Last Mile Innovations©

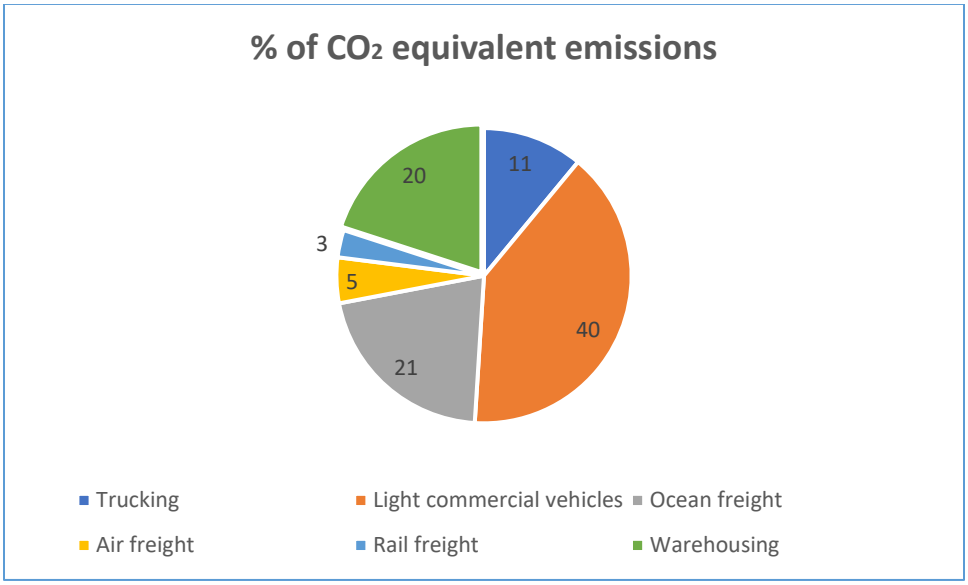
*This information was originally published monthly, within my book **ESG in Business**. In August 2024, I decided to have this important subset of logistics as its own tab on my website.* www.larryberglund.com

Larry Berglund SCMP MBA FSCMA

Table of Contents

Last Mile Innovations

A part of the challenge with deliveries of goods is to recognize the % of emissions from a logistics perspective. It will take a combination of technologies and types of energy to make meaningful reductions overall and to the last mile of delivery. Based on the McKinsey & Company, June 2024 report, *Decarbonizing Logistics*, a summary of the emissions shows that logistics account for *7%* of the global emissions. The following table provides the breakdown on this 7% of emissions.



A 2023 report produced by Frayt, which has an online delivery platform, with input from ~100 supply professionals, reiterates the attention being paid to the last mile of business. This is where the customer experience is really being felt according to the Fortune 1000 companies which participated in the survey. 80% of businesses see the last mile as the critical piece to solve from a service and a cost perspective. 35% of the respondents focus their logistics operations on the last mile specifically. One of the biggest barriers is capacity of the carriers to right size the delivery. The other key operational problems to accommodate are: traffic, weather, road conditions; inaccurate addresses or ability to contact the recipient; and theft, tampering or damage of the goods. Selection of the last mile partner was deemed an essential component for success.

A May 2023 *Supply Chain Insights* report, from *Project 44*, shows that the click-to-delivery time has been reduced from 6.8 days in December 2020 to 4.8 days in April 2023. The labour and materials shortages have been addressed by warehousing and shipping operations. A 30% decrease in wait times for customers is a significant change. On time *promised* performance has slipped by 3% over the past year where shippers are trying to meet the next-day expectations set by Amazon. The volume of shipments increased by 4.4% year-over-year.

Service issued still remain to be addressed. Over this time period customer complaint patterns are summarized as: delays 25%; delivered but missing 23%; damaged 21%; and specific carrier complaints 19%. Many shippers have increased the number of carriers they utilize to improve the last mile of service. www.project44.com

Trucking[1]

Outsourcing of logistics, warehousing, and distribution (LWD) services is a growing trend for its reduction of investment by customers and the access to expertise provided by the 3PL service providers. The primary activities of service providers are customer service, planning/demand forecasting, inventory management, warehousing, logistics communications, material handling, packaging, and transportation.

Transportation plays an integral role in our economy and will continue to do so. The infrastructure investments and maintenance costs require government and private sector attention. AI, the IoT, Big Data, telematics and algorithms are the means of improving logistics practices.

Manitoulin Transport invests in technology where there is a measurable improvement in productivity and efficiency. According to Jeffrey Smith, off-the-shelf software lacks the technical capabilities and requires in-house software to be developed to meet customer demands. Other carriers echoed Smith's view. Higher fulfillment rates with an ease of data flow between suppliers to address the last mile of delivery costs is one of the targets. In a 2021 Business Insider article, it argues that the last mile is the costliest in logistics at 53%. The LTL boom from ecommerce sees more smaller packages getting into the hands of the end customer.

Manitoulin rely on the PeopleNet fleet onboard truck system. This system offers end-to-end vehicle tracking with a focus on pre/post trip inspections, travel logging, navigation and routing, fleet performance monitoring, safety, and compliance. The software was initially developed for small to medium sized businesses which own a number of trucks. It has a custom designed GPS receiver device coupled with vehicle telematics. https://manitoulintransport.com/

In Canada, 3rd party certified ELD or electronic logging devices are a mandatory requirement as of 2021 in all commercial motor vehicles, to ensure safer operating conditions. The Canadian ELD system aligns with US regulations for use in both countries. Infractions for noncompliance were deferred until June 2022.

