

IPIC 2018



5<sup>th</sup> International Physical Internet Conference



# Physical Internet Enabled Bulky Goods Urban Delivery System

A Case Study In Customized Furniture Industry

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01

# Research Background

Bulky Goods Delivery



# Bulky Goods in Urban Logistics

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Fitness Equipment



Musical Instruments



Household Appliances



Furniture



## UPS weighs strategy to deliver bulky goods to boost growth

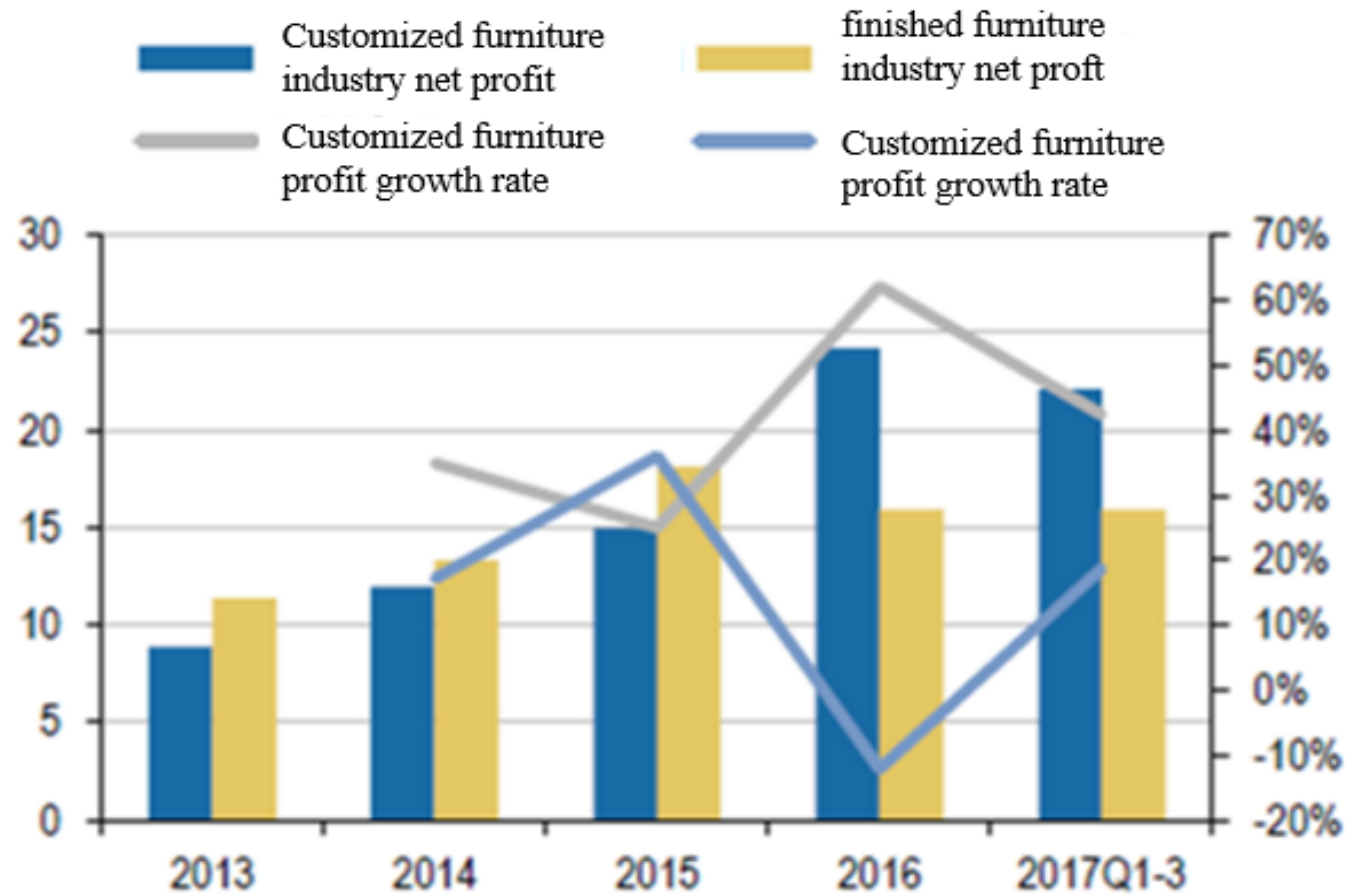
UPS and its rival FedEx Corp (FDX.N) currently deliver parcels up to 150 pounds (68.04 kg) in weight to a person's door step, and neither carries packages into a person's home or handles so-called "white glove" services such as product assembly or installation.



United Parcel Service Inc (UPS.N) is in talks with at least one U.S. trucking firm to launch an in-home delivery service for large, heavy goods such as couches and treadmills, as the world's largest package deliverer looks to cash in on one the fastest growing segments of online retail.

