# THE PORT-TRANSSHIPMENT SYSTEM DYNAMICS SOFTWARE SIMULATOR

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**Abstract.** Port is place of interlace of different kindle of cargo, and play important role in shipping process, connecting different type of traffic in one united system, and form interrupted traffic chain.
The aim of this paper is: to show the efficiency of System Dynamics Simulation Modeling during the study of the dynamics behavior of the Port-Transshipment system, and to find optimal solution for transshipment with regard to type of the cargo and size of traffic of the cargo, direction and dynamics of arriving and shipping the cargo. The System Dynamics Modeling is in essence special, i.e. "holistic" approach to the simulation of the dynamics behavior of natural, technical and organization systems, and it contains quantitative and qualitative Simulation Modeling of various natured realities. The concept of optimization in System Dynamics is based on belief that the "manual and iterative" procedure, i.e. optimization by the method "retry and error" can be successfully executed using "heuristic optimization" algorithm, with the help of digital computer, and in complete coordination with System Dynamics Simulation Methodology.

## 1. Introduction

The System Dynamics Modelling is in essence special, i.e. "holistic" approach to the simulation of the dynamics behaviour of natural, technical and organization systems. Systems dynamic comprise qualitative and quantitative simulation modelling, and the concept of optimization of dynamic systems and processes is based on so call "heuristic" procedure. Meaning that on the method of manual and iterative procedure, which is automatized with the help of fast digital computer, named "heuristic optimization" (retry and error!). This simulation model is only one from the large number of made and educationally and practically used simulation models for education and training of young students – mariner, wch use so call "white box" philosophy of investigation of complex systems, as distinguished from "black box" approach.

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## 2. System Dynamics modeling of the Port-transhipment

**Mental-verbal model:**

Fundamentally, unloading of any kind of cargo can be divided in:
- ship arrival to the berthing position,
- unloading the cargo from the ship to the shore,
- transport of the cargo from the shore to the wagons, trucks and warehouses.

Unloading/loading of the cargo in port is complex dynamics process with two subsystems:
- Unloading/loading of the cargo in port (BUTUL),
- Surrounding environment (OS).

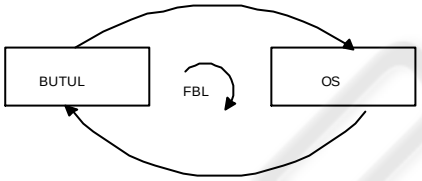


*Figure 1. Rudimentary structural model of the Port-Transshipment System*

**Subsystem BUTUL** have at least four sector i.e. subsections:
1. State of occupation of the berth,
2. Number of the cranes (on the ship and on the shore), which are objective at disposal,
3. Number of the fork-lift, which are objective at disposal,
4. Warehouses (number and the area that are at disposal).

**Subsystem OS** have at least four sector i.e. subsections:
1. Waiting ship (on the berth or in arrival),
2. Engaged wagons capacities,
3. Engaged trucks capacities,
4. Consignee (receiver) of the cargo.

## 3. Simulation results

This scenario includes putting to shore and unload of the ship on the berth, transshipment of the cargo on the wagons with subsection of logical management built in it, transshipment of the cargo on trucks also with subsection of logical management, an at the end transshipment of the cargo to the warehouse.

In this paper, cause of its largeness, we will present only zero scenarios with initial conditions:

- ship is on the berth 1,
- unloading of the ship have been started in time T=0,
- Transshipment of the cargo with cranes, and the number of cranes are D1= 2+STEP(2,47)-STEP(2,119), i.e. the capacities of the cranes are 50*D1
- Transshipment of the cargo on the fork-lift, and the number of fork-lift are V1= 2+STEP(2,47)-STEP(2,119), i.e. the capacities of the cranes are 50*V1
- Transshipment of the cargo with fork-lift from the berth to the gate and transshipment on the wagons, and the number of wagons are W1= 56+STEP(40,71)-STEP(40,119)
- transport of the cargo on the trucks, and the number of trucks are K1= 20+STEP(10,47)-STEP(10,95) ,
- transport of the cargo in the warehouse, and capacities of the warehouse are 54000.

