Reaching 50 million nanostores : retail distribution in emerging megacities

Research School for Operations Management and Logistics

Reaching 50 million nanostores: retail distribution in emerging megacities

Edgar E. Blanco, Jan C. Fransoo

Beta Working Paper series 404

BETA publicatie	WP 404 (working paper)
ISBN	
ISSN	
NUR	804
Eindhoven	January 2013

Reaching 50 million nanostores: retail distribution in emerging megacities

Edgar E. Blanco and Jan C. Fransoo

Working Paper, BETA Research School, Eindhoven University of Technology

This version: 22 January 2013

Edgar E. Blanco
Center for Transportation and Logistics
Massachusetts Institute of Technology
77 Massachusetts Ave, Room E40-295
Cambridge, MA 02139
USA
eblanco@mit.edu

Jan C. Fransoo
School of Industrial Engineering
Eindhoven University of Technology
P.O. Box 513, Pav. F4
5600 MB Eindhoven
Netherlands
j.c.fransoo@tue.nl

A video lecture that incorporates the main messages of this paper can be viewed at
http://youtu.be/UsU7hdgsxCs

Reaching 50 million nanostores: retail distribution in emerging megacities

Edgar E. Blanco, Center for Transportation and Logistics, Massachusetts Institute of Technology, USA, eblanco@mit.edu
Jan C. Fransoo, School of Industrial Engineering, Eindhoven University of Technology, Netherlands, j.c.fransoo@tue.nl

Abstract
With urbanization sprawling in emerging economies, retail opportunities abound. City structures, income distributions, and shopping patterns in emerging megacities are however very different from the ones we know from developed markets. One of the most dominant characteristics is the presence of millions of very small, family-owned and operated stores. We call these "nanostores". In this paper, we define and characterize these nanostores, and the associated logistics and channel strategies to reach them as the next opportunity in global retailing. We argue that structures and characteristics are fundamentally different of the developed economies organized big-box retail, and hence new research opportunities can be identified.

1. Introduction
In the past decades, research on retail logistics has primarily focused on the operations of organized retail. Retail operations have developed into a well-studied, well-documented field of research and practice, as exemplified for instance by the recent work by Fischer and Raman (2010). With the growth in emerging markets, however, a significant change in the retail landscape in happening. The population in developing economies is rapidly moving into cities, and very large cities are staring to dominate the landscape. In these developing economies, retailing is different. Although the big-box multinational retailers have been present in some of these countries now for several decades, their market share is significant, but very far from the dominance that these retailers experience in developed markets. The traditional retail channel, with its many small stores, are still dominating the retail scene. In contrary to common thinking at the end of the previous century, there is now increasing evidence that the traditional retailer in its small store is there to stay, at least for the coming decades. These small stores, which we will denote as "nanostore" in contrast to the supermarkets or hypermarkets, are the subject of this *insight* paper. We estimate there are around 50 million nanostores in the developing world, and they are a force to be reckoned with, as their market share in many countries is around half of the total retail market. Not only are nanostores different from an operations perspective (they are not "just" a small supermarket), but also in terms of the distribution to nanostores, and the sales process towards nanostores, these retail channel provide different challenges in supply chain management. These challenges are not only of a practical nature, of relevance to professionals, but also have different theoretical implications, of relevance to academics.

In this paper, we will characterize some of the main urbanization trends in developing economies, and their impact on the retail landscape in Section 2. We describe the characteristics of the nanostore in Section 3, and in Section 4 we discuss the various channel strategies. We conclude in Section 5 by highlighting the various opportunities for research.

2. Urbanization in developing economies drives retail landscape

The speed at which urbanization is happening has increased on the past decade. In particular in developing economies, this is happening at a very fast pace. In 2025, the top 600 cities of the world will cover 22% of the world population, and more than half of the world's GDP, according to a projection by the McKinsey Global Institute (Dobbs *et al.*, 2011). Most of these large cities will be in what is currently considered the developing economies. According to the same McKinsey projection, of the top 25 megacities in the world, only 4 will be in what is currently considered as the developed world. Moreover, the GDP per capita is increasing substantially in most of these cities, which implies a substantial change is where consumers are. This change is already visible in the growth statistics of Consumer Packaged Goods (CPG) companies. A multinational company like Unilever currently realizes more than half of its revenues in emerging markets, and the growth ambitions for the company towards 2020 need to be realized completely in emerging markets. Within these markets, the cities are the largest share of the economy, both the leading megacities and the second tier of cities.

There are multiple definitions of megacities around. Most take the population size as a criterion, with both 5 and 10 million inhabitants used as the cut-off point. Rather than the mere size of the city, from a logistics perspective it is in particular the high population density in combination with its size that makes the megacities in emerging markets very different from the large cities that we know, for instance, from the United States or Europe. In the list of most densely populated large metropolitan areas in the world published by City Majors (2007), the most dense European cities (Athens, London, Madrid) have a density of about 5,000 people per square kilometer. In the US, this is still much lower with most major cities having a density of 2,000 people or less per square kilometer (New York, New Orleans). Of course, Manhattan is much denser at 27,000 people per square kilometer and even just the city of New York counts about 10,000 people per square kilometer. However, compare this to Mumbai (India), where, for the metropolitan area the *average* population density is about 30,000 people per square kilometer.

The consequences for transportation in these cities are serious. Many of these cities are more or less permanently congested. Due to the rapid organic growth of the cities, with little planning, the infrastructure is insufficient to deal with the increase in traffic. Some areas of the city are, because of the width or steepness of the streets, not accessible by trucks or sometimes even by cars.

Moreover, these cities are characterized by unprecedented income disparities. As a consequence, the (average) income per capita is not necessarily a good indicator of wealth. In most of these countries, the median income growth is substantially slower than the average. This implies large portions of the population do not have access to transport or any significant amount of disposable cash. Nevertheless, the incomes of hundreds of millions of people have slightly increased, and they are now starting to buy more consumer packaged goods. It is this large group of people, their buying behavior, the stores at which they buy, and the strategies of the CPG manufacturers to reach these new consumers, which is the topic of our research.