UPS told Reuters it is now eyeing the furniture delivery business - one of the fastest-growing segments of online retail - with Amazon.com Inc (AMZN.O), Wayfair Inc (W.N) and other e-commerce companies competing for market share against chains like Crate and Barrel and big-box stores.

# Booming of Customized Furniture



Furniture is one of the typical products in bulky goods delivery. With the upgrading of consumption structure and the O2O commercial technology, customers are not satisfied with a standardized product. They are willing to participate in the design and manufacturing process. Furniture customization industry is growing as more and more promising one.

*Comparing the accumulated net profit (100 million RMB) and growth rate of customized and finished furniture in China*

*Source: <http://www.chyxx.com>*

02

## Business Challenges

Characteristic and Pain Points in Customized Furniture Delivery



# SPZP-Customized Furniture in China

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- Funded in 2004
- 800+ Chain stores in Beijing, Shanghai, Guangzhou, Wuhan
- 2017 total revenue 5.3 Billion (RMB)  
rise by 32.23 % over the same period of 2016
- 100+ Whole House Furniture Customization orders per Day
- Largest Furniture Database + House layout Database + House Design Database





# SPZP-O2O Customization

## STEP 1

### Online Reservation

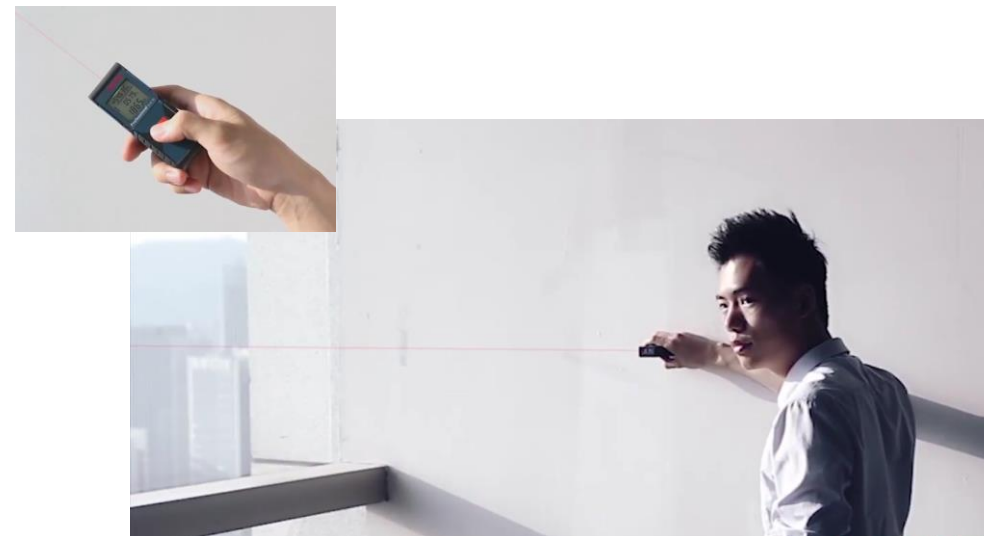
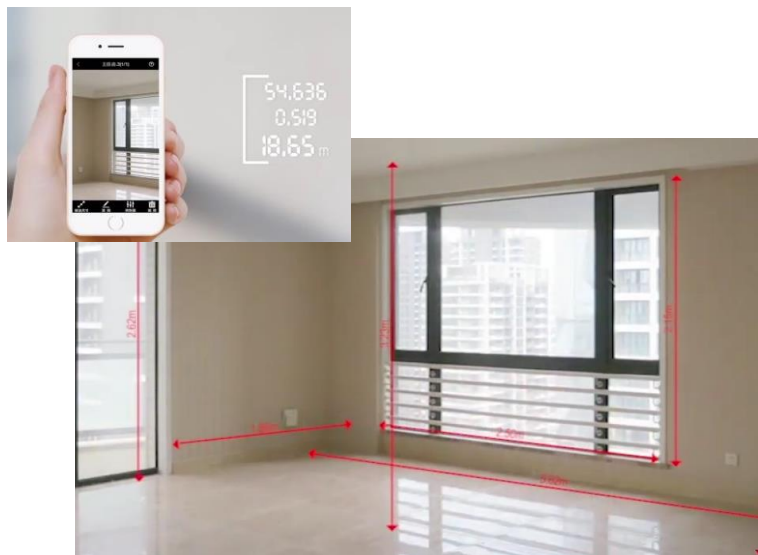