Application Programming Interface (API) is becoming more popular with shippers who wish to provide electronic information on bills of lading (BoL). API enables automatic uploading of all BoL data without clerical intervention to manually enter the information which increases accuracy and saves time. Similarly, customer portals allow BoLs to be completed, uploaded into the shipper's system, labels printed, and shipments can be tracked throughout the route.

Faxes have been superseded by sending PDF files via email to any customer's broker for any shipment. Manitoulin as an example, uses this in a centralized manner through their Customs Help Desk. They created a database for all customs brokers which includes their own customs brokers Summit Customs Brokers and Near North Customs Brokers.

Pre-Arrival Review Systems (PARS) allow customers brokers to notify the Canada Border Services Agency (CBSA) in advance of a shipments arrival to expedite its release. The carrier will affix a PARS sticker/label to the commercial documents and forward them to the customs brokers so they may set up the shipment with the CBSA in advance. Previously when faxing the broker, the shipper must also advise CBSA what port to cross, an estimated date and time of arrival, as well as the contact information in case the customs broker need to contact the shipper. Manitoulin uses a performance metric of 99.2% for successful clearance of PARS shipments. Their 2021 actual performance was 99.7% YTD.

One target at Manitoulin was a 60% reduction in the use of paper by 2023. An observation during the pandemic was the increase in staff working from home which led to far less paper being required. New

[1] Thanks to Eric Beckwitt, CEO, Freightera; Jeff Smith, Ex VP, Manitoulin Group; Cory Thorn, Dir of Ops, Canada Cartage; and Matt Zarzycki, COO, Amplify Logistics for sharing their industry insights and experience in a series of interviews in 2021.

document scanning and retention tools eliminate printing with reduced non-value clerical support. Manitoulin recently eliminated paper-checking and paper manifests and now scan all shipments. Each handling unit has a specific label with a unique identifier. Shipments are scanned throughout their network with electronic signature at the point of delivery.

Canadian-based Amplify Logistics has a leadership team with a CEO in his early 20s. Technology is an important means for them to stay competitive. Amplify uses Samsara Fleet telematics to track its operations. They provide refrigerated carrier services and can activate the trailers remotely to save energy. Amplify use BorderConnect software to coordinate with their customers' brokers.

A challenge for Amplify is in partnering with smaller truckers on the use of technology. To create mutual benefits, Amplify allows smaller carriers access to Amplify's system to reduce the cost of doing business where they need to have a smaller carrier do a contracted delivery. New technology ideas often come from their drivers with suggestions on how to increase efficiencies. Amplify use bots to handle their order entry data to save manual intervention of data.

Amplify measures its performance through customer satisfaction surveys; pulse checks; and freight growth trends. When capacity becomes an issue, they reach out to 3rd parties to support service. https://amplifylogistics.com/

A relatively new, US-based multi-modal company with a significant investment in a variety of logistics' technologies is Stord. They claim to partner with 15,000 carriers across the US. Stord runs a cloud-based transportation management system and embraces technology as a market differentiation strategy. They have heavily invested in a full suite of digital network services. https://www.stord.com/

The phasing out of the highest polluting vehicles is being led by IKEA, Unilever, A.P. Moller-Maersk, JSW Steel Limited and the GeoPost/DPDgroup. These players have signed on to the EV100 pledge targeting medium- and heavy-duty trucks which account for 4% of all vehicles but emit 40% of road transportation emissions and 33% of all transport fuel consumption. 2040 is the goal as announced by the environmental organization Climate Group in 2022 to convert fleets to EVs under the EV100 Initiative. They also want all new trucks to be designed as zero emission vehicles in larger markets.

Technology and the circular economy are enabling more resiliency in supply chains and optimizing the economic decoupling. Real time data sharing between business partners is a must.

FedEx is converting to Bluetooth Low Energy (BLE) sensors from GPS scanning of packages which tells the driver where to store the package on-board. Tracking information is sent every two seconds to update shippers. This is FedEx's SenseAwareID™. With ever-increasing ecommerce and consumer online habits, the "peak season" for the last mile appears to be mid-August to mid-October. FedEx and Mercedes have developed an auto scan system so as a package is placed in a delivery van, it tells the driver the optimum location to place it-referred to as a "CoRos" or cargo recognition and organization system. Lights designate the on-board location in a pick-and-put protocol to efficiently load and unload packages.

Even though FedEx has been operating 24/7 for several years, it is revamping its logistics in 2023. CEO Raj Subramaniam, says it will partner with 3rd party carriers to move lower priority shipments, referred to as deferred traffic. As part of their cost reduction strategy, FedEx will bring its operations under one business unit called the Federal Express Corporation. While FedEx is handling 6+million packages per day, it wants to cut its costs by US$4 billion by 2025. Through its DRIVE strategy to increase efficiencies, they will move to higher density routing with daily shipments having more packages per delivery vehicle. In a 2022 earnings call, FedEx stated that their operating income was down 64% year-over-year. FedEx expects downsizing of its air freight to contribute the largest savings in response to slower demand.

In Canada, FedEx is converting its *last mile* fleet of parcel, pickup and delivery (PUD) vehicles to the Zevo

600 built by GM with a range of ~400Kms on a full charge. FedEx is investing in a charging infrastructure for its Canadian operations to accommodate 2500 vehicles. They plan to have all zero emission vehicles by 2040.

Large US retailers have changed their business models in response to customer behaviours. Online ordering and omnichannels require adapting. Home Depot and Wal-Mart (US) joined forces to deliver Home Depot products for same-day and next-day service. Customers don't care what name is on the carrier – just the goodies inside. In 2017 Home Depot launched a successful campaign to reach 90% of the population with next-day or same-day delivery for a competitive advantage. In 2021, Wal-Mart launched *GoLocal* utilizing gig drivers from their Spark Driver program. Wal-Mart is targeting 30M household deliveries by 2023. This is part of the Wal-Mart delivery-as-a-service (DaaS) strategy.