Unfortunately, large income disparities are often associated with security problems and other problems of crime. Since much of the economy is a cash economy, this puts pressure on the operations, as deliveries of goods and the returning flows of cash are subject to robbery. Furthermore, income disparities also lead to huge geographic differences in the cities. Some cities are very dense, poor neighborhoods, while others may be very affluent. For instance, in the city of Bogota, Colombia, neighborhoods can be found with an average monthly income of

just over 100 USD, and a store for every 150 inhabitants, but also *adjacent* neighborhoods with an average monthly income of 1000 USD, and a store for every 250 inhabitants. This diversity is much beyond the characteristics that can be observed in cities in developed economies, where differences are much smaller.

3. Why is retailing in emerging megacities different: the nanostore

In retail, a distinction can be made between the so-called traditional and modern channel. The modern channel is the organized (corporate) retail channel. In this channel, large-scale retailers operate, either with their own stores or franchised stores. These typically large companies have professionals to support the various decision functions, such as marketing, merchandising, category management, logistics, and store operations. In many cases, information systems play a large role, and in much of the supply chains, they are the dominant partner. Consequently, they have a strong position in the price negotiations with the CPG manufacturers. Modern channel retailers do not only exist in developed markets. Many are active in developing markets, both big box international retailers such as Walmart and Carrefour, and convenience store retailers such as 7-11. Also, strong domestic players in emerging markets exist in the organized retail channel, such as Watson in China, Exito in Colombia, and Oxxo in Mexico.

The traditional channel is in almost all aspects the opposite of the modern channel. A traditional retailer is usually a family-operated business, with in most cases only one store in the retail company. This implies that all decision functions are united in a single owner-operator. There are different sizes of these businesses: some could be characterized as mini-stores, with 15-40 square meters of store surface (similar to convenience stores in organized retail). Most, however, are much smaller, and have less than 15 square meters of store, or maybe no stores at all but a street cart. We will denote these stores as “nanostores”.

A nanostore has a low barrier of entry: in most countries no formal barriers exist in practice to operate a store. The front or garage of a house can easily be converted into a store. Following the 2002 peso crisis in Argentina, the number of stores increased drastically and consumers shifted their shopping to these stores to take advantage of informal credit (McKenzie and Schargrodsky, 2005). Our data suggests that nanostores supply 100-200 consumers in their immediate neighborhood. This implies that they know their customers; they know who has a job and can provide a regular income. Boulaksil (2012) reports that informal credit is granted on an extensive basis, but not to customers that are likely not to pay. The ability to provide informal credit to consumers means that nanostore operators are usually also short of cash. Thus, one of the main challenges in the logistics planning and execution is to time the delivery such that cash is available to pay for the delivery.

In most of the developing economies the market share of the traditional channel is substantial. In the 1990s various marketing studies appeared that suggested that with the entry of the big-box retailers, this would soon come to an end. While in some countries, such as Brazil and China, the modern channel has been successful, even in these countries the market share of the modern channel does not exceed 60%. The plateauing of the growth of the modern channel is most likely affected by the limited access of lower income groups to the modern channel. For the hypermarkets, products are typically cheaper, but consumer needs access to transport and to formal credit (or substantial cash) to be able to buy in the large quantities by which products are sold in these stores. In a nanostore, they can very often buy a single cigarette or cookies in a two-pack. The modern convenience channel tries to address this by selling in smaller consumer units. However, the pricing in the modern convenience channel is usually targeted at

the middle class consumers, and only competes to a limited extent with the traditional channel; the modern convenience channel does not provide informal credit, requiring consumer to have either cash or access to formal credit. D'Andrea (2006) argues that beyond money and time, also the format of the nanostores is an important contributor to their continued market dominance.

Table 1 - Comparing the modern channel supermarket with the traditional channel nanostore

	Modern Channel Supermarket	Traditional Channel Nanostore
Functions	Professionals, dispersed	Single store owner-operator
Logistics support	Distribution centers, cross-docks, 3PL	None
Financial flow	Formal credit, bank transfers	Cash, relationship-based credit
Line items	Full casepacks to store, pallets to retailer DC	Consumer units, mixed casepacks
Number of SKUs	Thousands to tens of thousands	Hundreds
Category depth	Half dozen to dozens	Single or double
Number of consumers served per store	Tens of thousands	A few hundred
Technology	Enterprise systems, POS scanning, EDI	Personal mobile phone

Assortment depth is limited in nanostores. Due to the limited space in the store, owners will typically limit the depth in each category to a very small number: one type of toothpaste or two types of shampoo. Consequently, CPG manufacturers go through large efforts in trying to secure this shelf space. This is often done by claiming space in the store for their entire assortment, for instance by providing a specific display stand. Pre-sellers (see below for more detail) regularly visit the store to ensure replacement of empty spaces on the display stand.

The number of nanostores is large. In Mexico, Coca-cola supplies 1.2 million points of sale. In Mexico City alone, Unilever delivers ice cream to more than 10,000 freezers. Bimbo, a Latin American bread producer, directly supplies to 7 million points of sale across Latin America. Based on the five billion consumers that regularly buy in nanostores, and our data on the number of consumers per store, we estimate the total number of nanostores in emerging markets to be at least 50 million. Based on the data presented above on the growth of megacities, it is reasonable to expect that by 2025, at least 10 million of these stores will be present in the world's top 600 cities. In each of these cities, this implies tens of thousands of points of sale. This leads to different design characteristics in the distribution network. While in North America and Europe, the distribution structure from the manufacturer DC is usually single-tiered (only a single retailer DC or cross-dock), we have observed in Beijing 3 to 4 tiered structures, with multiple handovers of the product to smaller carriers, down to tricycle operators for the last leg.