Reservation by Website, Smart Phone, Phone Call

**FREE**

## STEP 2

### Offline Room Measurement



Professional Quantity Surveyor onsite Measurement

**FREE**

# SPZP-O2O Customization

## STEP 3

### Online Design



1000+ Professional Cloud based Online Designer **FREE**

## STEP 4

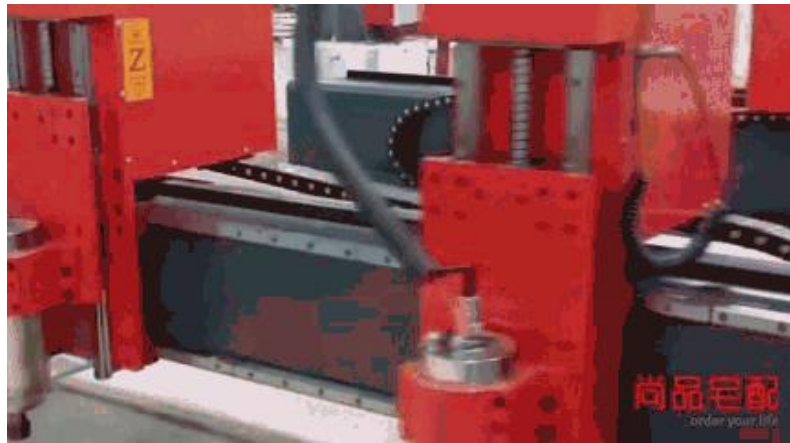
### Offline Experience



Review the Rendering in Offline Store. **Pay**

# STEP 5

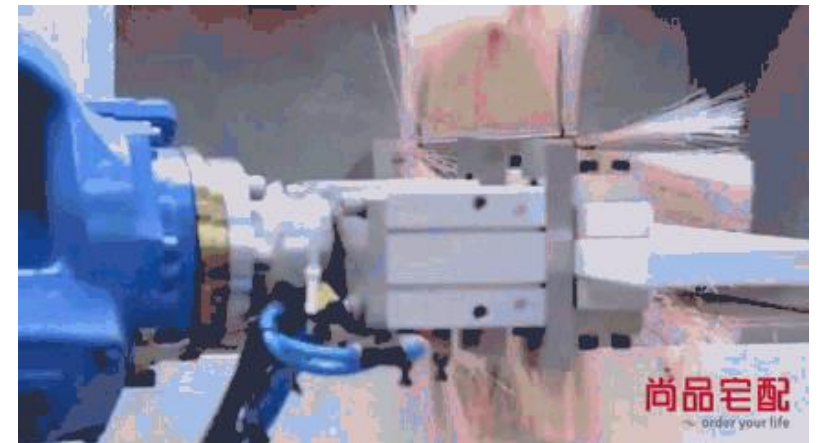
Manufacturing in Smart Factory



Cutting Robot

300,000 Pieces/Day

Packing Robot



Drilling Robot

Flag of Industry 4.0 in China

Warehouse Robot



# SPZP-Furniture Delivery



Logistics Manager of SPZP: "If nothing changes, the logistics cost will exceed the Product Price"

# Characteristics of Customized Furniture Industry

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01

OPTION

## Various of Order Size

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Order size is quite different. Due to the different sizes of the customers' rooms, the quantity of products contained in each order is different.

02

OPTION

## Multiple Components

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Most of the product form is board-shape furniture components and a large number of metal accessories.

03

OPTION

## Unique piece

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All components are make-to-order produced, and the customized furniture produces only one single piece.

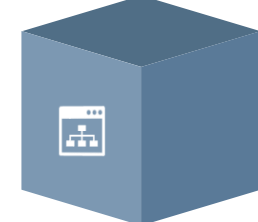
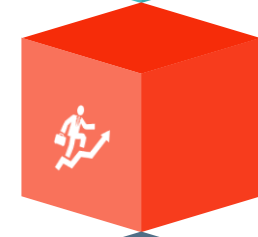
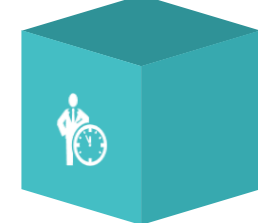
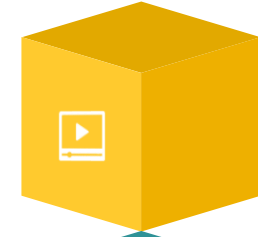
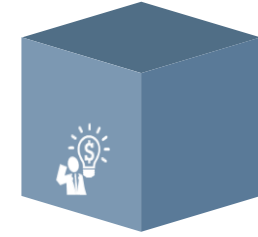
04

OPTION

## Punctual Delivery

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The delivery time is about 3 months after make order. Hard to predict the delivery time required by the customer when ordering.



# Pain Points of Customized Furniture Delivery

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## Heavy Workload of Material Handling

- 300+ pieces of components / order
- Unloading from the truck one by one
- Moving from unloading point to room
- Elevator may not available!!



