



A Collaboration Between National University
of Singapore and Georgia Institute of Technology

Supply Chain Digital Transformation: Insights and Tools

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White paper

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Introduction

Digital technologies are advancing at an ever-greater speed. For example, by 2020, it is predicted that there will be over 50 billion interconnected devices¹, which equates to approximately 6.58 connected devices per person. The growth of cloud computing is also increasing at an average rate of 19% per year, reaching almost \$162 billion in 2020, as illustrated in Figure 1². The advancement of digital technologies, ranging from Big Data, cloud, data analytics, the Internet of Things (IoT), Blockchain, and artificial intelligence enables and accelerates digital changes in all aspects of human society and affects everyone in their daily lives.

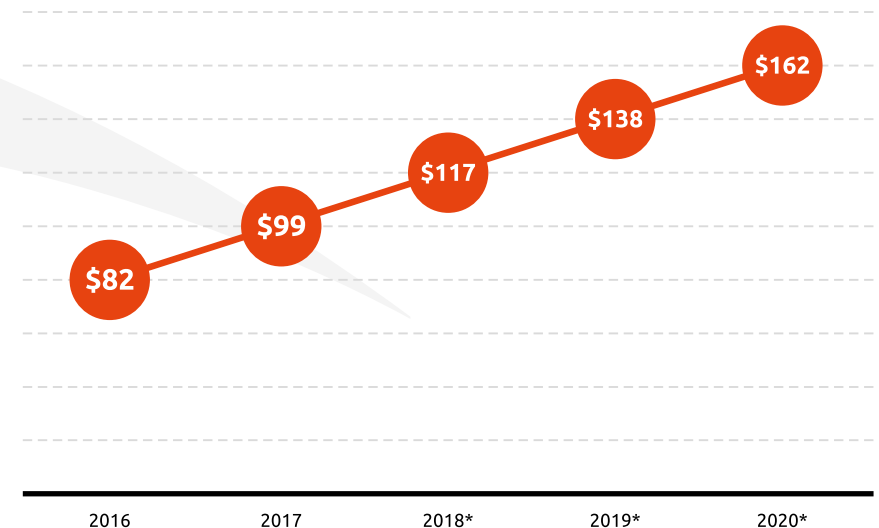
From a business perspective, digital transformation can be described as using digital technologies to create innovations in services and products. It is not just digitalizing existing routine business processes and moving from traditional sales to e-commerce. Digitalization is the cause of large-scale and profound transformations across multiple aspects of business, providing great opportunities for value creation and capture, but it is also a major source of risk. In today's business climate, with all industries being disrupted at every turn, companies must be able to quickly change their products and processes to take advantage of new market opportunities.

In this paper, we will underline the significant differences between traditional and digital supply chain networks, mention challenges you can face during the digital transformation of your supply chain, and run through solutions and tools that can address these kinds of challenges.

¹ Evans, D., The Internet of Things: How the Next Evolution of the Internet Is Changing Everything, CISCO Whitepaper Series, April 2011.

² International Data Corporation (IDC), The Salesforce Economy: Enabling 1.9 Million New Jobs and \$389 Billion in New Revenue Over the Next Five Years, IDC Whitepaper, September 2016.

**Growth of Cloud Computing
(in \$billion)**



* = prediction

— Figure 1. Growth of Cloud Computing

Digital Business Transformation Impacts on Supply Chain

Digital business transformation requires companies to rethink all of their business operations and ecosystems, including partners and stakeholders in their supply chain network. As business shifts from traditional offline methods to being digital