Hence, in nanostores the operation of the stores, the merchandising of the suppliers, and the distribution towards the stores is substantially different from the modern channel, and even substantially different from the modern convenience channel.

4. Reaching the nanostores: channel strategies

Frazier and Shervani (1992) defines a route to market as the distinct process through which a product or service can be selected, purchased, ordered, and received by a customer. Anderson et al (1997) argued on the importance of channel design. In traditional manufacturer-retail environments, this decision is often described as a choice between direct store deliveries vs. indirect service models. Supplying nanostores face the same choice. However, due to the unique characteristics of the nanostore there are deeper implications for the manufacturer and a wider range of strategic and operational choices between both models.

Figure 1 shows the key functions that need to be considered when serving nanostores: demand generation, order processing, physical distribution, payment collection and after-sale service. When serving the modern retail channel, these functions are usually split among various departments within the retailer and within the manufacturer. For example, the manufacturer sales organization works with the retailer buyer group to determine product launches, promotions and assortment. Accounting and finance departments interface to creating purchase orders and follow agreed payment terms. Warehouse and backroom operators coordinate with delivery vehicles delivery time windows and loading/unloading protocols.

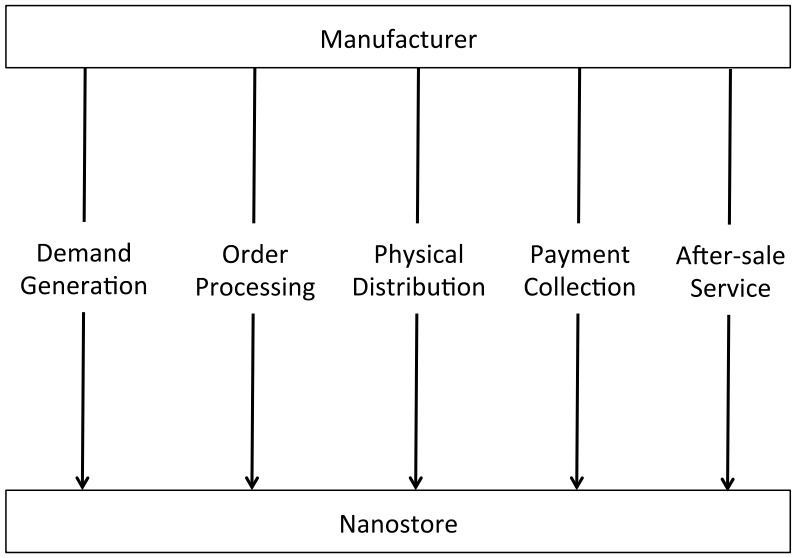

Figure 1 – Key functions that need to be considered when serving nanostores

If a manufacture chooses an indirect service model (via a wholesaler or a distributor) to serve a "modern" retailer, the order processing, physical distribution, payment collection and after-sale service functions are simply considered transactional elements and are evaluated in pure logistics efficiency terms. The demand generation activities are usually maintained within the manufacturer sales and marketing departments, and processes are developed to coordinate with wholesalers and distributors.

In the case of nanostores, these functions work in a very different way. First, physical distribution is much more complex. The number of delivery points is larger, with smaller drop sizes and may have higher costs compared to developed market logistics operations. We have found that companies like Colombina (a candy manufacturer) or Coca-Cola, often operate distribution routes with over one hundred stops per day in Bogotá (Colombia). When looking at logistics efficiency metrics, manufacturers often conclude that a wholesaler or a distributor will

achieve higher economies of scale and select an indirect service model to reach nanostores. The importance of the other functions is usually ignored.

As mentioned earlier, nanostores are often part of the “informal” economy or work with limited assets and no access to credit by financial institutions. As a consequence, cash is usually collected on-delivery. In other words, the physical and monetary flows of the supply chain operate in close proximity and are responsibility of the physical distribution function. This proximity creates an inherent risk to the supply chain that forces companies to design distribution operations that need to handle significant amount of cash. Depending on the risk profile and relationship with its distribution activities, this sometimes means that the vehicle driver is directly responsible of the product (e.g. is in consignment) during the transportation operations and is responsible for its value throughout the distribution process (including theft). In the other extreme, distribution vehicles are equipped with security boxes and tracing systems to safeguard the cash collection process. On the other side, the fast cash-to-cash cycle common when distributing to nanostores, creates opportunities to realize higher profitability due to lower levels of working capital and, if paired with financial analysis, turned into a mechanism to further secure market share by extending credit to nanostores owners.

With regard to demand generation, and given the limited shelf space and low technological level of nanostores mentioned earlier, the sales organizations have an interest in having direct contact with nanostore owners. During this contact, products and promotions are evaluated and product orders are placed. This combined demand generation with order processing activity is usually referred to as “pre-sales” and leverages a close connection with the nanostore. Moreover, pre-sales activities often include support on product merchandising to guarantee shelf visibility.

Over time, the pre-seller and product delivery staff interacts on a regular basis with the nanostore owner (or his family). This close connection motivates the sales and logistics organization to share responsibilities (e.g. merchandising) and often provide or coordinate any after-sale service processes working as a virtual team. Manufacturers can also opt to completely merge the functions into a single operation referred as “on-board sales”, where the delivery vehicle carries inventory and performs all the activities as part of its order processing is effectively eliminated and demand generation, product delivery, payment and after-sale service are combined in a single interface to the nanostore. Smaller SKU assortment and specially designed vehicles are often used in these operations.

Figure 2 summarizes the various options a manufacturer has to reach the nanostore.