## Unclear Responsibility for Operators

- Truck driver may need to do the material handling work.
- Truck driver may need to wait during the material handling.
- Material handling operator has to go with driver



## High Risk of Product Damage

- Many times loading and unloading work
- Components without any protection
- One piece damage, whole order delay
- Long time for remanufacturing



## Complicated Human and Vehicle Resource Planning

- Order consolidation Planning
- Truck loading planning
- Delivery route planning
- Operator assignment planning

03

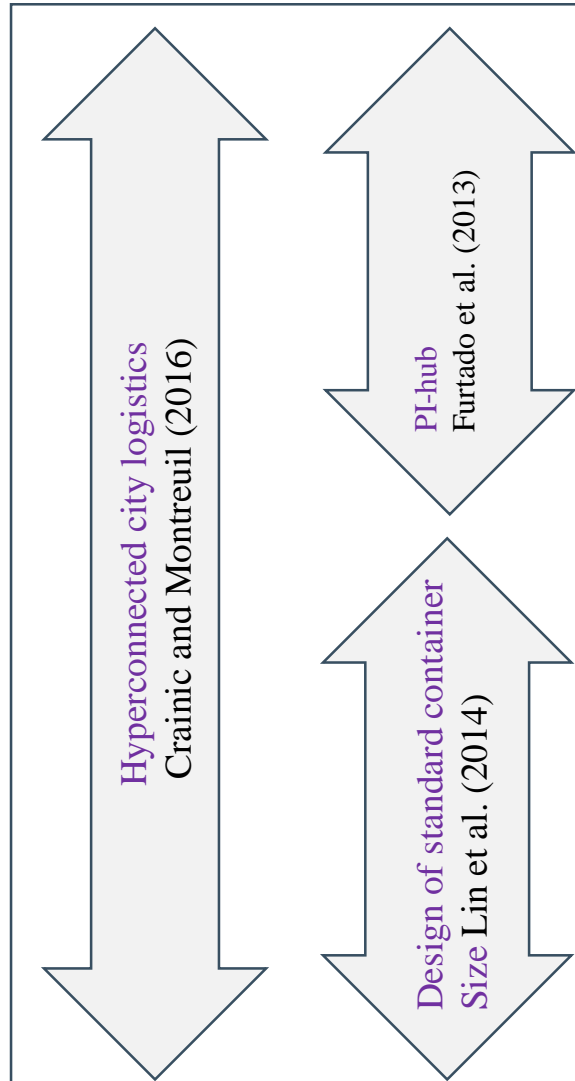
## Proposed Solution

Physical Internet Enabled Bulky Goods Delivery System



# Proposed Solution Framework

## Supporting PI Concepts

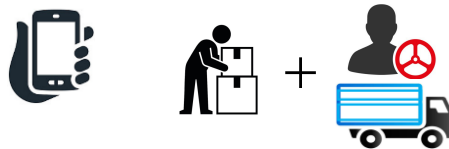


## PI enabled Bulky Goods Delivery System

### Real-time resource planning



### Mobil Task Execution



### PI Vehicle



### PI Container



## Supporting Methodologies

Collaboration mechanism for truck driver and material handling operator

Routing optimization and vehicle planning optimization

Mobil APP for truck driver

Mobil APP for material handling operator

Mechanical design for vehicle-mounted loading/unloading equipment

Mechanical design for container stabilization During transportation

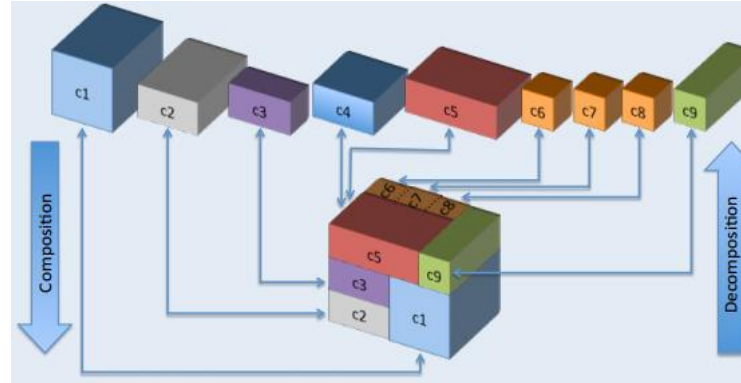
Data Analysis for Container Size Optimization

