Intelligent Decision Support and Big Data for Logistics and Supply Chain Management – A Biased View

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Abstract

"Intelligent Decision Support and Big Data for Logistics and Supply Chain Management" features theoretical developments, real-world applications and information systems related to solving decision problems in logistics and supply chain management. Methods include optimization, heuristics, meta-heuristics and matheuristics, simulation, agent technologies, and descriptive methods. In a sense, we were and are representing the future of logistics over the years.

1. Introduction

Over the last few decades information and communication technology (IT) has served as a most important prerequisite for successful supply chain management (SCM) and will do so in the future. While IT systems are vital components in supply chains, their successful management rests on coordinated decision making throughout logistics and supply chain networks. With related advances, the logistics and SCM field is developing very dynamically. Business-to-business transactions are made via the Internet and enterprise resource planning (ERP) systems support managing the transactional information within the enterprise. While cooperation and coordination are essential for business success, they are only possible based on IT and information systems (IS). While IT and IS are vital components in supply chains, their successful management rests on intelligent and coordinated decision making throughout logistics and supply chain networks. Intelligent decision support and decision analytics using advanced decision technologies and analytics methodology are of utmost importance in logistics and SCM. Sensor networks, social network activities, RFID deployment, internet search histories and retail transactions are just a few examples of sources to provide data to support efficient decision analytics. Big data issues are well recognized and offer opportunities long waited for but also provide challenges in handling and decision analytics. Cloud computing allows also small and medium sized enterprises to access resources to support analytics functions. Business intelligence and data mining can be used to store and analyze supply chain, logistics, product, inventory, and sales information. Important methodologies incorporate simulation and optimization, which can be employed for, e.g., inventory, production, procurement, and distribution planning. Intelligent agents can, e.g., communicate with different partners in the supply chain, assist in collecting information, share product information, negotiate prices, and distribute alerts throughout logistics and supply chain networks. The design and implementation of intelligent decision analytics tools to support human agents in computational logistics and SCM is a very active field in research, consulting and software development. Many such technologies or systems are continuously being developed, implemented and used in real-world scenarios.

Next we provide some historical remarks regarding the "Intelligent Decision Support and Big Data for Logistics and Supply Chain Management" minitrack followed by some more general considerations of the current state and future of this area. We conclude with some final outlook into the "future" of logistics.

2. Historical Remarks

Overall, "Intelligent Decision Support and Big Data for Logistics and Supply Chain Management" incorporates papers dealing with decision analytics, business intelligence, big data, cloud computing and decision technologies which contribute to intelligent

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decision support in the whole field of logistics and in particular in all categories of SCM. This includes but is not restricted to simulation, optimization, heuristics, metaheuristics, agent technologies, decision analytics, descriptive models, and data mining. A special focus has been and is on real-world applications and in IS and software solutions which assist in solving hard decision problems. This is extended towards computational logistics, advanced planning systems and the intelligent use of ERP and so-called advanced planning systems.

This minitrack has quite some historical development over the years. Let us start our observations around the year 2000. By then the name of the minitrack was "Intelligent Systems in Traffic and Transportation."[1] Intelligent systems designed to solve real-world applications in traffic and transportation were and are built on the basis of an advanced software engineering concept and well-founded mathematical concepts. On the algorithmic side several techniques coming especially from the areas of operations research and artificial intelligence have been investigated including various metaheuristics like tabu search and evolutionary algorithms, approaches from constraint programming as well as agent-based technologies and discrete event simulation.

Main drivers in those early years were real applications, for instance, to support the management of complex transportation networks operated for mail delivery [8,9], vehicle dispatching at seaport container terminals with a focus on the Burchardkai container terminal in Hamburg, Germany [2], or the use of an intelligent system used by the Dutch railway operator NS Reizigers for supporting their internal planning [7].