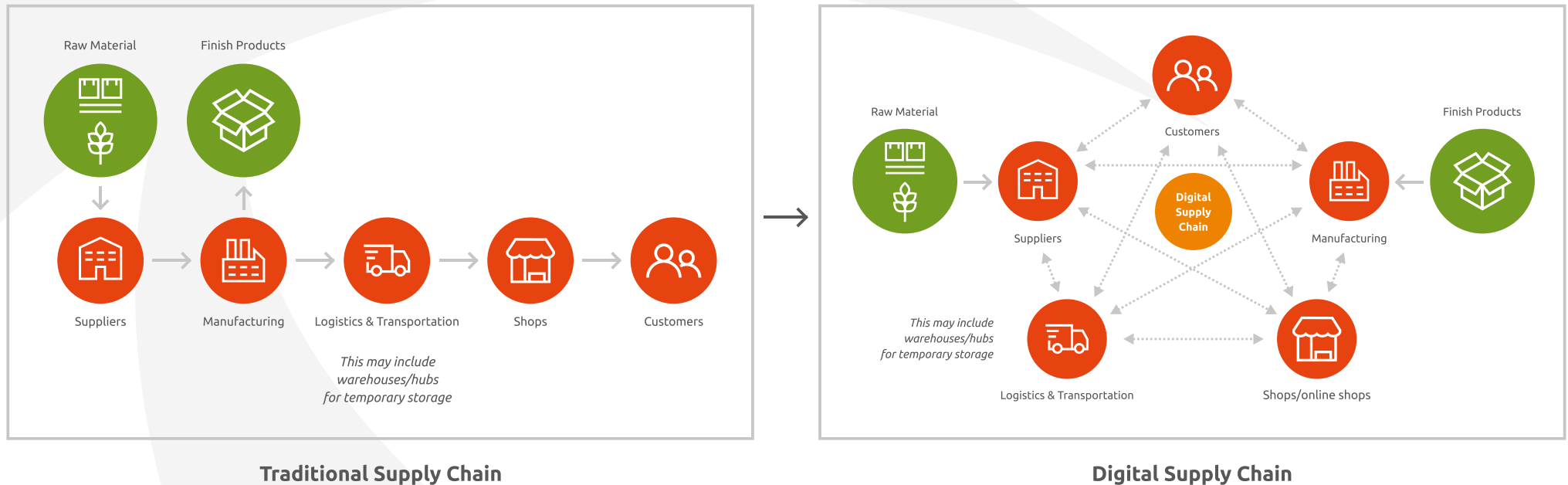
and online, focus has shifted from handling product complexity to handling service complexity. It creates significant differences between traditional and digital supply chain networks and logistics as summarized in Table 1.

Aspect	Traditional Supply Chain Networks	Digital Supply Chain Networks
Product variety	Depends on the product, but is relatively uniform.	Greater variety of commodities, especially in e-commerce business.
Delivery cycle	Weekly.	Anytime, anywhere. Higher frequency of orders.
Package size	Uniform package size. Generally large and consolidated.	Large volume of small packages.
Service importance (in terms of lead time and delivery time)	Quality of service does not affect the customers.	Customers consider the lead time and delivery time as important as the quality of goods itself. Reliable and on-time delivery according to the customers' preferred time windows are required.
Packing requirement	Bundle packing (in boxes, cases etc.). Packing is just for easy handling of the products and can be cost efficient.	Individual packing. Careful packing is essential for the products as it is being delivered directly to the end customer.
Delivery process	Retailers and distributors are generally the end node of the deliveries. The customers would purchase and pick-up from the retailers/distributors.	The end customers are the end node of the deliveries. Their locations are more widespread compared to retailers/distributors.
Delivery failure	High delivery failure rate.	Minimum failed delivery since the deliveries are scheduled and expected at the defined time and thus there are less failed deliveries.

— Table 1. Differences between Traditional and Digital Supply Chain Networks and Logistics

All these differences lead us to an obvious conclusion – traditional supply chains may no longer be sufficient for the digital transformation era. Modern markets demand from supply chains not only efficiency, but also agility and flexibility. Today's supply chain is evolving from the traditional model of linear, individual, dis-synchronized relations into a more connected and harmonized network of trading partners. This renovated supply chain is expected to be digital

and provide on-demand service. So, it has to be transformed through digital interconnected devices and complex networks (as illustrated in Figure 2). This digital supply chain would link different stakeholders (including customers) more efficiently, enabling them to react faster and to better adapt to a fast-changing market.