IoT and LBS enabled Lock/unlock control



# PI Container

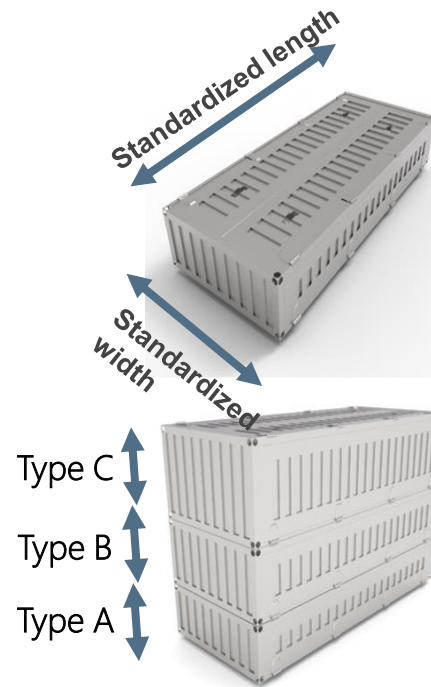
\* China Patent in Progress 2017.07.01



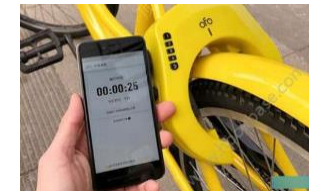
History Data of Order Size



Container Sizing Optimization



Universal wheel Design for on-site movement



**NB-IoT**

**GPS**

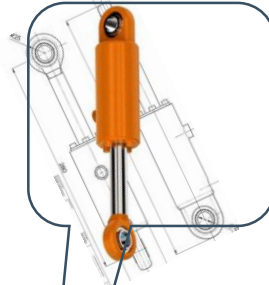
IoT Locker with LBS (location base service) And Mobile App Control

# PI Vehicle

\* China Patent in Progress 2017.07.01



Electric Motor      Hydromantic System



Vertical Movement

Horizontal Movement



Transpiration status



Loading/Unloading status



Unloading Finished

# Mobil Task Execution



| PANIC 2014 schedule        |                             |                            |                                   |                            |                            |
|----------------------------|-----------------------------|----------------------------|-----------------------------------|----------------------------|----------------------------|
| Sunday                     | Monday                      | Tuesday                    | Wednesday                         | Thursday                   | Friday                     |
| 24/09/14                   | 25/09/14                    | 26/09/14                   | 27/09/14                          | 28/09/14                   | 29/09/14                   |
| Registration 08:00 - 17:00 | Registration 08:00 - 17:00  | Registration 08:00 - 17:00 | Registration 08:00 - 17:00        | Registration 08:00 - 17:00 | Registration 08:00 - 17:00 |
| 9:00                       | Plenary 1 A                 | Plenary 2 A                | Plenary 3 A                       | Plenary 4 A                | Plenary 5 A                |
| 10:30                      | Coffee break                | Coffee break               | Coffee break                      | Coffee break               | Coffee break               |
| 11:00                      | Plenary 1 B                 | Plenary 2 B                | Plenary 3 B                       | Plenary 4 B                | Plenary 5 B                |
| 12:00                      | Lunch break                 | Lunch break                | Lunch break                       | Lunch break                | Lunch break                |
| 14:00                      | Parallel sessions           | Parallel sessions          | Parallel sessions                 | Parallel sessions          | Visit to DSIY and RIEL     |
| 16:00                      | Registration 15:00 - 18:00  | Coffee break               | Plenary session with coffee break | Conference Decisions       | Coffee break               |
| 16:30                      | Parallel sessions           | Parallel sessions          | Parallel sessions                 | Parallel sessions          |                            |
| 19:30                      | Hamburg Town Hall Reception |                            | 38:00 % Concert / Public lecture  | Conference Dinner          |                            |