In October 2022, Loblaws introduced a fleet of multi-temperature autonomous box trucks utilizing Gatik technology. This follows a 3-year trial with a 3rd party safety compliance audit. Loblaws can make deliveries 7-days per week to select customers using driverless vehicles over fixed, repetitive and predictable routes.

As reported in Supply Chain Dive in October 2022, Walmart acquired Alert Innovation to deploy their Alphabot system to store, retrieve, and dispense grocery orders using robots. No need for lifts or conveyors with these omnidirectional bots reducing space constraints and allowing for scalable applications. Walmart now has access to 90% of the US population within 10 miles for storage and fulfillment.

In mid-2023, Lowes (US) announced it is expanding same day and next day delivery for consumers and contractors by partnering with OneRail. OneRail is an omnichannel company which integrates software with logistics-as-a-service (LaaS). OneRail's network connects with 12M carriers with real time tracking on a 24/7 basis.

Amazon has been expanding the use of the all-electric Rivian delivery vehicles in its packaged delivery services, since mid-2022. Amazon have announced that they will deploy 100,000 Rivian vehicles by 2030 as part of their 2019 Climate Pledge commitments.

To reduce costs of electric trucks for fleets, is the use of electric *trailers*. Electric trailers can hook up to any type of truck which allows fleet operators to utilize existing tractor vehicles. US-based startup Range Energy, has secured funding and tested its electric trailers in 2023. Their powered trailers reduce emissions by 40%, reduce fuel costs and are intended to easily allow for operators to hook up with any type of tractor, be it diesel or all-electric. The electric trailer allows for a more affordable transition to all-electric or alternative powered tractor-trailer rigs.

NorthStar Digital Solutions was launched in 2019 and developed an integrated application called *FR8Focus* to share information on LTL shipments. "Deploying FR8Focus to a real asset-based company that moves 300,000-500,000 pieces of freight annually gave FR8Focus a real good run for the investment. Results included $25,000 monthly revenue increase; 100% decrease in missed invoices due to lost/incomplete paperwork; 95% decrease in quality assurance audit needs; 90% straight-through automation of invoicing; 75% decrease in document handling; 50% decrease in customer disputes (with real-time invoicing); 40% acceleration of accounts receivable payment cycles (from weeks to days)," according to North Star Digital Solutions. https://northstardigital.solutions/

Last-Mile solutions are going to be rooted in technology solutions. Automated dispatching replaces manual calling for its efficiencies in scheduling routes, driver availability and proximity to the final address. Optimization of routing utilizes algorithms which factor traffic patterns and conditions, traffic lights, and even eliminating most left turns. The latter problem was identified a decade ago as bottlenecks in urban areas costing too much time. Through the application of electronic proof of

delivery (ePOD) tracking in real time lets customers and delivery drivers avoid missed delivery times and adjust trips to inadvertent occurrences. Other options include e-bikes and scooters for smaller packages in city centres; sharing the cost of supplying Smart lockers in key locations for fewer deliveries and access by customers. In 2021, Bluemyth Technologies, installed lockers in Vancouver, BC via BlueBox Smart Lockers. This mitigates the first attempt delivery rate (FADR) costs and allows for flexible delivery times for drivers and customers.

Founded in 2018, Locomation, from Carnegie Mellon's National Robotics Engineering Center and trucking industry leaders, uses human-guided and AI which enables two trucks and two drivers in a leader and follower concept. While driving, one driver controls the lead truck while the following truck follows in autonomous mode, allowing the second driver to rest. This operation addresses working hour limitations, increases the load capacity by time, and has a smaller carbon footprint.

In 2024 Wal-Mart Canada received its first hydrogen-fueled truck from Nikola Hydrogen Fuel Cell to reduce emissions. Nikola is delivering ~75 vehicles to US retailers in competition with other manufacturers. Nikola is hoping to sell ~350 vehicles per year. Hydrogen-fuel cells for big rig trucks continues to take over from battery-powered vehicles.

The counterpoint to the last mile cost is the use of reverse logistics. Reverse logistics goes beyond simply returning goods which have been purchased. Reverse logistics incurs operational costs associated with reusing products and materials, recycling, reclamation of raw materials, refurbishment and reselling. While online shoppers were drawn to the buy it, try it, and return it at no charge, this practice is waning as retailers realize it is becoming financially unsustainable. More sellers are imposing restocking and handling fees. Larger retailers such as the Walmarts may be able to afford the return of goods in the short-term, but SMEs who have a limited line of goods and face heavy inventory carrying costs cannot. The National Retail Federation estimates that the cost to retailers to return goods from consumers amounts to ~21%, which is up from 18.0% in 2020. The National Retail Federation estimates that returned goods cost sellers ~16% of the sales. In November 2023, Amazon partnered with ReturnGo's SaaS system to automate their return and exchange process.

Nabil Malouli, Senior VP of Global eCommerce at DHL estimates the cost of returned goods ~$750B on 2021 data. Further Malouli says that "return abuse", often from impulse fashion purchases, is from 1% of the online customers and accounts for 40% of the problem. Some companies like Zara, have tried to impose a modest return fee for online returns and not apply the fees to in-store returns. Amazon has refunded the purchase price and told the customer to keep the goods, as the cost of return logistics is excessive. Retailers are going to need to be more creative to resolve cost issues. Reverse logistics must be affordable to avoid unnecessary waste or write-downs of finished goods and surplus inventory problems.