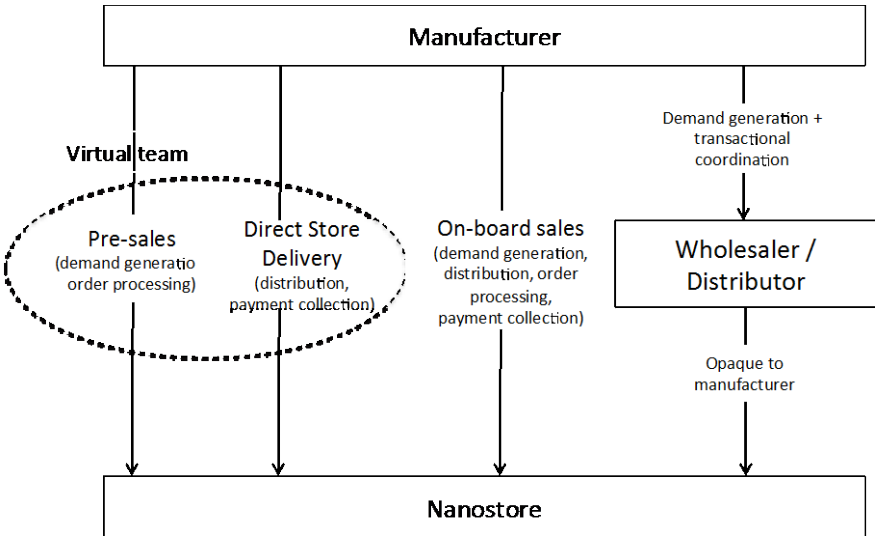

Figure 2 – Supply choices to nanostores

Leading companies in emerging markets have been using direct service models. Coca-Cola FEMSA, Grupo Bimbo, Grupo Polar, and Alpina are just some example of companies that are using a wide variety of presales, direct store and on-board sales supply schemes to nanostores (Blanco and Garza, 2012). This has enabled higher levels of execution in terms of merchandising and control. This sometimes includes owning or leasing a large share of the vehicle fleet to support distribution operations in urban areas. On the downside, it may results in higher transportation and service costs for the manufacturer. These leading companies, leverage unique business characteristics to streamline distribution operations. In Brazil, using the concept of a “broker” for example, the direct store delivery process may be outsourced for nanostores that are not the very smallest ones. The top 10-20% of stores that have been formally registered and have bank accounts, would allow for a system in which a service provider takes care of the actual delivery while the manufacturer keeps control of the information and manages the credit system. Although this leads to less cash in the system, security concerns still exist on the actual products and adequate risk mitigation strategies need to be negotiated with the “broker”.

Multinational manufacturers (MNCs) often rely on indirect service models to reach the nanostores. A major reason for this is that MNCs prefer safety to developing the business opportunity. Direct delivery to nanostores requires knowing the market and its culture, and many MNCs avoid this risk. Further, it requires building up a large system with hundred of people in each city to conduct presales and direct delivery, and potentially also invest in trucking capacity. Using local parties will considerably speed up ramp-up opportunities, but the ceiling of the markets that can be reached through distributors will be reached more quickly. Regional and local manufacturers tend to depend on indirect service models when they face capital and scale constraints. Their choice of direct service to nanostores increases, as they understand the specific requirements of their customers.

Table 2 summarizes the strategic trade-offs that companies need to consider as they decide between direct versus indirect strategies to serve nanostores. Developing on-board sales, presales and direct store delivery capabilities allows a closer proximity with the channel, but requires complex operations to balance inventory, SKU assortment and cash flow management.

Table 2 – Supply strategies to serve nanostores.

Supply Strategy	Pros	Cons
On-board sales	• Single point of contact with nanostore • Full control of all functions and flows • Urban logistics capabilities	• High logistics cost • Increased inventory • Limited assortment in vehicle
Presales + Direct Store Delivery	• Control in demand generation • Control of monetary flows • Proximity with nanostore owners • Urban logistics capabilities	• Logistics complexity • Cash management • Medium/high logistics cost
Presales + Distributor	• Active relationship with nanostore • Reduced distribution and operational costs	• Complex coordination with distributor • Two points of contact with nanostore • Loss of urban logistics capabilities
Distributor	• Low complexity • Low cost • Operational influence to distributor	• Opaque view of nanostores • Reduced influence on monetary flows • Loss of urban operational capabilities
Wholesaler	• Lowest cost Lowest complexity	• No visibility to nanostores

5. Conclusions and Research Opportunities

Nanostores will continue to be a critical retail channel in large urban areas in emerging markets. Designing the right supply strategy needs to balance not only traditional logistics efficiency trade-offs, but increasingly take into account the business impact in demand generation and cash flow management. This has implications both for the private sector, but also for policy makers that are trying to design urban logistics policies.

We believe there are rich research opportunities in logistics and supply chain management tailored to nanostores and their unique urban context:

- Understanding the behavioral and cultural patterns of consumers in urban areas will allow to model consumer choice in the urban context (e.g. mobility) and its impact on the resilience of the nanostore. This includes tracking the growth potential of home-delivery and electronic commerce in low-income urban populations.
- Modeling and optimizing direct vs. indirect channels to service nanostores, including the impact of assortment in nanostore shelf management and buying patterns.

- Explicit analysis of cash-to-cash cycles and their impact in designing sales and distribution routes
- Risk management in urban logistics operations (both cash and product)
- Vehicle routing in dense and highly congested urban areas
- Adoption of mobile technologies in nanostores to enable information sharing and mobile payments and its impact in urban distribution

Finally, it is critical that city logistics research (see Crainic et. al 2004, Taniguchi et. al. 2007, Dablanc, 2007) is updated to recognize the importance of nanostores in megacities in the developing world. The outlined dynamics require policy makers and private actors to explicitly consider the unique relationship between manufacturers and nanostores as they evaluate policy mechanisms. For example, the proximity between the financial and physical flows to nanostores and the fierce competition for shelf space, make less attractive for companies to share logistics providers or participate in urban consolidation centers. Also, adoption of off-hour deliveries initiatives will most likely face similar barriers due to the intense interaction between single-owner nanostores and fragmented distribution operations. There are also unique levers available to urban logistics planners not available in developed markets such as providing access to credit to nanostores or developing risk mitigation incentives to urban logistics operators that may create strong incentives for distribution consolidation and collaboration.