Moving Task Location



Material Handling Operator App

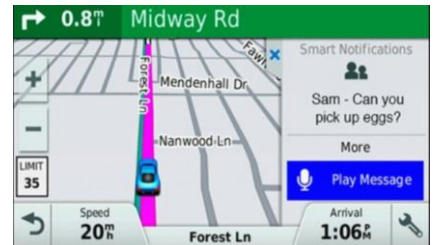


Truck Driver App

Delivery Time Table



Moving Task Assignment

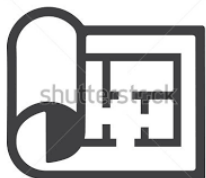


Delivery Task Navigation



NB-IoT

PI container Unlock



Assembly Instruction

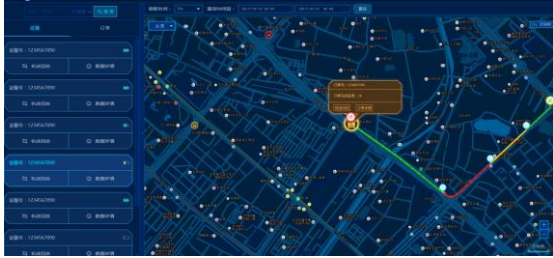


Material Handling Task Generation

# Real-Time Resource Planning



Real Time Delivery Task Tracing

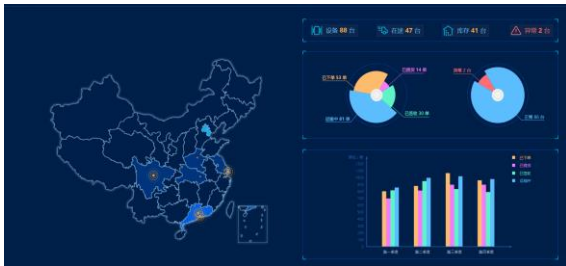
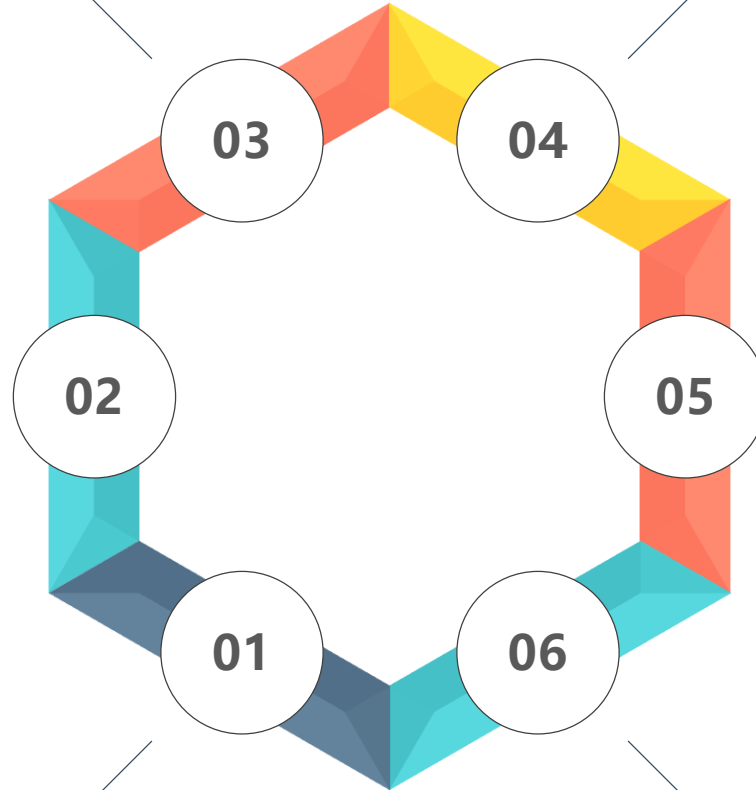


Real Time Material Handling Task Assignment



Real Time Delivery Task Assignment

Real Time Material Handling Task Tracking



Real Time Order Consolidation

Real Time Container Collection Task Assignment



04

## Feasibility Analysis

Process Feasibility and ROI Analysis



# Assumptions of Process Analysis

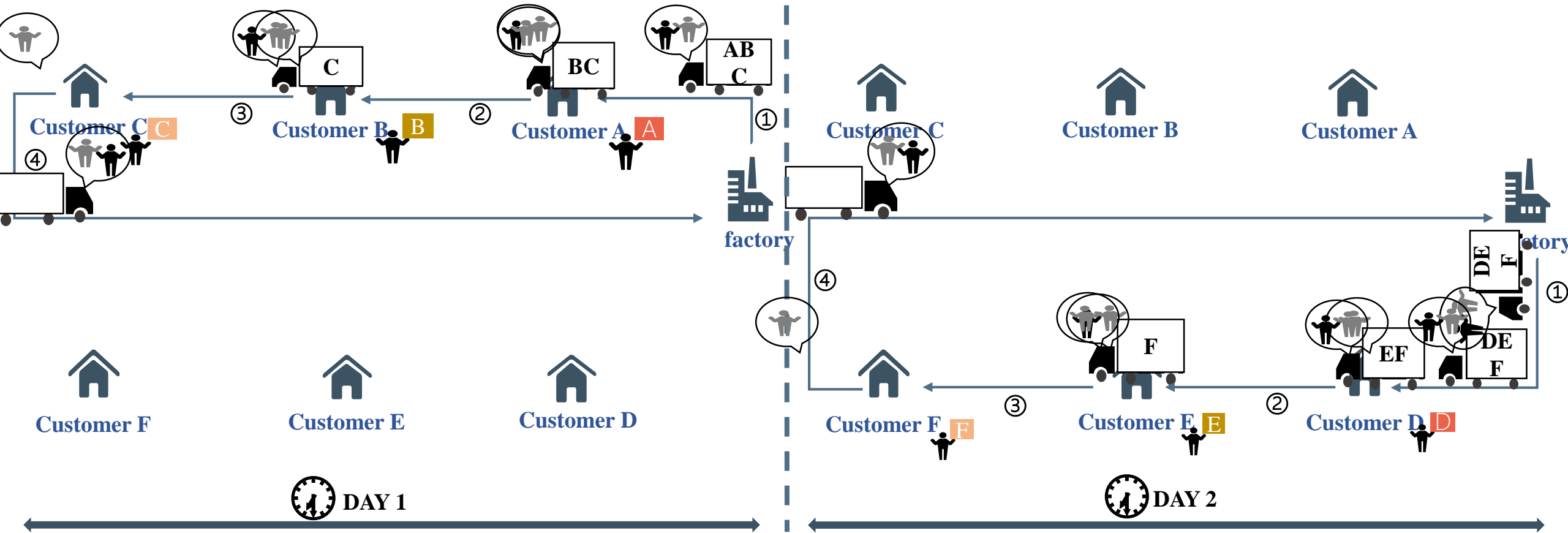
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- 6 delivery points: Customer A, B, C, D, E and F)
- 1 product warehouse in the factory.
- 1 truck can load at most 3 customer orders
- Delivery the orders one by one in a milk run route.
- The transportation time between each delivery point is about 1 hours.
- The unloading time and material moving time for 1 order is about 3 hours.