Contributions to the minitrack always provided a heterogeneous, yet complementary ensemble as they consider different approaches in coping especially with real-world issues in logistics and SCM. This also included consideration of uncertainty and complexity found in decision making, linking towards virtual environments for advanced modelling [4] and computational logistics. The minitrack continuously evolved, over the consideration of e-logistics up to "Intelligent Decision Support and Big Data for Logistics and Supply Chain Management" as it is named now in 2017. Over time it was also affiliated with tutorials on optimization software class libraries [12], computational logistics and cloud computing [6].

[1] Over the years, since 2000, the minitrack was organized with the help of several people including A. Fink, T. Grünert and H.G. Nüßer with H.-J. Sebastian and S. Voß acting as anchor points after a most successful inauguration by the former.

3. Intelligent Decision Support and the Future of Logistics

Decision analytics can be interpreted as the answer to the operations research community's long-standing desire for a full recognition from the business community that the kinds of modeling they do are directly important and relevant (cf. Dan Dolk in [11]). With this we would state that IT and logistics are undoubtedly interwoven which has most successfully been shown in the advances in computational logistics.

While borrowing words from above, computational logistics involves the use of IS and modern IT for the design, planning and control of logistics networks as well as the complex tasks within them. As the logistics and SCM fields are developing very dynamically, related service networks are seeking for improved decision support. While modern IS / IT systems are vital components in supply chains and logistics, their successful management rests on intelligent and coordinated decision making throughout the logistics network.

Well recognized in economics are some 40 to 60 years long Kondratiev-cycles (or waves) with the IT-oriented cycle being somewhat different as it interfered with all previous cycles in a way that it was influencing all previous developments regarding their recent advances. There might be speculation regarding what the next cycle will be.

Regarding the future of logistics we might concede that "the technology" is there, it just has to be applied. And that might also bring new problems. Everything seems optimized so that vulnerability issues and the influence of disturbances get bigger and more important; a well-known example from production planning is the consideration of load dependent lead times. And on the societal side humans need to be trained to solve and resolve problems which are considered to be even more complex as more data is involved, system-wide implications are more visible etc.

Regarding the future of logistics and SCM one may find a dime a dozen references every year. A recent one with a focus in our sense is [10] emphasizing operations research issues. On a different scale one may also brainstorm related buzzwords and get the following (biased and certainly incomplete) list:

- Reverse Logistics, Closed-loop Supply Chains
- Green Logistics
- Internet of Things (IoT)
- Logistik 4.0
- Collaboration

- Big Data, Cloud Computing
- 3D-Printing
- Drones
- Digital Transformation

All of these buzzwords describe important issues influencing the future of logistics.[2] They are related to different mindsets and technologies. Borrowing again from D. Dolk in [11], "decision analytics has made a huge impact in a relatively short period of time. As the business world is becoming more aware of the potential value that analytics can contribute, there is a natural rush towards explaining how companies should leverage this technology for 'transforming data into insight for making better decisions' and getting a full return on invest on big data and decision analytics investment. This consultant-flavored enthusiasm inevitably accompanies the advent of new technologies and will run its course accordingly. However, there are very real challenges that confront business with respect to the design, development, and management of big data and decision analytics systems. Model management, for example, will become a big issue as companies find that severely time-compressed decision loops result in running thousands of models in just a few seconds or minutes.

This year's contributions are covering a small subset of this as they deal with green logistics [13], big data [3], and digital transformation [5].

4. Conclusions and Future Research

The technology is there (at least in many cases); we just need to learn using it. It is not only about winning the "horse-race" in operations research (one such example was provided by [1]). We need to be able to put our algorithms and methodological developments into running systems. If we succeed in that, we may have an impact. The minitrack has shown that multidisciplinarity and intelligent system design are key towards business success in logistics and SCM. Joint knowledge about information systems and operations research – and the skill and experience to use it for actual planning, problem solving and decision making – is sought after (C. Carlsson in [11]).

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[2] While one could assume that the list is somewhat biased with a German mindset, we are fully aware that there are many other buzzwords (e.g., digital manufacturing, cyber physical systems), some of which even come from specific countries, like, e.g., synchromodality (from the Dutch side).

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