References

Anderson, E., Day G.S., and Rangan V.K.. 1997. "Strategic channel design." *Sloan Management Review* 38 (4): 59-69.

Blanco, E.E. and Garza J. 2012. “Distribution Strategies in Emerging Markets: Case Studies in Latin America.” *Proceedings of the 4th P&OM World Conference*.

Boulaksil, Y. 2012. “The operational performance of small retailers in developing countries – the case of Morocco.” *Proceedings of the 4th P&OM World Conference*.

City Majors. 2007. http://www.citymayors.com/statistics/largest-cities-density-125.html, accessed on 7 November 2012.

Crainic, T.G., Ricciardi N., and Storchi G. 2004. "Advanced freight transportation systems for congested urban areas." *Transportation Research Part C: Emerging Technologies* 12 (2): 119-137.

Dablanc, L. 2007."Goods transport in large European cities: Difficult to organize, difficult to modernize." *Transportation Research Part A: Policy and Practice* 41 (3): 280-285.

D'Andrea, G., Lopez-Aleman B., and Stengel A. 2006. "Why small retailers endure in Latin America." *International Journal of Retail & Distribution Management* 34 (9): 661-673.

Dobbs, R., Smit, S., Remes, J., Manyika, J., Roxburgh, C., and Restrepo, A. 2011. *Urban World: Mapping the economic power of cities.* McKinsey Global Institute.

Fisher, M., and Raman A. 2010. *The new science of retailing: How analytics are transforming the supply chain and improving performance*. Harvard Business Press.

Frazier, G. L., and Shervani T.1992. "Multiple channels of distribution and their impact on retailing." *The future of US retailing: An agenda for the 21st century* : 217-237.

McKenzie, D., and Schargrodsky E. 2005. "Buying less, but shopping more: Changes in consumption patterns during a crisis." *Bureau for Research and Economic Analysis of Development (BREAD) Working Paper* 92.

Taniguchi, E., Yamada T., and Okamoto M.2007. "Multi-agent modelling for evaluating dynamic vehicle routing and scheduling systems." *Journal of the Eastern Asia Society for Transportation Studies* 7: 933-948.

Working Papers Beta 2009 - 2013

nr.	Year	Title	Author(s)
404	2013	Reaching 50 million nanostores: retail distribution in emerging megacities	Edgar E. Blanco, Jan C. Fransoo
403	2013	A Vehicle Routing Problem with Flexible Time Windows	Duygu Tas, Ola Jabali, Tom van Woensel
402	2013	The Service Dominant Business Model: A Service Focused Conceptualization	Egon Lüftenegger, Marco Comuzzi, Paul Grefen, Caren Weisleder
401	2013	Relationship between freight accessibility and Logistics employment in US counties	Frank P. van den Heuvel, Liliana Rivera, Karel H. van Donselaar, Ad de Jong, Yossi Sheffi, Peter W. de Langen, Jan C. Fransoo
400	2012	A Condition-Based Maintenance Policy for Multi-Component Systems with a High Maintenance Setup Cost	Qiushi Zhu, Hao Peng, Geert-Jan van Houtum
399	2012	A flexible iterative improvement heuristic to Support creation of feasible shift rosters in Self-rostering	E. van der Veen, J.L. Hurink, J.M.J. Schutten, S.T. Uijland
398	2012	Scheduled Service Network Design with Synchronization and Transshipment Constraints For Intermodal Container Transportation Networks	K. Sharypova, T.G. Crainic, T. van Woensel, J.C. Fransoo
397	2012	Destocking, the bullwhip effect, and the credit Crisis: empirical modeling of supply chain Dynamics	Maximiliano Udenio, Jan C. Fransoo, Robert Peels
396	2012	Vehicle routing with restricted loading capacities	J. Gromicho, J.J. van Hoorn, A.L. Kok J.M.J. Schutten
395	2012	Service differentiation through selective lateral transshipments	E.M. Alvarez, M.C. van der Heijden, I.M.H. Vliegen, W.H.M. Zijm
394	2012	A Generalized Simulation Model of an Integrated Emergency Post	Martijn Mes, Manon Bruens

393	2012	Business Process Technology and the Cloud: Defining a Business Process Cloud Platform	Vasil Stoitsev, Paul Grefen
392	2012	Vehicle Routing with Soft Time Windows and Stochastic Travel Times: A Column Generation And Branch-and-Price Solution Approach	D. Tas, M. Gendreau, N. Dellaert, T. van Woensel, A.G. de Kok
391	2012	Improve OR-Schedule to Reduce Number of Required Beds	J.T. v. Essen, J.M. Bosch, E.W. Hans, M. v. Houdenhoven, J.L. Hurink
390	2012	How does development lead time affect performance over the ramp-up lifecycle?	Andres Pufall, Jan C. Fransoo, Ad de Jong
389	2012	Evidence from the consumer electronics industry	Andreas Pufall, Jan C. Fransoo, Ad de Jong, Ton de Kok
388	2012	The Impact of Product Complexity on Ramp-Up Performance	Frank P.v.d. Heuvel, Peter W.de Langen, Karel H. v. Donselaar, Jan C. Fransoo
387	2012	Co-location synergies: specialized versus diverse logistics concentration areas	Frank P.v.d. Heuvel, Peter W.de Langen, Karel H. v.Donselaar, Jan C. Fransoo
386	2012	Proximity matters: Synergies through co-location of logistics establishments	Frank P. v.d.Heuvel, Peter W.de Langen, Karel H.v. Donselaar, Jan C. Fransoo
385	2012	Spatial concentration and location dynamics in logistics:the case of a Dutch province	Zhiqiang Yan, Remco Dijkman, Paul Grefen
384	2012	FNet: An Index for Advanced Business Process Querying	W.R. Dalinghaus, P.M.E. Van Gorp
383	2012	Defining Various Pathway Terms	Egon Lüftenegger, Paul Grefen, Caren Weisleder
382	2012	The Service Dominant Strategy Canvas: Defining and Visualizing a Service Dominant Strategy through the Traditional Strategic Lens	Stefano Fazi, Tom van Woensel, Jan C. Fransoo
381	2012	A Stochastic Variable Size Bin Packing Problem With Time Constraints	K. Sharypova, T. van Woensel, J.C. Fransoo
380	2012	Coordination and Analysis of Barge Container Hinterland Networks	Frank P. van den Heuvel, Peter W. de Langen, Karel H. van Donselaar, Jan C.