— Figure 2. Shift from Traditional Supply Chain to Digital Supply Chain³

³ The Logistics Institute – Asia Pacific (TLI-AP), Digital Transformation of Supply Chains – Perspective, Cases and Applications, THINK Executive White Paper Series, March 2018.

Digital technologies provide businesses with capabilities that can completely transform the way their supply chains operate. At the organization level, digital transformation means utilizing analytics, artificial intelligence, robotics, IoT, and other advanced technologies to collect and process information automatically, support decision making, and further enable automation.

Supply chain digital transformation is about using digital applications to improve service, cost, agility, and inventory levels, and implementing changes that use these technologies to drive operational excellence and competitiveness⁴. An effective transformation depends on a forward-looking concept for the future supply chain. This means thinking about the outlook for the company, forecasting the pressures and trends, as well as the changing expectations of customers. The key point is that the supply-chain vision should correspond to the company's strategic goals. Companies that consider supply chain as a strategic asset work much more effectively than their competitors and achieve much higher financial results.

The effect of focused goals is that industry leaders continue to develop their lead, while those behind keep losing their competitiveness. Leaders give direction to their development and their supply chains are fast and effective. This allows them to efficiently serve customers in volatile markets, understand the needs of different consumer groups, and outclass the competition.

⁴ Enis Gezgin, Xin Huang, Prakash Samal, Ildefonso Silva, "Digital transformation: Raising supply-chain performance to new levels", November 2017, <https://www.mckinsey.com/business-functions/operations/our-insights/digital-transformation-raising-supply-chain-performance-to-new-levels>



Using Optimization and Simulation to Navigate Infrastructure and Logistics Assets

To shift toward the digital supply chain, companies have to place emphasis on the design of their supply chain and logistics systems, including navigating and monitoring their assets to ensure distribution efficiency and customer satisfaction with quality, speed, reliability and flexibility in deliveries, as well as identifying and mitigating risks. Moreover, all changes require thorough evaluation before introduction. If not, they can be costly and lead to even greater losses than if the supply chain is kept as it is.

To deal with all these challenges, many interdependent processes inside and outside the organization must be considered, and most commonly these are issues of a different scale: from locating new warehouses to optimizing space at a manufacturing site. This makes the digital transformation process even more unpredictable, forcing supply chain managers to accomplish many different tasks and make many decisions in a short space of time and with great uncertainty.

For example, let us look at the several potential impacts of supply chain digital transformation that are summarized in Table 2.

Aspect	Potential Impacts
Greater product variety	• Higher demand for floor area • Higher ceilings are needed
Higher volume of small size packages	More intensive labor requirements due to increased picking intensity
Higher frequency of orders	• Increasing need for forward areas to facilitate item-level picks • More amenities for personnel • Space for order consolidation • More loading bays
Shorter delivery lead times and shorter delivery time windows	Increasing need for urban consolidation centers to meet lead times

— Table 2. Impact of Digital Supply Chain on Navigating Infrastructure and Logistics Assets

As we have already seen, variability creates complexity in supply chains. Supply chain managers must forecast how these problems will impact their company's operational performance as a whole and decide how to manage it. They should understand what the outcome will be for each decision taken and calculate how their actions affect KPIs. Only after thorough analysis should these decisions be put into effect.

The task is complicated even more by the fact that the most commonly adopted tool, spreadsheet-based modeling, is often not capable of handling complex, interdependent, and time-related systems, such as supply chains. More powerful forecasting and analytics tools are needed.