UPS estimates the 2022-2023 returns from the peak season (Nov 20 – Jan 21, 2023) at 70 million packages – that's just for UPS. This is the majority of returned gifts over the US Holiday season. The UPS VP of Retail and Business Development summarizes the trend as customers wanting to buy online and return in-store. In October 2023, UPS acquired Happy Returns from PayPal. The strategy is to help UPS with the 2023 holiday season and offers box-free returns to more than 800 merchant customers. UPS handles ~24M packages and documents per day!

FedEx is beginning its Consolidated Returns program in 2023 to allow a broader segment of customers to return items without a box or shipping label to its ~2000 FedEx office locations. These small packages will be brought into LTL return shipments from multiple sellers and sent back to the shipper. Addressing the skyrocketing increases in reverse logistics' costs becomes a much higher priority.

In early 2024, Walmart USA reported it has reduced its last mile costs by 20% over the past year.

Increased demand and consolidating shipments have led to these efficiencies. Stores provide parcel stations in fulfilment centres and deliveries can be made inbound through Walmart vehicles and outbound through 3rd parties.

The practice of *recommerce* has evolved to address the reverse logistics problems. Recommerce is the reselling of returned goods with acceptable margins without destroying the merchandise. Larger brands are turning to 2nd hand outlets to resell in traditional store fronts.

In the e-commerce, ocean freight logistics world, reverse logistics is a more complex and costly undertaking. The sheer volumes of containerized goods and rerouting can cost 3-5% of the total revenues. While this is a considerable expense, the circular economy relies heavily on ensuring products at their end-of-life can be recovered for extracting critical materials, precious metals, and be repurposed wherever possible.

Although the last mile will always entail emissions, buying carbon offsets is an emerging circular economy practice to act as responsibly as possible. In 2007, Harbour Air out of Vancouver introduced carbon offsets for its passenger flights. A nominal fee which gave environmentally conscientious travelers the ability to reduce their impact. The carbon offset fees collected are aggregated and invested in global projects. These have provided efficient wood cook stoves in Uganda to protecting wildlife habitats in Zambezi. A 3rd party company, Offsetters, manages the carbon offset aggregation for Harbour Air, measured in tonnes by tCO_2e.

There are several sites to measure the number of tonnes of emissions, based on your life style. Vancouver-based Ostrom Climate© has an online tool to calculate air travel and automobile emissions, in order to buy carbon offsets. Using their tool, one person flying economy class from Vancouver to Edmonton return, would generate 0.26 tCO_2e requiring carbon offsets of $6.76 @ 26.00 Cdn/tonne; and driving a 2001 Honda Accord, 6-cylinder, automatic car for 20,000 Kms per year would generate 4.342 tCO_2e requiring offsets of $112.92 per year. https://ostromclimate.com/calculate-emissions/

Another simple to use site for estimating the number of tCO_2e one generates per year is https://www.carbonfootprint.com/calculator.aspx. This site will calculate the various types of generation by home, flights, vehicles, bus/rail, and secondary emissions. You can calculate as an aggregate value or by type and determine the # of carbon offsets to buy.

Other transportation companies are buying carbon offsets to address GHG emissions. DHL, FedEx, and as reported in Transport Dive, April 2022. JB Hunt is advising its intermodal shippers the volume of offsets required for a carbon neutral shipment. While carbon offsets are voluntary in nature, progressive companies see this as their way of participating in the circular economy and mitigating their environmental impact where their type of business operations make them unavoidable.

Digital logistics

The essence of LTL freight is finding the best rate to move goods from point A to B, based on the weight, distance, freight classification, and the commodity. Currently, this requires an inordinate amount of human intervention to search through thousands of carriers to manage these transactions. While technology to digitize transportation is unfolding, the majority of transactions are paper-based with phones and faxes.

What was needed was a means to aggregate dynamic data into a simple model for shippers to select carriers. In 2014, Vancouver-based Freightera figured this out. CEO Eric Beckwitt leveraged this gap and filled the void. Freightera connects 13,000 plus logistical companies on their hosted platform which allows shippers/carriers to select the best rate along with environmental considerations, if they choose. Their proprietary software uses a transaction fee-based service where lane options can be transacted

within minutes-including the printing of labelling and waybills. Carriers have 15 minutes to respond to a query from a shipper as to their capacity to handle an order.

Freightera focuses on the small, medium business sector and is growing at a rate of 74% year-over-year, which is a sign their services are in high demand. They have taken a lot of the guesswork out of trying to find the best rate for shipping. Carriers have been pushed to the limit on rates by large shippers and try to carve out better rates from smaller shippers. Freightera serves the US, Canada, and cross border markets.

Freightera's software allows the carriers/shippers to select the best fit based on a load basis. Customers enter basic shipping information including postal codes and Freightera identifies their carrier options and decide which one best fits their needs. Invoicing is automated.

As an SaaS (Software as a service) provider, Freightera was recognized with the 2020 Deloitte Technology Fast 50™ award. In part, as a result of their 678% revenue growth from 2016-2019. The circular economy requires that we optimize the use of energy in the LWD sector to support production without adding more emissions. www.freightera.com

Robotics

Warehouses have been transformed into fulfillment centres and involve *RaaS*-Robotics as a service. RaaS has accelerated their presence in warehousing, in part due to the demand created through the COVID pandemic. The rush by consumers to adopt online ordering and businesses increasing their ecommerce activities, required forward thinking to invest in CMRs. Order fulfillment speed and accuracy are the characteristics of CMRs. The productivity of CMRs has a definite payback to warehouse operators. Amazon currently operates more than 100,000 robots in its fulfillment centres.