			Fransoo
379	2012	Proximity matters: Synergies through co-location of logistics establishments	Heidi Romero, Remco Dijkman, Paul Grefen, Arjan van Weele
378	2012	A literature review in process harmonization: a conceptual framework	S.W.A. Haneya, J.M.J. Schutten, P.C. Schuur, W.H.M. Zijm
377	2012	A Generic Material Flow Control Model for Two Different Industries	H.G.H. Tiemessen, M. Fleischmann, G.J. van Houtum, J.A.E.E. van Nunen, E. Pratsini
376	2012	Dynamic demand fulfillment in spare parts networks with multiple customer classes	K. Fikse, S.W.A. Haneyah, J.M.J. Schutten
375	2012	Improving the performance of sorter systems by scheduling inbound containers	Albert Douma, Martijn Mes
374	2012	Strategies for dynamic appointment making by container terminals	Pieter van Gorp, Marco Comuzzi
373	2012	MyPHRMachines: Lifelong Personal Health Records in the Cloud	E.M. Alvarez, M.C. van der Heijden, W.H.M. Zijm
372	2012	Service differentiation in spare parts supply through dedicated stocks	Frank Karsten, Rob Basten
371	2012	Spare parts inventory pooling: how to share the benefits	X.Lin, R.J.I. Basten, A.A. Kranenburg, G.J. van Houtum
370	2012	Condition based spare parts supply	Martijn Mes
369	2012	Using Simulation to Assess the Opportunities of Dynamic Waste Collection	J. Arts, S.D. Flapper, K. Vernooij
368	2012	Aggregate overhaul and supply chain planning for rotables	J.T. van Essen, J.L. Hurink, W. Hartholt, B.J. van den Akker
367	2011	Operating Room Rescheduling	Kristel M.R. Hoen, Tarkan Tan, Jan C. Fransoo, Geert-Jan van Houtum
366	2011	Switching Transport Modes to Meet Voluntary Carbon Emission Targets	Elisa Alvarez, Matthieu van der Heijden
365	2011	On two-echelon inventory systems with Poisson demand and lost sales	J.T. van Essen, E.W. Hans, J.L. Hurink, A. Oversberg

364	2011	Minimizing the Waiting Time for Emergency Surgery	Duygu Tas, Nico Dellaert, Tom van Woensel, Ton de Kok
363	2011	Vehicle Routing Problem with Stochastic Travel Times Including Soft Time Windows and Service Costs	Erhun Özkan, Geert-Jan van Houtum, Yasemin Serin
362	2011	A New Approximate Evaluation Method for Two-Echelon Inventory Systems with Emergency Shipments	Said Dabia, El-Ghazali Talbi, Tom Van Woensel, Ton de Kok
361	2011	Approximating Multi-Objective Time-Dependent Optimization Problems	Said Dabia, Stefan Röpke, Tom Van Woensel, Ton de Kok
360	2011	Branch and Cut and Price for the Time Dependent Vehicle Routing Problem with Time Window	A.G. Karaarslan, G.P. Kiesmüller, A.G. de Kok
359	2011	Analysis of an Assemble-to-Order System with Different Review Periods	Ahmad Al Hanbali, Matthieu van der Heijden
358	2011	Interval Availability Analysis of a Two-Echelon, Multi-Item System	Felipe Caro, Charles J. Corbett, Tarkan Tan, Rob Zuidwijk
357	2011	Carbon-Optimal and Carbon-Neutral Supply Chains	Sameh Haneyah, Henk Zijm, Marco Schutten, Peter Schuur
356	2011	Generic Planning and Control of Automated Material Handling Systems: Practical Requirements Versus Existing Theory	M. van der Heijden, B. Iskandar
355	2011	Last time buy decisions for products sold under warranty	Frank P. van den Heuvel, Peter W. de Langen, Karel H. van Donselaar, Jan C. Fransoo
354	2011	Spatial concentration and location dynamics in logistics: the case of a Dutch provence	Frank P. van den Heuvel, Peter W. de Langen, Karel H. van Donselaar, Jan C. Fransoo
353	2011	Identification of Employment Concentration Areas	Pieter van Gorp, Remco Dijkman
352	2011	BOMN 2.0 Execution Semantics Formalized as Graph Rewrite Rules: extended version	Frank Karsten, Marco Slikker, Geert-Jan van Houtum
351	2011	Resource pooling and cost allocation among independent service providers	E. Lüftenegger, S. Angelov, P. Grefen