Apart from the spreadsheet-based approach, there are solutions that can empower supply chain experts with an exhaustive set of tools for detailed end-to-end network analytics, supply chain design, and optimization. These are **analytical optimization** and **dynamic simulation modeling**. With these two methods, a digital prototype is created to model the real-world supply chain. It takes into consideration the criteria or success factors of the supply chain, logistics design, and processes.

As these methods are different in their nature and the technology used, they are utilized to solve different kinds of problems.



Analytical Methods

Placing logistics assets, such as freight facilities, in the correct location is one of the key elements of improving the efficiency and effectiveness of a supply chain. Many factors must be considered, including market trends, proximity to existing customers/demands, access to suppliers or vendors, transportation costs, and travel times. This can be done using Greenfield analysis. When the best locations for new facilities are determined, it is necessary to conduct master planning including the quantity of goods to produce and order, where to stock them, and how to foresee seasonal peaks/falls in demand. For solving supply chain challenges at the network level, and when considering low-level operational logic is excessive, the analytical optimization method should be used.



Dynamic Simulation Modeling

With dynamic simulation modeling many challenges can be addressed:

1. Implementing new supply chain configuration

If analytical optimization is perfect for getting the most appropriate supply chain plan, then dynamic simulation is helpful in finding out how to implement this plan while avoiding risks and losses. After the optimal supply chain structure is determined, it is important to find the safest way to implement it. For this purpose, it is crucial to see how the new supply chain network will operate in the real world: how it will behave over time, in conditions of randomness and volatility. Dynamic simulation modeling helps carry out detailed analysis and foresee the possibilities before implementation.

2. Experimenting with innovations

With dynamic simulation, it is easy to experiment with a supply chain and decide on the best solutions to implement. A dynamic simulation model can serve as a digital twin of the supply chain that allows experimentation with improvements and the tracking of all the important metrics: costs, revenue, inventory dynamics, service levels, bullwhip effect, capacity, utilization, incoming/outgoing orders, and products. Managers can try many scenarios of supply chain transformation, vary parameters, and come to business decisions based on the testing and evaluation of results in a risk-free virtual environment.

3. Policy planning

Dynamic simulation describes the real logic of supply chain element interaction, while analytical methods just represent the system as flows between facilities. Simulation models describe the actual behavior of a supply chain, taking into account time and resource utilization rates (fleet, people, equipment). So, with dynamic simulation, supply chain managers are empowered to model any process in a supply chain, including aspects beyond other methods, such as

dynamic inventory, sourcing, or transportation policies. It does not produce one optimal solution from multiple combinations, but it allows the analyst to comprehensively study particular dynamic scenarios and supply chain interdependencies and come to an informed decision.

4. Risk assessment

Dynamic simulation models allow users to integrate randomness into supply chain inputs and processes, empowering analysts to estimate all risks related to supply chain structure and consider such random factors as the disruption of supplies, contract breakdowns, natural disasters, and more.

5. Inside the four walls business process assessment

Modeling inside four walls enables the change and customization of any supply chain component, such as warehouses, distribution centers, factories, customers, and the market. It helps solve in-depth supply chain problems related to manufacturing or distribution center processes, resources, scheduling, layouts, and costs. Moreover, it gives an opportunity to figure out how the internal processes in supply chain facilities influence operational excellence across the whole supply chain.

While analytical optimization has been around for a while and is used by many, dynamic simulation modeling is only now becoming mainstream for supply chain practitioners, and the process of adoption has begun with industry leaders. To stay competitive, it is crucial to introduce digital technologies and innovation. Analytical optimization and dynamic simulation modeling provide a platform for organizations to stay efficient and competitive.

Analytical optimization and dynamic simulation modeling were implemented on a real-world case study carried out by the institute in collaboration with a Logistics Service Provider (LSP) in Indonesia.

