size, of which many newly formed domestic suppliers are, to participate in large contracts usually reserved for larger players, bringing further enhanced stability to a distributed domestic market.

Even such a purchasing model poses challenges of complexity, and would have to be

automated to appropriately eliminate the extra administrative work it could pose. Challenges like how long the credit would last into the future before it must be redeemed, the total number of shipments that each large order could be broken into, of what maximum and minimum size, and how far each of these shipments could be sent would need to be addressed in new types of purchasing agreements, and both a legal and technological framework. However, since such a solution would be posed to solve such fundamental problems for both purchasers and suppliers, we believe these challenges could ultimately be overcome.

Such a complete strategy poses the ability for:

1. Domestic suppliers to become more profitable and stable without subsidization.
2. Reliance on non-domestic supplies to be lowered, especially in emergency situations.
3. Supplier costs of medical materials to be lowered.
4. After the fact sub-distribution costs of medical materials to be lowered.
5. Volume discounts to be realized across smaller suppliers, and to be in sum increased.
6. A 'freeing up 'of these costs to return to providing care, reducing administrative and financial burden often taken from frontline operations.

## References


Alberga, H. (2021, June 10). *Almost 16 million medical procedures built up in Ontario pandemic backlog*. CTV News; Bell Media. https://toronto.ctvnews.ca/almost-16-million-medical-procedures-built-up-in-ontario-pandemic-backlog-1.5464945

Andersson, R., Eriksson, H., & Tortensson, H. (2006). Similarities and differences between TQM, six sigma and lean. *The TQM Magazine*, *18*(3), 282–296. https://doi.org/https://doi.org/10.1108/09544780610660004

Babych, S. (2020, October 7). *AHS enters $60-million agreement with Calgary-based manufacturer to produce locally-sourced masks*. The Calgary Herald; Post Media. https://calgaryherald.com/news/local-news/ahs-enters-60-million-agreement-with-calgary-based-manufacturer-to-produce-locally-sourced-masks

Barua, B., & Moir, M. (2019). *Waiting Your Turn: Wait Times for Health Care in Canada, 2019 Report*. Www.fraserinstitute.org; Fraser Institute. https://www.fraserinstitute.org/studies/waiting-your-turn-wait-times-for-health-care-in-canada-2019

Davies, A. J., & Kochhar, A. K. (2002). Manufacturing best practice and performance studies: a critique. *International Journal of Operations & Production Management*, *22*(3), 289–305. https://doi.org/10.1108/01443570210417597

Dawson, T. (2020, November 10). *Despite big spending, Canada's health care near bottom for wait times, doctor and hospital bed availability: report*. National Post; Post Media. https://nationalpost.com/news/canada/despite-big-spending-canadas-health-care-near-bottom-for-wait-times-doctor-and-hospital-bed-availability-report

Dhanraj, T. (2020, March 22). *Coronavirus: Ontario stockpiled 55 million N95 masks after SARS, officials checking usability*. Global News; Corus. https://globalnews.ca/news/6715814/coronavirus-n95-masks-ontario/

Diaz, D., Sands, G., & Alesci, C. (2020, April 16). *Cost of protective equipment rises amid competition and surge in demand*. CNN. https://www.cnn.com/2020/04/16/politics/ppe-price-costs-rising-economy-personal-protective-equipment/index.html

Ernst & Young. (2019). Alberta Health Services Performance Review. In *Government of Alberta*. Government of Alberta. https://open.alberta.ca/dataset/c0724ccd-832e-41bc-90d6-a0cd16bc6954/resource/c934a00c-a766-41f5-8c69-2c2ac449eb84/download/health-ahs-review-final-report.pdf

Eurostat. (2020). *Freight transport statistics*. Ec.europa.eu; European Union. https://ec.europa.eu/eurostat/statistics-explained/index.php?oldid=492516#Road_transport

Government of Canada. (2016). *Electricity facts | Natural Resources Canada*. Nrcan.gc.ca; Government of Canada. https://www.nrcan.gc.ca/science-data/data-analysis/energy-data-analysis/energy-facts/electricity-facts/20068

Government of Canada. (2020). *ITQ Canadian Nitrile Gloves Manufacturing [ISQ Fabrication canadienne de gants en nitrile]*.; Government of Canada. https://service.ariba.com/Discovery.aw/ad/viewRFX?id=9359173


© 2021 The Author. Journal Compilation © 2021 European Center of Sustainable Development.

Health Canada. (2020). *Medical Device Respirator recalls*. Healthycanadians.gc.ca; Government of Canada. https://healthycanadians.gc.ca/recall-alert-rappel-avis/hc-sc/2020/73137a-eng.php

Hogan, K. (2021). *Securing Personal Protective Equipment and Medical Devices*. Office of the Auditor General of Canada.

Krisher, T. (2021, May 13). *As chip shortage goes on, cars are scarce and prices are up*. ABC News. https://abcnews.go.com/Business/wireStory/chip-shortage-cars-scarce-prices-77645971

Leo, G. (2020, April 16). Health minister reviewing management of Canada's emergency stockpile | CBC News. *CBC*. https://www.cbc.ca/news/canada/saskatchewan/heath-minister-emergency-stockpile-1.5530081

Mazareanu, E. (2020). *Trucking industry in Canada*. Www.statista.com; Statista. https://www.statista.com/topics/5047/trucking-industry-in-canada/

Morrison, T. (2020, April 14). *Funding available to businesses able to retool to help fight COVID pandemic*. Chatham Daily News; Post Media. https://www.chathamdailynews.ca/news/local-news/funding-available-to-businesses-able-to-retool-to-help-fight-covid-pandemic

OECD. (2020). *Waiting Times for Health Services: Next in Line*. OECD Health Policy Studies, OECD Publishing. https://doi.org/10.1787/242e3c8c-en

Public Services and Procurement Canada. (2021). *COVID-19 contract information - Supplying the Canadian healthcare sector in response to COVID-19 - Supporting Canada's response to COVID-19 - PSPC*. Www.tpsgc-Pwgsc.gc.ca; Government of Canada. https://www.tpsgc-pwgsc.gc.ca/comm/aic-scr/contrats-contracts-eng.html

Rieger, S. (2021, April 27). *Up to 30% of surgeries delayed in Calgary, Edmonton, northern Alberta as COVID-19 hospitalizations rise*. CBC; CBC/Radio-Canada. https://www.cbc.ca/news/canada/calgary/surgeries-postponed-alberta-1.6004922

Silva, J. (2021, May 24). *Chip manufacturers have started to increase prices due to the global chip storage*. TechSpot; TechSpot, Inc. https://www.techspot.com/news/89802-chip-manufacturers-have-started-increase-prices-due-global.html

Statista Research Department. (2021). *Road freight market size Europe 2010-2021*. Statista; Statista. https://www.statista.com/statistics/1068472/road-freight-market-size-europe/