350	2011	A Framework for Business Innovation Directions	Remco Dijkman, Irene Vanderfeesten, Hajo A. Reijers
349	2011	The Road to a Business Process Architecture: An Overview of Approaches and their Use	K.M.R. Hoen, T. Tan, J.C. Fransoo G.J. van Houtum
348	2011	Effect of carbon emission regulations on transport mode selection under stochastic demand	Murat Firat, Cor Hurkens
347	2011	An improved MIP-based combinatorial approach for a multi-skill workforce scheduling problem	R.J.I. Basten, M.C. van der Heijden, J.M.J. Schutten
346	2011	An approximate approach for the joint problem of level of repair analysis and spare parts stocking	R.J.I. Basten, M.C. van der Heijden, J.M.J. Schutten
345	2011	Joint optimization of level of repair analysis and spare parts stocks	Ton G. de Kok
344	2011	Inventory control with manufacturing lead time flexibility	Frank Karsten, Marco Slikker, Geert-Jan van Houtum
343	2011	Analysis of resource pooling games via a new extenstion of the Erlang loss function	Murat Firat, C.A.J. Hurkens, Gerhard J. Woeginger
342	2011	Vehicle refueling with limited resources	Bilge Atasoy, Refik Güllü, TarkanTan
341	2011	Optimal Inventory Policies with Non-stationary Supply Disruptions and Advance Supply Information	Kurtulus Baris Öner, Alan Scheller-Wolf Geert-Jan van Houtum
339	2010	Redundancy Optimization for Critical Components in High-Availability Capital Goods	Joachim Arts, Gudrun Kiesmüller
338	2010	Analysis of a two-echelon inventory system with two supply modes	Murat Firat, Gerhard J. Woeginger
335	2010	Analysis of the dial-a-ride problem of Hunsaker and Savelsbergh	Murat Firat, Cor Hurkens
334	2010	Attaining stability in multi-skill workforce scheduling	A.J.M.M. Weijters, J.T.S. Ribeiro
333	2010	Flexible Heuristics Miner (FHM)	P.T. Vanberkel, R.J. Boucherie, E.W. Hans, J.L. Hurink, W.A.M. van Lent, W.H. van Harten
332	2010	An exact approach for relating recovering	

		surgical patient workload to the master surgical schedule	Peter T. Vanberkel, Richard J. Boucherie, Erwin W. Hans, Johann L. Hurink, Nelly Litvak
331	2010	Efficiency evaluation for pooling resources in health care	M.M. Jansen, A.G. de Kok, I.J.B.F. Adan
330	2010	The Effect of Workload Constraints in Mathematical Programming Models for Production Planning	Christian Howard, Ingrid Reijnen, Johan Marklund, Tarkan Tan
329	2010	Using pipeline information in a multi-echelon spare parts inventory system	H.G.H. Tiemessen, G.J. van Houtum
328	2010	Reducing costs of repairable spare parts supply systems via dynamic scheduling	F.P. van den Heuvel, P.W. de Langen, K.H. van Donselaar, J.C. Fransoo
327	2010	Identification of Employment Concentration and Specialization Areas: Theory and Application	Murat Firat, Cor Hurkens
326	2010	A combinatorial approach to multi-skill workforce scheduling	Murat Firat, Cor Hurkens, Alexandre Laugier
325	2010	Stability in multi-skill workforce scheduling	M.A. Driessen, J.J. Arts, G.J. v. Houtum, W.D. Rustenburg, B. Huisman
324	2010	Maintenance spare parts planning and control: A framework for control and agenda for future research	R.J.I. Basten, G.J. van Houtum
323	2010	Near-optimal heuristics to set base stock levels in a two-echelon distribution network	M.C. van der Heijden, E.M. Alvarez, J.M.J. Schutten
322	2010	Inventory reduction in spare part networks by selective throughput time reduction	E.M. Alvarez, M.C. van der Heijden, W.H. Zijm
321	2010	The selective use of emergency shipments for service-contract differentiation	B. Walrave, K. v. Oorschot, A.G.L. Romme
320	2010	Heuristics for Multi-Item Two-Echelon Spare Parts Inventory Control Problem with Batch Ordering in the Central Warehouse	Nico Dellaert, Jully Jeunet.
319	2010	Preventing or escaping the suppression mechanism: intervention conditions	R. Seguel, R. Eshuis, P. Grefen.

318	2010	Hospital admission planning to optimize major resources utilization under uncertainty	Tom Van Woensel, Marshall L. Fisher, Jan C. Fransoo.
317	2010	Minimal Protocol Adaptors for Interacting Services	Lydie P.M. Smets, Geert-Jan van Houtum, Fred Langerak.
316	2010	Teaching Retail Operations in Business and Engineering Schools	Pieter van Gorp, Rik Eshuis.
315	2010	Design for Availability: Creating Value for Manufacturers and Customers	Bob Walrave, Kim E. van Oorschot, A. Georges L. Romme
314	2010	Transforming Process Models: executable rewrite rules versus a formalized Java program	S. Dabia, T. van Woensel, A.G. de Kok
313	2010	Getting trapped in the suppression of exploration: A simulation model	
	2010	A Dynamic Programming Approach to Multi-Objective Time-Dependent Capacitated Single Vehicle Routing Problems with Time Windows	
312	2010	Tales of a So(u)rcerer: Optimal Sourcing Decisions Under Alternative Capacitated Suppliers and General Cost Structures	Osman Alp, Tarkan Tan
311	2010	In-store replenishment procedures for perishable inventory in a retail environment with handling costs and storage constraints	R.A.C.M. Broekmeulen, C.H.M. Bakx
310	2010	The state of the art of innovation-driven business models in the financial services industry	E. Lüftenegger, S. Angelov, E. van der Linden, P. Grefen
309	2010	Design of Complex Architectures Using a Three Dimension Approach: the CrossWork Case	R. Seguel, P. Grefen, R. Eshuis
308	2010	Effect of carbon emission regulations on transport mode selection in supply chains	K.M.R. Hoen, T. Tan, J.C. Fransoo, G.J. van Houtum
307	2010	Interaction between intelligent agent strategies for real-time transportation planning	Martijn Mes, Matthieu van der Heijden, Peter Schuur
306	2010	Internal Slackening Scoring Methods	Marco Slikker, Peter Borm, René van den Brink
305	2010	Vehicle Routing with Traffic Congestion and Drivers' Driving and Working Rules	A.L. Kok, E.W. Hans, J.M.J. Schutten, W.H.M. Zijm
304	2010	Practical extensions to the level of repair analysis	R.J.I. Basten, M.C. van der Heijden, J.M.J. Schutten
303	2010	Ocean Container Transport: An Underestimated and Critical Link in Global Supply Chain Performance	Jan C. Fransoo, Chung-Yee Lee
302	2010	Capacity reservation and utilization for a manufacturer with uncertain capacity and demand	Y. Boulaksil; J.C. Fransoo; T. Tan