Case Study: Re-Designing Distribution Network for a Logistics Service Provider

Problem

A Logistics Service Provider (LSP) seeking competitiveness in the digital economy needs to efficiently and effectively redesign a supply network. It should reduce transportation costs and optimize transportation routes. This case study focuses on the distribution network of an LSP company that operates a countrywide logistics network for both B2C (business to customer) and B2B (business to business). The scope of this case study covers last mile delivery in a major urban area whereby the company runs a two-tier network encompassing one large Distribution Centre (DC), several intermediate DCs, and the end customers. It clearly demonstrates the challenges of changing from a traditional to a modern digital supply chain.

The two main research questions are framed as follows:

- What is the optimum number of intermediate DCs to serve a particular city?
- Where to locate these DCs?

An integrated approach encompassing Greenfield analysis and Network optimization was implemented to address these two questions.

The LSP also wanted to optimize supply chain policies and cost-to-serve. Cost-to-serve analysis yields information about the true cost of servicing individual customers by quantifying specific business activities and overhead costs. In our case, cost-to-serve changed due to a change in the number of DCs and transport/storage costs. For policies optimization and cost-to-serve analysis, LSP used the dynamic simulation method.

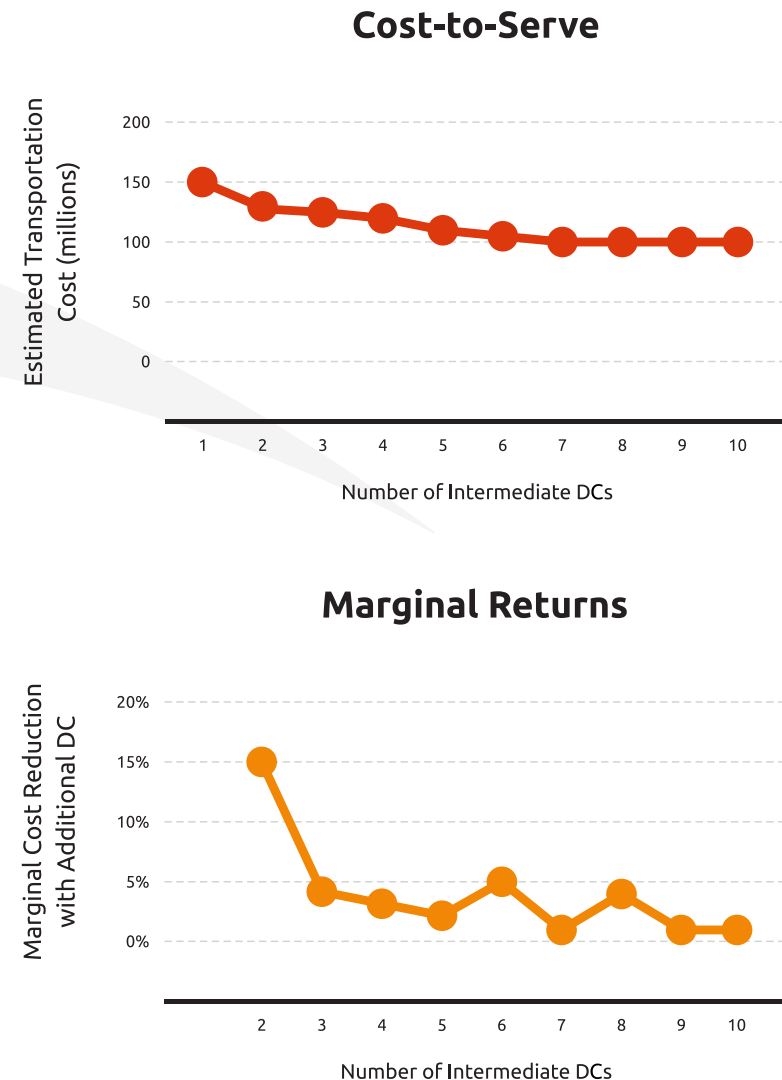


Solution

The case study began with structural data gathering. The data included network data as well as operational information such as demand patterns, cost, and resources. An initial analysis of data led to the identification of bottlenecks and criticalities, as well as areas for improvements. Next, the existing network was modeled, including its main supply chain costs, such as manpower for warehousing and delivery operations. Greenfield analysis was used to identify a list of locations and the coordinates for potential network nodes. Then, Network optimization was used to determine the optimal configuration of the supply network for minimizing costs.