Amazon announced in November 2023, it is now utilizing robots with the lifting capacity of ~1200 Kgs. These robots will be able to move appliances and pallets of products. Amazon is also testing a 2-legged robot called Digit in its Seattle research and development location.

One caveat to the growth of fulfillment centres by major players such as Amazon, is the reduced level of consumer buying in early 2023. Amazon is making big cuts to its operating costs said CEO Andy Jassy, in a February earnings call. The slower economy hits the distributors after retail and online sales slump. Another example of having a resilient supply chain. Being able to manage the boom and the bust cycles in the market.

In July 2023, Amazon and UPS are both responding to reduced orders and are curtailing their mutual services. Amazon is shifting towards building its own logistics network and relying less on 3rd parties such as UPS. UPS has seen substantial reductions in its Amazon business and UPS will look replace the Amazon reductions by serving smaller businesses with higher yield rates, according to CFO Brian Newman in an earnings call. FedEx is also adjusting its network to adapt to reduced parcel demand in 2023.

It has been estimated that 70% of warehouse operating costs are attributed to labour. A case study published by 6 River Systems indicates a return on investment over 15 months with a net present value of US $7.1M when using CMRs to replace a manual cart and RF picking method. The savings were attributed to 2.5 times increase in pick rate; reduced supervisory time; reduced training time; reduced operational supply costs; reduced licensing and hardware costs; and reduced replenishment costs.

A January 2023 report from Supply Chain Dive, order picking costs run at 55% of warehouse operating costs. Walgreen's is expanding its micro-fulfilment centres by using robots to fill pharmacy orders and address the shortage of pharmacists. The robots target repetitive tasks which can be easily replicated by

robotics. Their Chief Supply Chain Officer, Roxanne Flanagan says that 60% of its 2022 prescriptions were filled through automation.

Smart sorting systems using machine vision technology are now being used where bots select the correct package size for a specific product. In part, this can increase the load capacity in a trailer with the right-sized package. Small-item sorting through bots in a distribution centre adds to the efficiency in the handling processes.

Warehouse Management Systems (WMS) enable batch order picking; pick-to-light; inventory cycle counts; and AutoCAD to optimize locations. Carousel systems are now competing against Loop sorters which can process 50,000 pieces per hour. DHL has invested US $300M for (2) Loop sorters in one of its distribution centres with a 30% labour saving costs.

In a January 2023, 4th quarter market call with investors, food products and spice company, McCormick & Co. announced a 10% US labour force cut which will largely be addressed through automation. As a result of declining profits and labour shortages, increasing investment in automation to replace ~1400 workers, has McCormick on track to achieve the labour savings and its long-term operating cost structure. If labour shortages continue, we can expect more and more automation wherever possible across most sectors.

Order management systems (OMS) complement the WMS. OMS use visibility throughout an ordering process as the key value. Tracking in real time from the sales order through to fulfillment can be done from any location by the parties involved, depending upon security requirements for access. Checking on an order status, packing, processing, shipping, return goods, inventory levels, product details, and supplier contact information, all easily accessible, when required.

Pet food online retailer, Chewy, reports that its automated fulfillment centres handled 30% of the sales orders in Q3 2022, up from 10% in 2021. Shipping distances were reduced by 25% with 18-20% lower processing costs than Chewy's previous labour-intensive distribution system. Based on their success, they plan on two more automated fulfillments centres over the next 2 years. Concurrently, Chewy is planning two import routing facilities, expected to handle 90% by early 2023.

Walmart's US president and CEO Doug McMillon, is on the record to reduce store-level wage investments through increased automation of picking orders. This will entail retrofitting existing facilities and upgrading with multiple technologies to automate storage and retrieval systems. The retrofit will reduce the need to build new facilities. Walmart's new Chicago high-tech fulfillment centre does not require a "lot of human engagement." Micro fulfillment centres (MFC) will complement existing operations and address grocery order picking. McMillon's vision is to be an omni-channel organization.

The warehouse connectivity systems such as the Mobility Edge™ from Honeywell utilize voice automation with voice and visual picking; voice and autonomous mobile robots (AMR); voice guided work solutions; voice enabled workflows; voice activated maintenance; with real time locations.

Wearable devices have been used in warehouses but are becoming more of a standard requirement to achieve the next level of efficiency in operations. Wearables are the enabler of augmented reality warehousing operations. Hands-free devices offer increased productivity for picking and packing operations and increased safety for workers. Training and onboarding of new staff has been shown to be improved through the use of wearables. Wearables include voice-activated headsets, light-weight wrist and ring scanners, smart glasses with HUD scanning capability, exoskeleton suits designed for ergonomic advantages, which all contribute to increased accuracy. Wearables can advise on trouble shooting and maintenance instructions to reduce downtime on equipment. Frito-Lay partnered with Kinetic Reflex to trial wearable devices. The results were reported as achieving a ~20% reduction in repetitive strain injuries across (9) Frito-Lay warehouse operations.

Simbe Robotics has a grocery store robot named *Tally*. Tally travels throughout a store scanning digital tag and QR codes for JIT replenishment. Saves labour and a claimed 30% reduction in stockouts.

In California, Fulfil Solutions has partnered with the Save Mart companies to fully automate the picking and packing of all types of grocery product categories. Within minutes of receiving an order, robots fill the order and have it ready for delivery. Fulfil's proprietary system uses computer-vision and a series of algorithms to sequence the picking efficiencies and updates the inventory on demand. Their database monitors locations, origin and expiry dates in real time to build order accuracy and is meeting customer service requests. Save Mart operates 200 stores and is currently one of the few successful, fully automated grocery services.