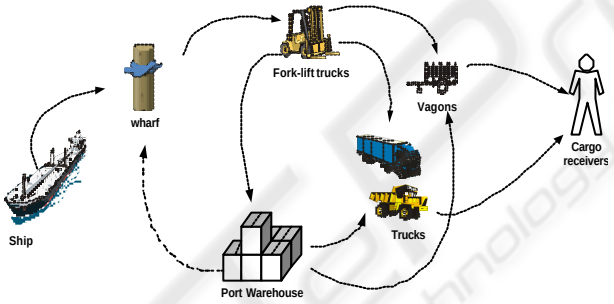


*Figure 2. Structural model of material flow of the cargo*

Graphic results of simulation:

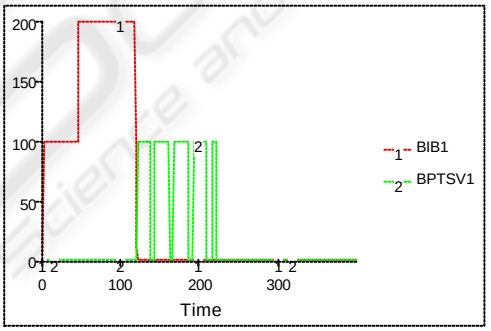


*Figure 3. Speed of unloading the ship-BIB1, Speed of shipping of the cargo to the warehouse-BPTSV1*

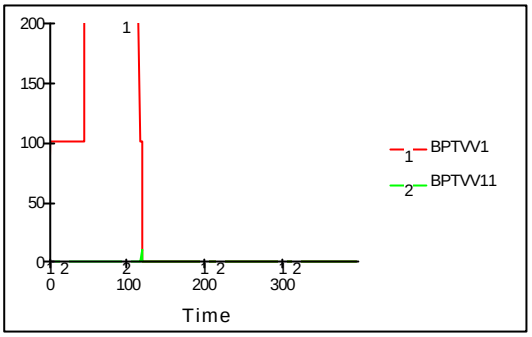


*Figure 4. Speed of shipping of the cargo with fork-lift from the berth1 to the platforms for loading on the wagons, trucks or warehouse-BPTVV1, Speed of shipping of the cargo with fork-lift from the berth 1 in the case that SITV1 is multiple of the number of the fork-lift-BPTVV1*

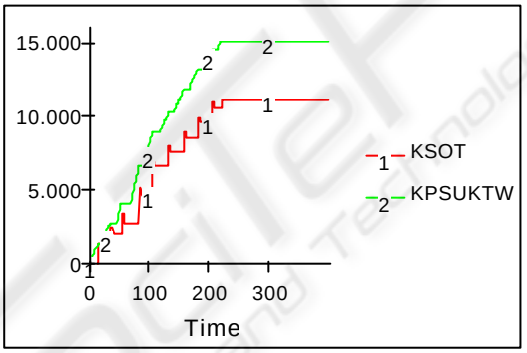


*Figure 5. Cumulative display of the state of the loaded cargo on the wagons-KPSUKTW, Cumulative book-keeping state of the shipped cargo-KSOT*

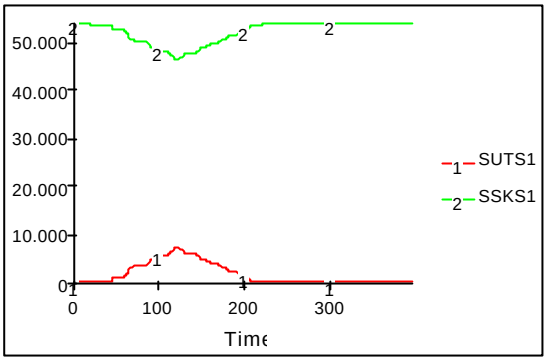


*Figure 6. State of available warehouse capacities-SSKS1, State of the loaded cargo to the warehouse-SUTS1*

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