Cost-to-serve optimization improves the network by enabling visibility of profitable solutions and finding a configuration that drops fixed costs at a greater rate than it drops margin. So, it was decided to calculate the cost-to-serve rate for different numbers of DCs and supply chain configurations.

Based on transportation costs only, the Greenfield analysis, carried out in [anyLogistix supply chain software](#), determined that by increasing the number of intermediate DCs, the cost-to-serve would be reduced, as shown in Figure 3. Figure 3 also shows the marginal returns for operating additional DCs. The marginal return is the investment return for operating additional DCs. As shown in Figure 3, the curve suggests that six intermediate DCs would be the optimal number. Six DCs would give a minimum cost-to-serve while having the highest marginal return. The marginal reduction when adding a sixth DC is significant (at 5%).

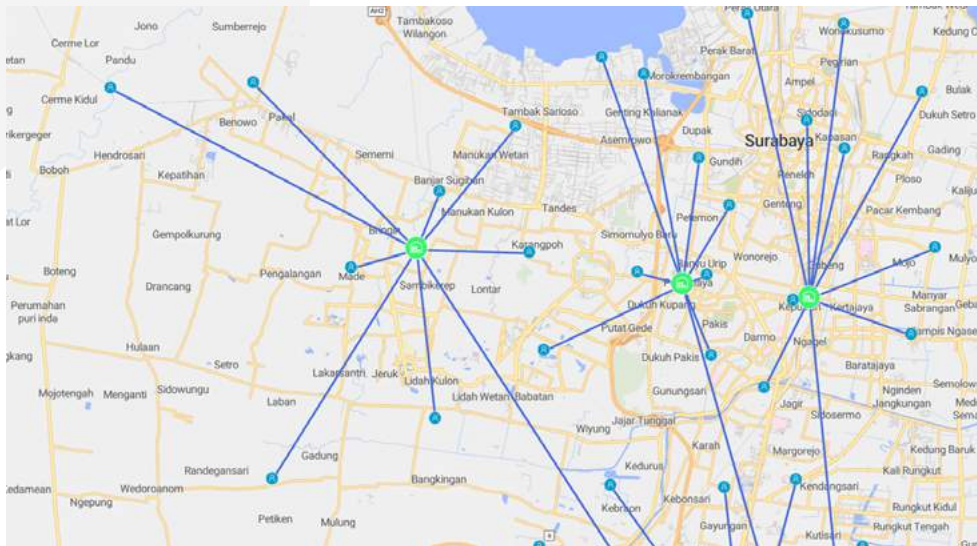


— Figure 3. Flow cost estimate by number of intermediate DCs.