Stellantis opened its state-of-the-art product distribution PDC) centre in Brampton, Ontario in 2024. The PDC operates with 27 robotic order pickers, 500,000+ ft² facility, 55,000 SKUs, handles 2 million orders per year, 16 ft high part racks, automated storage and retrieval, and on-site classroom training. Stellantis was able to consolidate 2 of its other PDCs into the one new facility. https://www.supplypro.ca/stellantis-commemorates-opening-of-mopar-parts-dc-in-brampton/

Emerging robotics companies which bear following are: 6 River Systems (Shopify); Fetch Robotics; Geek+; Locus Robotics; RightHand Robotics; and Fabric. Harnessing technology is a key part of the circular economy being efficient with energy consumption and waste reduction.

RFID

RFID means radio frequency identification wireless technology. While CMRs are taking on larger roles, RFID still has its place in the market. The key feature is the ability to track and identify items in real time and is used commonly for inventory control. RFID tags or chips transmit data to a central database to affect inventory levels and locations. Each tag represents a SKU in the system. RFID have replaced barcodes due to the line-of-sight limitations which barcodes require. An RFID negates the need to manually inspect each shipment and enables items to be scanned and catalogued even if it hidden by other goods. The RF signal is the key. RFID tags or RFID transponders include passive, semi-passive and active forms.

Passive, which are the most common, have no power source and only interact with the RFID reader or scanner. *Semi-passive*, have battery power but rely on the RFID reader to transmit data to the reader. *Active*, have battery power which enables the tag to transmit signals to the reader up to ~30 metres.

RFID smart labels use an embedded technology in an adhesive label. These are often used where there is a need for a person to read the tag to know what the product is and to have it readable by a scanner. Retailers often have the smart label for customers ease of viewing on the contents. Smart tags differ from smart labels. The advanced smart tags are usually appropriate where a level of security is necessary. The advanced smart tags have built in processors and can therefore be quite costly.

In a February 2023 earnings call, UPS said it will invest US$140M to implement its smart package initiative in ~900 US sites. UPS trialed the RFID tag program in ~100 of its facilities where employees wear scanning devices to accelerate parcel handling and reduce misloads. CEO Carol Tomé says this will eliminate 20 million manual scans across the UPS system.

RFID benefits include accuracy, response time improvement, and efficiency. In a Canadian health care operation, they went from an ~80% accuracy and fill rate to 99% accuracy and fill rates. When RFID was combined with a horizontal carousel system, there was also a 50% reduction in staffing for similar work volumes. The payback on the RFID and carousel system was 1.5 years on a $400K investment, at the time.

QR codes

A quick response (QR) code is a two-dimensional barcode. The QR function is to inform the reader about the item. They can contain data for location, identification or links to a website or application. During the pandemic, restaurants provided menus in QR format for diners. Post-COVID, the QR codes seem to be staying as customers can use their smart phones easily to access menus and order. QR codes are replacing the UPC barcodes commonly used in the grocery industry.

QR codes are becoming more common to provide information on the *provenance of products* across a supply chain. They can inform as to where the product was grown, harvested, manufactured, processed, repaired, and a host of other data for customers, consumers, and inspection services. QR codes serve as business cards, discount coupons, provide video content and many other marketing and service functions without the use of a print format.

2D bar codes are the next generation of QR codes. 2D codes can contain far more information. Having easily accessible data and an error correction capability makes them valuable for connecting with consumers and customers. 2Ds con advise on expiration dates, batch/lot numbers, serial numbers, shipping dates or other details of an order.

Drones

Drones are being used to reduce warehouse staffing. Drones can perform inspection services for construction, petrochemical, oil and gas, and power generation industries. Drones can inspect roofing, racks, pallet locations, and physical structures. Drones can also deliver materials from inventory to staging or internal work process stations, which is referred to as intra-logistics. For inventory management activities drones can increase the inventory count accuracy, decrease labour costs, and provide a safer workplace.

Erez Agmoni, VP with Maersk, confirmed in January 2023, that they are deploying Verity drones to collect 3-dimensional data inventory data via high-res cameras. The e-drones run off a battery charging pad and usually operate at nights or on weekends without overhead lighting required. The drone data is reconciled with the WMS data from the pallets to identify SKU or location errors.

Emerging technologies for indoor use of drones is being developed concurrently with several companies using a variety of systems. Warehouses which can benefit from drones typically are >50,000 ^{2}ft; > 5 metre shelving; >50 metre corridors; and single depth pallet racking.

Drone technologies in use or being piloted are SLAM – simultaneous localization and mapping algorithm; LiDAR – light detection and ranging; UWB – Ultrawide Band. The use of drone technology is expanding exponentially year-over-year.

In 2022, Walmart completed 6000+ drone deliveries out of 36 stores through drone delivery hubs. These hubs are operated by DroneUp, Flytrex and Zipline in seven states. This promising service is targeting a goal of 1M packages per year, per Vik Gopalakrishnan, Walmart US VP of Innovation and Automation. In 2024, Walmart was given approval by the FAA to use drone deliveries out to 10 miles, up from the previous 6-mile limit from store sites in the Dallas-Fort Worth area in Texas. Orders for household goods and groceries will be completed by Wing and Zipline websites. Zipline and Wing are subsidiaries of Google parent company Alphabet.

Amazon has been using drones to deliver pharmaceuticals to customers. Their drones fly between 40-120 meters above ground and has sensors to avoid people, pets, and power lines. The customers retrieve their package without any direct contact with a drone. Amazon is going to launch same day delivery services through drones in Italy, UK and more US communities, it said in late 2023. For the past year, Amazon has delivered thousands of packages of household products, weighing up to 2.5Kgs. It will

replace its existing drones with an MK30 model capable of further distances by the end of 2024.