# Real-Time Resource Planning

## Traditional Delivery System



Legend:



empty container

PI enabled container



driver

material handling worker

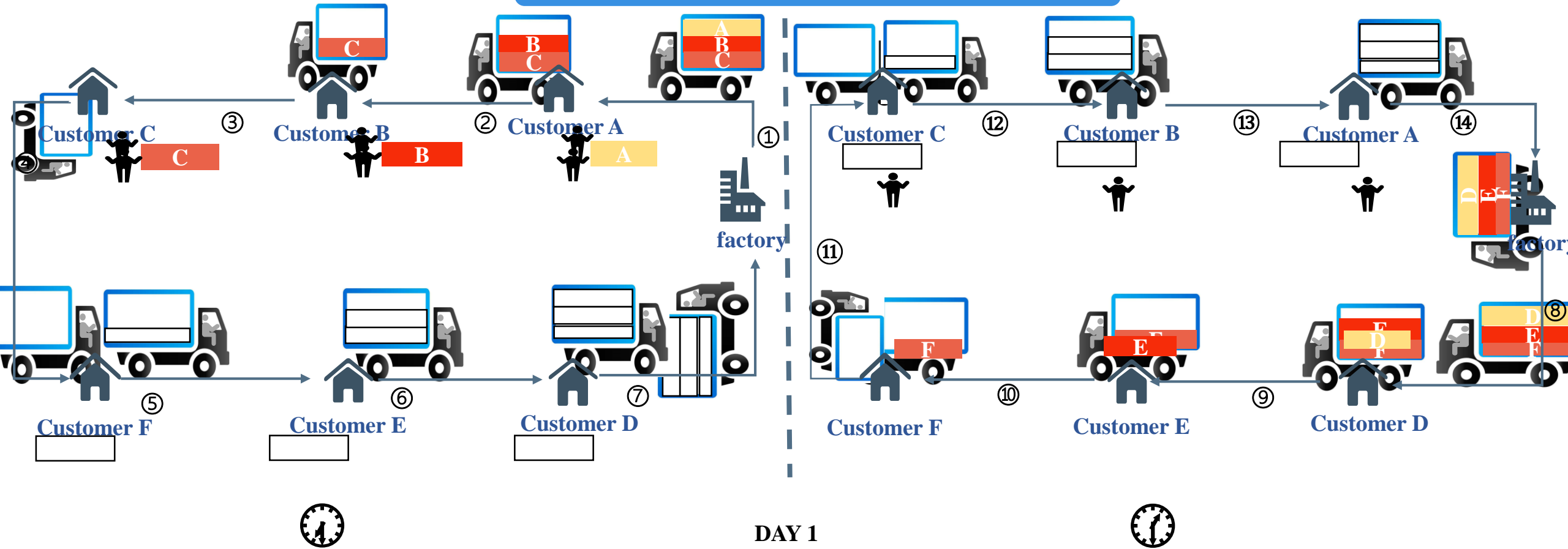


traditional Vehicle

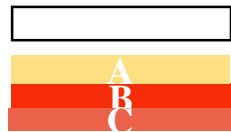
PI enabled Vehicle

# Real-Time Resource Planning

## PI enabled bulky goods delivery System



Legend:



empty container



PI enabled container



driver



material handling worker



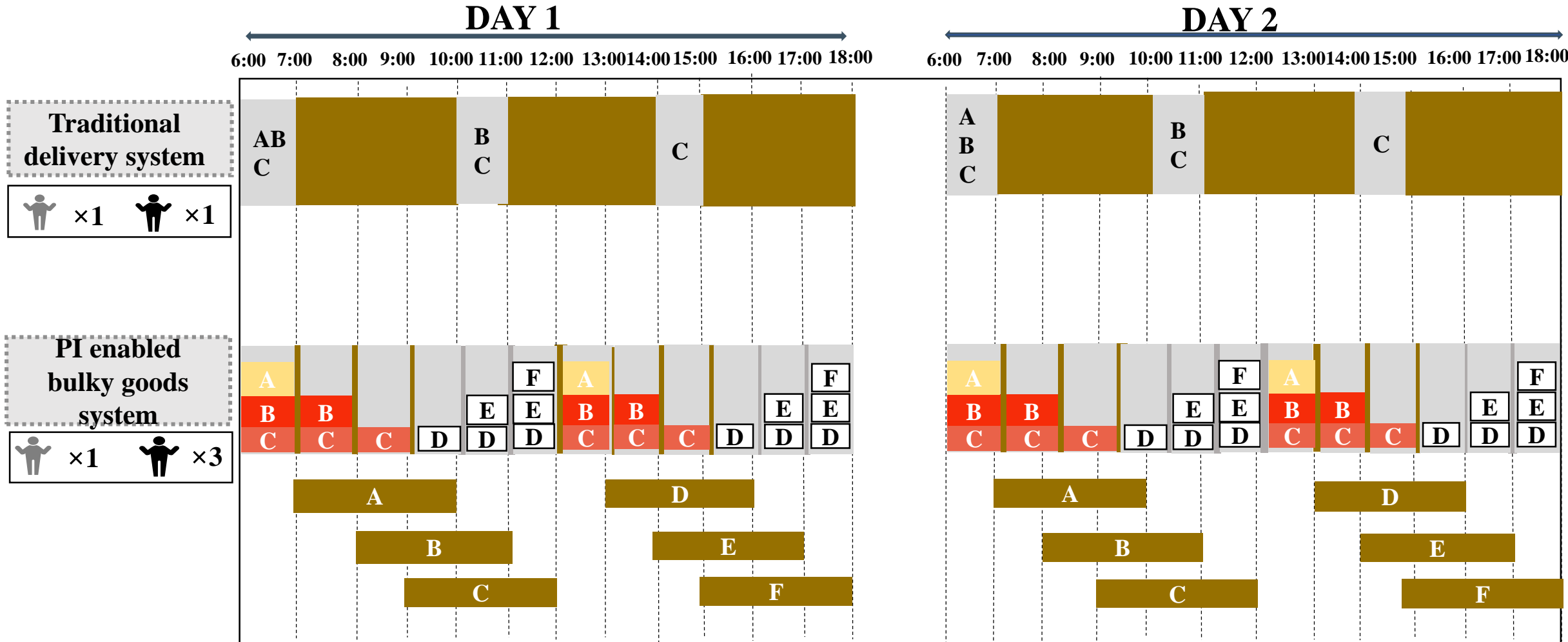
traditional Vehicle



PI enabled Vehicle



# Efficiency Comparison



## Legend:

- on the way
- unloading, handling upstairs
- driver
- material handling worker
- loading
- PI enabled container
- empty container

# Return on Investment Analysis

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Investment of PI Vehicle and PI Container

| <b>Equipment</b>                              | <b>Quantity</b> | <b>Unit Price(RMB)</b> | <b>Total Cost(RMB)</b> |
|---|-----------------|------------------------|------------------------|
| <i>Cost of PI enabled Vehicle Development</i> | <b>10</b>       | <b>100,000</b>         | <b>1,000,000</b>       |
| <i>Cost of PI enabled Container</i>           | <b>50</b>       | <b>5,000</b>           | <b>250,000</b>         |
| <b>Total</b>                                  |                 |                        | <b>1,250,000</b>       |

# Return on Investment Analysis

## Operation Cost and Profit Comparison

| Items   | Unit Price<br>(RMB) | Traditional Process<br>(3 delivery point/day) |                | PI-BGDS Process<br>(6 delivery point/day) |                  |
|---|---------------------|---|----------------|---|------------------|
|   |                     | Quantity                                      | Total<br>(RMB) | Quantity                                  | Total (RMB)      |
| <i>Income</i>   |                     |   |                |   |                  |
| Transportation Fee  | 300/Point           | 3   | 900            | 6   | 1800             |
| <i>Cost</i>   |                     |   |                |   |                  |
| Salary of Driver  | 300/day             | 1   | 300            | 1   | 300              |
| Salary of Material handling worker                                | 200/day             | 1   | 200            | 3   | 600              |
| Fuel Cost   | 20/point            | 4   | 80             | 7   | 140              |
| <i>Profit</i>   |                     |   | 320/day        |   | 760/day          |
| <i>Period of Cost Recovery (10 PI-Vehicles, 50 PI-containers)</i> |                     |   |                |   | 284 working days |
| <i>Return on investment (ROI) (240 working day/year)</i>          |                     |   |                |   | 84.48%           |

# Conclusions



The key challenges and pain points of bulky goods delivery, especially in customized furniture industry are identified.



Preliminary attempt to apply the PI concept into real life industry. PI enabled Bulky Goods Delivery System is proposed.



The proposed solution can improve the efficiency of transportation. It also has good ROI for logistics service providers.



# Future Works

Future studies will focus on making the proposed solutions more practical.

- Algorithm for PI Container sizing optimization.
- Algorithm for multi Vehicle Routing Planning
- Resource management and Dashboard System Development
- PI-Container and PI Vehicle Development

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Thank you