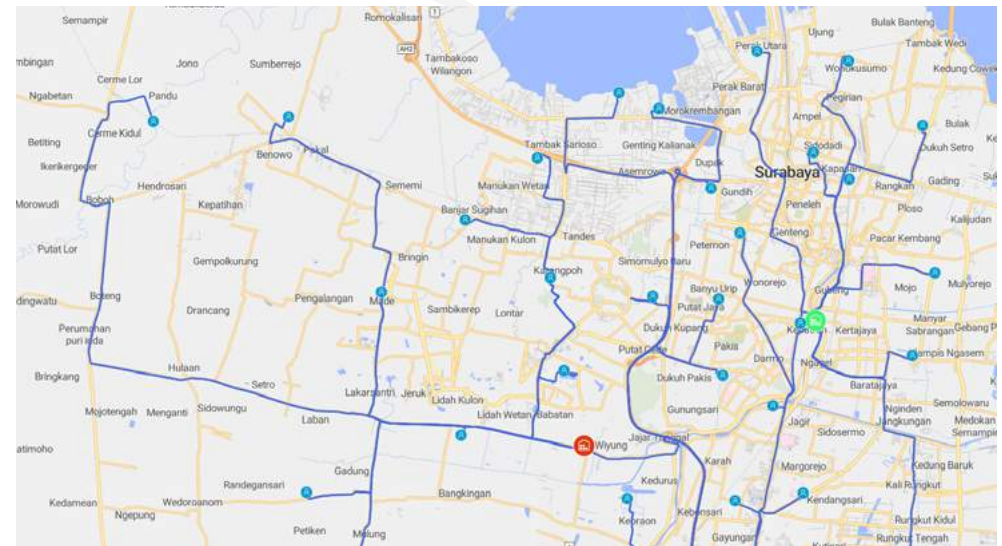
The next step was Network optimization. To do this, the model included costs for both transportation and warehousing. Analysis of the locations suggested by the Greenfield analysis combined with the company's existing network and cost structure (transportation and warehouse costs), determined that only five, and not six, intermediary DCs would be the optimal number of DCs for minimizing transportation costs and supply chain costs overall. Consequently, the input of warehousing costs into the model showed that the six DC supply chain configuration was inefficient, expensive and unprofitable. The results of the Network optimization experiment are illustrated in Figure 5.

Using the Network optimization approach, the most appropriate set of facilities was identified. The chosen scenario made it possible to enhance cost effectiveness by reducing almost 18% of the total cost in transportation and warehousing. These results showed that traditional supply chains can be successfully adapted to meet the demands of the digital economy.

The next stage will be the optimization of inventory, sourcing, and transportation policies using the dynamic simulation approach. Dynamic simulation will also help avoid risks and losses while implementing a new supply chain configuration into the real world. Moreover, using dynamic simulation, LSP can recalculate the cost-to-serve, taking into account transportation and warehouse costs cut.



— Figure 4. Sample results from Greenfield analysis (for illustration purposes only)



— Figure 5. Sample results from Network optimization (for illustration purposes only)

Conclusion

Supply chains are undergoing significant transformations, with digital technologies offering opportunities to create new business models and competitive advantages across all kinds of industries. In this new digital era, customers expect more and more from the supply chain in terms of service, including shorter delivery windows, free shipping, full order status visibility, and more.

Modern supply chains will be required to provide anytime, anywhere delivery to customers. That means that a company must always be online and digitally connected. Retail stores, e-commerce sites, inventory control points, distribution and fulfilment centers, upstream suppliers and manufacturers all must align with consumer demand. This new reality will present many challenges for supply chains managers in the near future.

Analytical optimization and dynamic simulation modeling can help managers solve these complex supply chain problems. Analytical optimization allows the selection of the best solution from among many (for example, site location), while dynamic simulation makes it possible to test multiple specific scenarios that consider more in-depth details and enables robust risk analysis. Targeting different kinds of problems, these two techniques together offer new supply chain analysis opportunities for evaluating assumptions and testing innovations before they are introduced. A company can then implement innovations in the real business system while using the tools to minimize accidents and risks.

Digital transformation makes everything complex. To stay competitive and handle this complexity, supply chain leaders must introduce innovations to their business processes. One solution is to utilize optimization and simulation techniques. Both methods together provide an efficient supply chain analytics toolset, which helps them quickly react to disruptive changes, adopt new strategies, and improve what must be improved. Overall, these technologies provide the ability to take advantage of new market opportunities.



Additional resources



- [anyLogistix Webinar](#)
- [anyLogistix Demo Video](#) – tutorials
- [anyLogistix PLE](#) – free version for self-study and education
- Related white papers for this work:
 - [Supply Chain Optimization and Simulation: Technology Overview](#)
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