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### ICT Applications for a Global Freight Transport System

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The general framework concerns embedding ICT into the physical process of distribution. Incidentally, information bottlenecks tend to correspond to transportation bottlenecks, ports being the most relevant example for freight. A port region is composed of thousands of players in interaction ranging from port authorities, terminal operators, maritime shipping companies, freight forwarders, trucking companies etc. Their transactions generate large quantities of information and since these transactions take place within a regional cluster, there is a propensity to better interconnect the regional transactional system and consequently improve the efficiency of the bottleneck. In many cases, more benefits can be realized through better synchronization of existing transport and distribution assets than through additional infrastructure.

On a positive side, several issues have converged in recent years to favor the diffusion of ICT in freight transportation:

- **Lower ICT equipment costs.** The cost of hardware and software has been reduced significantly, while performance has been improved. This has considerably favored the diffusion of ICT, even among more marginal elements of the system. ICT hardware and software can thus be implemented at a lower cost.
- **Ubiquity of telecommunication infrastructure.** With WIFI networks and broadband it is possible to access information systems from almost every location. This is prone to the management of mobile transport modes and innovative uses of ICT, such as flexible scheduling.
- **Standardization.** From standard components, operating systems, telecom protocols, programming languages and file formats, large economies of scale are possible and interoperability is improved. This also permits significant customization in adapting ICT for specific uses.

All this put together implies lower operational costs while managing an increasing level of complexity taking place at three scales of application:

- **Strategic.** Monitor and assess trade flows and macroeconomic trends that have an impact on growth prospects and the business environment. The general issue concerns the assignment of investments so that future growth expectations (or decline) are met. ICT are mostly static, enabling the collection of relevant data to assist decision making.
- **Tactical.** Concerns activities related to supply chain management, namely purchase and orders processing, production planning and inventory management. ICT are tools helping assign production and distribution capacity as well as assessing the general costs of these functions.
- **Operational.** Insures the efficiency and reliability of the transport process, which includes routing and scheduling along intermodal transport chains. Operational consideration are likely to be those benefiting the most from ICT.

However, three forces among others shape the diffusion and application of ICT over freight transport systems:

- **Path dependency.** Transport systems are the outcome of substantial capital accumulation that takes place over decades and that shapes operations and additional investments. There are sunk costs within freight transport systems that future innovation cannot effectively bypass. Infrastructures have been built, modes selected and specific locations have been reinforced through the development of intermodalism. More than any other transport technology in history, containerization has geared global freight distribution in a path dependency that undermines future paradigm shifts towards new forms of distribution, but which is still significantly prone to incremental improvements.
- **Asymmetry.** Different actors have different level of access to information, which results in unequal power relations. A common pattern is that large transport firms have more information and the capacity to use it than small firms, for the simple reason that they operate a larger network and are thus able to better understand and shape the systems they are operating in. Asymmetry is also a competitive advantage as firms will not reveal comprehensive information about their general costs and operational characteristics (e.g. capacity, scheduling) to their customers and competitors. Competitiveness tends to alleviate asymmetry since competing firms will reveal more information about their services to capture and retain customers. Still, firms are reluctant to reveal their market intelligence and operational knowledge, which are essentially their business model. This is particularly the case for their deficiencies (such as spare capacity) which would enable customers and competitors to gain a temporary advantage. While there is always a price discovery mechanism at play influenced by market forces, several freight transportation systems operate in an oligopolistic environment, particularly the international segment, so a level of obfuscation is implicitly part of business strategies. Even with ICT, asymmetry is likely to endure in global freight transport systems.
- **Internalization.** Concerns an ICT strategy established by a firm to help take control of its management and decision making processes. Information within the firm can thus be more efficiently collected, organized and used. Thus, internalization appears to be a prevalent strategy of ICT development which operates within the boundaries of the firm, but several channels / conduits can be established with partners and customers to insure proper

interactions. This can reinforce asymmetry as the more internalized and ICT system is, the less likely the involved firm will share the information and the associated business practices.

There is a particular belief that ICT can help break these forces, particularly asymmetry, but it is more likely that ICT will reinforce them. Thus, the outcome will not necessarily be an harmonization of ICT systems since asymmetry and internalization of powerful forces embedded into business models, but a convergence towards better interoperability. The latter opens opportunities to establish specific information exchange schemes where the concerned players see mutual benefits; where cooperation provides more returns than competition. Port community systems appear to be such an endeavor where cooperation leads to efficiency improvements since the maritime / land interface and its intermodalism are complementary.

One of the most significant impacts of ICT on freight transport systems concern multiplying effects related to a better utilization of existing assets. This implies that the same asset base can provide additional capacity and reliability, therefore improving its amortization. The outcome is an improvement of the "velocity of freight" without an improvement in modal velocity. Supply chain management is therefore improved, leading to economic benefits for producers and consumers. Three particular dimensions deserve consideration:

- **Freight terminals and ICT.** For containerized freight distribution the terminal is a fundamental element in the intermodal chain. There are several issues that undermine the efficiency of intermodal terminals, which ICT could help alleviate. One concerns the interface between the mode (containership, unit train) and the stacking yard of the terminal. This is particularly an issue about port terminals that have felt the pressures of the economies of scale in maritime shipping, implying that a large quantity of containers have to be handled in a short amount of time so that containerships can maintain their schedule integrity. As import containers are unloaded from a vessel, they are stacked in import blocks designated by the yard planner. Unlike export containers that are segregated by vessel, destination, size, and weight, import containers are stacked in the order they arrive to the yard block. Such strategy facilitates unloading operations and reduces vessel turn-around time, which is the main priority of the terminal operator. Over time, newer import containers are stacked on top of older ones, particularly if a terminal receives several ship calls over a short period of time. Hence, the longer an import container has been in storage, the more likely it is to be at the bottom of a stack and the more likely it is to be the next container to be picked up. When a drayage truck arrives to the yard block to pick up a container that is buried at the bottom, additional moves, called "rehandles", are needed to retrieve the desired container. Another issue concerns the interface between the terminal and the regional transportation system, notably gate access. Tight supply chain management and security concerns are placing pressures to quickly and reliably process container pick-ups and deliveries. This can involve appointment systems and automated storage and retrieval systems that are ICT intensive.
- **Terminalization.** A growing quantity of containerized cargo finds itself in transit because of global supply chains and the extended transport distance they involve. Consequently, supply

chain management is increasingly considering terminals as buffers to be used as part of their inventory management. Such a practice is made possible by ICT, enabling to consider a container at a nearby terminal as available inventory. This helps mitigate warehousing costs, but places pressures on terminal operations.

- **“Intelligent” containers.** A likely evolution of ICT will concern to container itself, able to provide real-time (or at frequent intervals) information about its status. This involves GPS and RFID technologies, enabling to know position but also sensor reports assessing cargo temperature (for temperature sensitive goods; cold chain), chocks (for fragile cargo) and cargo integrity (if there was an unauthorized opening of the container). In addition to improve supply chain management, security issues can more comprehensively been dealt with as well as insurance claims if the cargo was lost, stolen or damaged.