Marine traffic

Real time transportation visibility (RTTV) is the focus of many ocean shippers and carriers to improve efficiencies. In a 2021 survey, sponsored by software company Fourkites, they report that 50% of international shipments are conducted on a manual system with paper-documents being faxed and emailed around the globe. The desire for greater visibility requires technology investments. Where are the paybacks? Significant operational savings and improved customer services such as on time, in full (OTIF) and less dwell time. Dwell time is the # of days containers sit at a terminal after being unloaded. Dwell is a KPI for terminal operational efficiency. Delays can be attributed to many different factors beyond the control of the terminal but can also provide a sense of their capabilities and resilience.
A single RTTV platform connects freight forwarders shippers and carriers with less staff intervention to trace and expedite orders. In March 2021, the container ship *Ever Given* blocked the Suez Canal, with months of delays as a ripple effect. Those shippers which had a RTTV platform were able to reroute much faster than those that depended on individual staff to intervene during the crisis.

In 2024, shipping through the Red Sea continues to be compromised due to armed conflicts in the region related to the Israeli-Hamas wars. With capacity curtailed in the Panama Canal due to droughts, this will exacerbate the ability to move goods globally and add to the rising costs and risks of ocean freight. This supports the ideas for more onshoring or nearshoring of supplies. An energy related problem with reduced shipping through the Panama and the Red Sea, is the fact that 1/3 of oil supplies are seaborne, according to the IEA.

Large terminal operators are investing in dock scheduling systems to increase their supply chain visibility. Cross docking operations are very complex and scheduling systems are aimed at driving efficiencies to coordinate multiple products, from multiple carriers going to multiple destinations out of a warehouse or terminal.

Norway launched the first all-electric ferry with rechargeable battery system, in 2019, claiming 90% reductions in emissions and 80% reductions in cost. Electric ferries run much quieter when compared with the traditional diesel engine powered designs. Two electric propulsion ferries were ordered for operating in Ontario in 2021. In 2021, New York ordered its first, 150 passenger electric ferry for commuters. It would seem that all-electric ferries could replace many of the diesel-powered fleets as a scalable solution.

British Columbia announced in 2021, it would be accelerating the conversion of its fleet to electrify (6) ferries. However, this $135 M plan was contingent upon federal and provincial funds. In October 2023, they had to pull back on their e-ferry plans, as funding was *not* provided. The BC ferry fleet has failed to deliver the promised reduction of emissions, using a 2008 benchmark level, and it is doubtful it will meet the 2030 targets. This was reported by Rochelle Baker, through the *Local Journalism Initiative*.

The waters off British Columbia saw the first ell-electric tugboat in July 2023. The *Wamis,* the first of 3 tugs, will be deployed in Kitimat to service the LNG ship operations. With 100% electric power and a total of 5000 kWh of battery capacity.

While the e-ferry systems will continue to grow, there is still going to be a need for renewable fuels to displace the bunker fuel for large container and cruise ships. Methanol engines are now in use. E-Methanol can be made from CO_2 derived from biomass and green hydrogen. This requires a scalable carbon capture process for industrial sources of biogenic CO_2. The Methanol Institute reports that AP Moller-Maersk has ordered dual-fueled ships to address the decarbonization of international shipping. The supply of e-Methanol at major shipping ports would be required to support the fuel distribution

system. Methanol is used in household products, automotive components, and in the production of chemicals.

A revolutionary idea from Michelin is putting sails back on ships. Michelin's Wing Sail Mobility (WISAMO) project was trialed in 2023. Designed with inflatable, retractable, and automated sails to reduce fuel savings by 20%. The WISAMO system can be adapted for any type of vessel including Ro-Ro, bulk carriers, container ships and tankers. The system can be part of a new design of a vessel or retrofitted on existing ships. This scalable solution could provide another option to reduce GHGs in a global market. https://www.offshore-energy.biz/michelins-wisamo-wing-sail-testing-the-waters-on-mn-pelican/

In September 2023, Moller-Maersk and Amazon renewed their commitments to decarbonization of ocean freight by agreeing to use methanol fueled container ships. This replaces the need for traditional bunker fuel and is estimated to save 44,600 tCO_2 e when shipping 20,000 FFE containers. Moller-Maersk's terminology refers to its ECO Delivery shipments where it defines certified *green fuels* as low to very low GHG emissions. Moller-Maersk complies with the ISAE 3000 guidelines.

Biofuels for marine transportation will reduce emissions by ~20%. One of the scalability issues is that currently marine biofuels cost significantly more than bunker oils. The marine industry consumes 330 M tonnes of fuel per year, which is primarily from crude oil products. One of the largest marine hubs is Singapore. At present Singapore forecasts that its biofuel demand could reach 1M tonnes by 2025. A drop in the bucket comparatively to the supply availability of biofuel.

Singapore's Global Centre for Maritime Decarbonization completed the final trials of various biofuels in mid-2024. The trials led to the development of a B30 blended biofuel. B30 is made with 30% fatty acid methyl esters and 70% very low sulfur fuel oil. This reduces GHGs by ~30% over traditional bunker fuels.

Further evidence that sustainable solutions to fossil fuel problems must be affordable or require government intervention, is seen in the competition between biodiesel and renewable diesel fuels. Both products are made from the similar sources of biomass, such as cooking and vegetable oils. However, blending diesel fuel with biomass is a much lower cost than only using renewables without a diesel base. Renewables are a complete replacement for diesel. In the larger US market, government credits to develop renewable diesel pushed production to 4 times the usual supply during the 2021-2023 period. Due to the over-supply, prices of renewables dropped by 75%. US refineries shut down production of renewables in late 2023 and are returning to blended diesel fuels. Canada has continued with production of renewable diesel and hopes that a US tax benefit will come into effect in2024, encouraging exports back to the US market.