300	2009	Spare parts inventory pooling games	F.J.P. Karsten; M. Slikker; G.J. van Houtum
299	2009	Capacity flexibility allocation in an outsourced supply chain with reservation	Y. Boulaksil, M. Grunow, J.C. Fransoo
298	2010	An optimal approach for the joint problem of level of repair analysis and spare parts stocking	R.J.I. Basten, M.C. van der Heijden, J.M.J. Schutten
297	2009	Responding to the Lehman Wave: Sales Forecasting and Supply Management during the Credit Crisis	Robert Peels, Maximiliano Udenio, Jan C. Fransoo, Marcel Wolfs, Tom Hendrikx
296	2009	An exact approach for relating recovering surgical patient workload to the master surgical schedule	Peter T. Vanberkel, Richard J. Boucherie, Erwin W. Hans, Johann L. Hurink, Wineke A.M. van Lent, Wim H. van Harten
295	2009	An iterative method for the simultaneous optimization of repair decisions and spare parts stocks	R.J.I. Basten, M.C. van der Heijden, J.M.J. Schutten
294	2009	Fujaba hits the Wall(-e)	Pieter van Gorp, Ruben Jubeh, Bernhard Grusie, Anne Keller
293	2009	Implementation of a Healthcare Process in Four Different Workflow Systems	R.S. Mans, W.M.P. van der Aalst, N.C. Russell, P.J.M. Bakker
292	2009	Business Process Model Repositories - Framework and Survey	Zhiqiang Yan, Remco Dijkman, Paul Grefen
291	2009	Efficient Optimization of the Dual-Index Policy Using Markov Chains	Joachim Arts, Marcel van Vuuren, Gudrun Kiesmuller
290	2009	Hierarchical Knowledge-Gradient for Sequential Sampling	Martijn R.K. Mes; Warren B. Powell; Peter I. Frazier
289	2009	Analyzing combined vehicle routing and break scheduling from a distributed decision making perspective	C.M. Meyer; A.L. Kok; H. Kopfer; J.M.J. Schutten
288	2009	Anticipation of lead time performance in Supply Chain Operations Planning	Michiel Jansen; Ton G. de Kok; Jan C. Fransoo
287	2009	Inventory Models with Lateral Transshipments: A Review	Colin Paterson; Gudrun Kiesmuller; Ruud Teunter; Kevin Glazebrook
286	2009	Efficiency evaluation for pooling resources in health care	P.T. Vanberkel; R.J. Boucherie; E.W. Hans; J.L. Hurink; N. Litvak
285	2009	A Survey of Health Care Models that Encompass Multiple Departments	P.T. Vanberkel; R.J. Boucherie; E.W. Hans; J.L. Hurink; N. Litvak
284	2009	Supporting Process Control in Business Collaborations	S. Angelov; K. Vidyasankar; J. Vonk; P. Grefen
283	2009	Inventory Control with Partial Batch Ordering	O. Alp; W.T. Huh; T. Tan
282	2009	Translating Safe Petri Nets to Statecharts in a Structure-Preserving Way	R. Eshuis
281	2009	The link between product data model and process model	J.J.C.L. Vogelaar; H.A. Reijers
280	2009	Inventory planning for spare parts networks with	I.C. Reijnen; T. Tan; G.J. van Houtum

		delivery time requirements	
279	2009	Co-Evolution of Demand and Supply under Competition	B. Vermeulen; A.G. de Kok
278	2010	Toward Meso-level Product-Market Network Indices for Strategic Product Selection and (Re)Design Guidelines over the Product Life-Cycle	B. Vermeulen, A.G. de Kok
277	2009	An Efficient Method to Construct Minimal Protocol Adaptors	R. Seguel, R. Eshuis, P. Grefen
276	2009	Coordinating Supply Chains: a Bilevel Programming Approach	Ton G. de Kok, Gabriella Muratore
275	2009	Inventory redistribution for fashion products under demand parameter update	G.P. Kiesmuller, S. Minner
274	2009	Comparing Markov chains: Combining aggregation and precedence relations applied to sets of states	A. Busic, I.M.H. Vliegen, A. Scheller-Wolf
273	2009	Separate tools or tool kits: an exploratory study of engineers' preferences	I.M.H. Vliegen, P.A.M. Kleingeld, G.J. van Houtum
272	2009	An Exact Solution Procedure for Multi-Item Two-Echelon Spare Parts Inventory Control Problem with Batch Ordering	Engin Topan, Z. Pelin Bayindir, Tarkan Tan
271	2009	Distributed Decision Making in Combined Vehicle Routing and Break Scheduling	C.M. Meyer, H. Kopfer, A.L. Kok, M. Schutten
270	2009	Dynamic Programming Algorithm for the Vehicle Routing Problem with Time Windows and EC Social Legislation	A.L. Kok, C.M. Meyer, H. Kopfer, J.M.J. Schutten
269	2009	Similarity of Business Process Models: Metics and Evaluation	Remco Dijkman, Marlon Dumas, Boudewijn van Dongen, Reina Kaarik, Jan Mendling
267	2009	Vehicle routing under time-dependent travel times: the impact of congestion avoidance	A.L. Kok, E.W. Hans, J.M.J. Schutten
266	2009	Restricted dynamic programming: a flexible framework for solving realistic VRPs	J. Gromicho; J.J. van Hoorn; A.L. Kok; J.M.J. Schutten;

Working Papers published before 2009 see: http://beta.ieis.tue.nl