Air freight

This sector handles less volumes than the other modes of transport and is usually the fastest means of moving goods with a higher cost. Air freight is catching up with digitalization of its services. One of the leaders in air freight is FedEx. Their fully integrated logistics systems arguably set the bar. FedEx is one of the largest air freight airlines in the world. FedEx operates 281 aircraft to reportedly handle the shipment of 13M packages per day. Amazon, for comparison operates 73 aircraft and ships 3M packages per day. One could make the case that without the technical tools of the buyers, sellers, and logistical connections, these volumes would not have been possible. The relative ease of ordering through to the fulfilment processes is only feasible because of the technologies being deployed in mature markets. Emerging economies are much more labour intensive and have fundamental problems where the demand side and the supply side are not as connected, which adds costs but does not increase the value.

With the loss of passenger flights through the pandemic, the cost and capacity of air freight was a

challenge for passenger airlines which focus on people rather than packages. The biggest customers of airlines are freight forwarders. The integration of freight forwarding services into larger logistics network companies may reduce the need for independent freight forwarders. Forwarders advise on costs, documentation, insurance, customs clearance, labelling, scheduling and arrange intermodal services. Forwarders don't own transportation assets. They historically rely on their expertise. Digital integration tools may negate some of the forwarder's niche in the market where the soft skills compete with technology.

In early 2024 Chinese e-commerce, fast fashion companies are consuming as much air cargo space as possible. Reuters reported that Shein and Temo account for 600,000 packages per day, being shipped to the US.

Rail

Rail services do utilize many of the aforementioned technologies for safety, scheduling, track inspections and are also looking at the redesigning of rail cars. Hazmat materials are a common commodity on a rail line. Compartmentalizing flammable liquids as an example where a single puncture does not affect the entire contents. Drones inspect track and rail bridges routinely. Crew scheduling is provided through SaaS as a mobile solution to employee assignments, seniority rights, allows manual adding of trains, and hours of service data. An innovator of SaaS for rail is PS Technology.

The inspection of rail cars has been a labour intensive process for decades. Norfolk Southern reimagined safety inspections by installing Digital Train Inspection Portals (DTIP) across its network. This is machine vision coupled with AI and multiple, 360-degree high-resolution cameras, identifies problems the human eye can't detect while a train is moving at 70 MPH. The DTIP captures the images and converts them into algorithms where rail safety and maintenance experts are able to find potential problems before accidents occur. The system has very low false-positive readings. The railroad plans on having 24 DTIPs in place by the end of 2024.

As per the International Energy Agency (IEA) CO2 emission statistics, the transport sector is tagged with ¼ of our global emissions. For freight transport, rail produces 36 grams of CO2 per ton km, compared to 96 grams by long haul trucking and 946 grams for aviation.

Idling reduction technologies are a part of the SmartWay verified services for locomotives. These include: Automatic Engine Shut-Down/Start-Up Systems (AESS); Auxiliary Power Units and Generator Sets (APU/GS); Fuel Operated Heaters aka Direct Fired Heaters (FOHakaDFH); Shore Connection Systems (SCS).

SmartWay offers a Green Freight Assessment to Canadian companies to apply for funding to hire a 3rd party to conduct a fleet energy assessment. The review would provide a carrier with recommendations on how a company could improve fuel efficiencies through retrofits and using different fuel types.
https://natural-resources.canada.ca/energy-efficiency/transportation-alternative-fuels/greening-freight-programs/smartway-fuel-efficient-freight-transportation/21050

One of the more interesting technical disruptors in rail transit is the use of hydrail-hydrogen energy for power. Mass transit is trialing various vehicle designs to look for scalable outcomes for the types of vehicles best suited for hydrogen-based fuels. Most Canadian railways use diesel and diesel-electric propulsion systems. Biofuels have not been welcomed due to potential problems in the diesel engines in Canada, whereas, biofuels are a source of fuel for several European diesel train engines. LNG has been used but is not seen as a large-scale alternative fuel.

Zero-emission passenger trains are operating in Germany using 100% hydrogen. The French engineering firm Alstom designed the trains which only emit steam and condensed water. The engines are refueled

daily from an industrial gas company Linde hydrogen generation depot with an 1800 Kg storage capacity. The operator, LNVG, will replace its fleet of (15) diesel-powered units. The trains will attain a speed of 140 Kms with a range of 1000 Kms. It's estimated that 1 Kg of hydrogen will replace 4.5L of diesel.

In May 2024, Italy, Germany, and Austria committed to an agreement to expand hydrogen into northern EU to decarbonize the higher polluting industries.

Canadian Pacific is heavily investing in hydrogen-fueled freight locomotives with Provincial government funding. Ballard Power Systems will develop the hydrogen-electric powertrains to convert the diesel-electric powertrains which most rail lines have used for decades in North America. Retro-fitting existing locomotives is part of the circular economy strategy of decarbonization. CP is trialing their hydrogen-fueled trains in early 2023 through the Rocky Mountain pass which will be a critical test area with the variations in grade and temperatures.

Mass transit has used magnetic levitation (Maglev) technology successfully in China and Japan. While Maglev enables high speeds it has limited scalability. There are US projects which are assessing the use of Maglev but have not moved forward. The French TGV, electric-powered trains have been in service for 30 years and the TGV technology has been used on other European countries, which is a scalable solution.