

# A STUDY ON SUPPORTING THE CHOICE BETWEEN PURCHASED PALLET AND RENTAL PALLET USING A COMPARISON MODEL

購入パレットとレンタルパレットの選択支援に関する研究  
ー比較モデルを利用してー

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## Pallets

- An essential foundation of Logistics, improving efficiency
- For all the basic functions of logistics: transportation, storage, packaging, cargo handling, distribution processing, and information processing.
- Pallets in use
  - Worldwide: 5 billion (50億)<sup>(1)</sup>
  - Japan: 500 million (5億)<sup>(2)</sup>



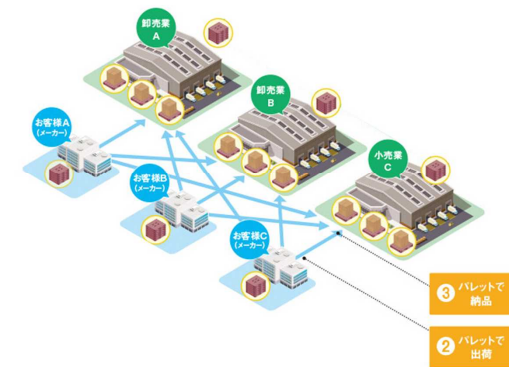
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## Issues with Pallets

- Pallet Size Standardization (サイズ標準化)
- Unit Load System and Intermodal Palletization (一貫パレチゼーション)
- Management
  - Quantity maintenance: Pallet loss (パレット流出)
  - Quality maintenance: Damage (修理), Sanitization (especially for exports) (衛生処理)
  - Return trip of empty pallets (空パレット回収)
  - Transfer of goods to different owners' pallets (積み替え作業)
- A potential solution/  
Alternative choice: **Pallet Rental Services, Pallet Pools**

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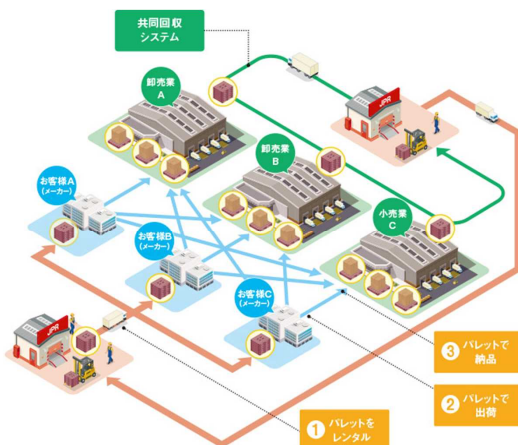
## A Supply Chain Using Pallets



Reference: JPR 日本パレットレンタル株式会社<sup>(4)</sup>

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## A Supply Chain Using **Pallet Rental Services**



Reference: JPR 日本パレットレンタル株式会社<sup>(4)</sup>

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## Comparison between Purchased and Rental Pallet

**Purchased**



**Rental**

- ✗ Initial/ purchasing cost is high
- ✓ Longer usage time leads to lower cost per unit time
- ✗ Fluctuations in goods demand are costly
- ✗ Return trips for empty pallets
- ✗ Management and Maintenance required
- ✗ Extra work to transfer to different pallets if the owners are different

- ✗ Rental fee per unit time is higher
- ✓ Flexibility in renting
  - ✓ Short time (Starting from ~10days)
  - ✓ Small quantities (Starting from ~50) \*
  - ✓ Can choose the (nearest) depot to return
- ✓ Less life cycle CO<sub>2</sub>
- ✓ Less waiting time for empty pallets

Reference: レフォルモ株式会社, [rental-pallet.net](http://rental-pallet.net)<sup>(5)</sup>

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## Objectives of Research

- To compare the different aspects of using purchased pallet and rental pallet; compare the different costs by creating a mathematical model
- To decide the better choice of pallet system in each situation, and to find out the effect of each condition on the cost, and the trend of cost
- To support the Logistic Society's economic decision making between using Purchased Pallet and using Rental Pallet and to contribute to the progress of palletizing, intermodal palletization and increase in logistics efficiency

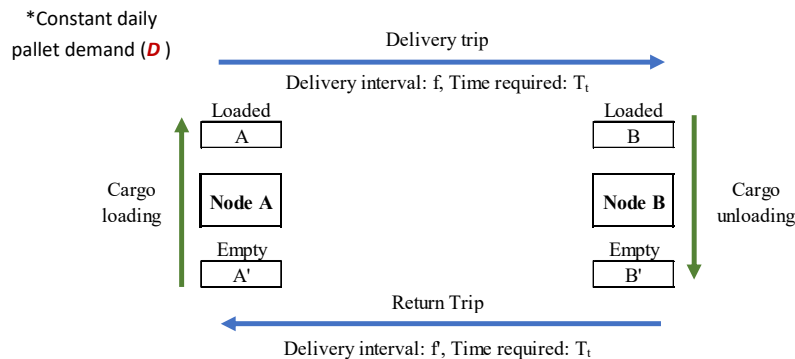
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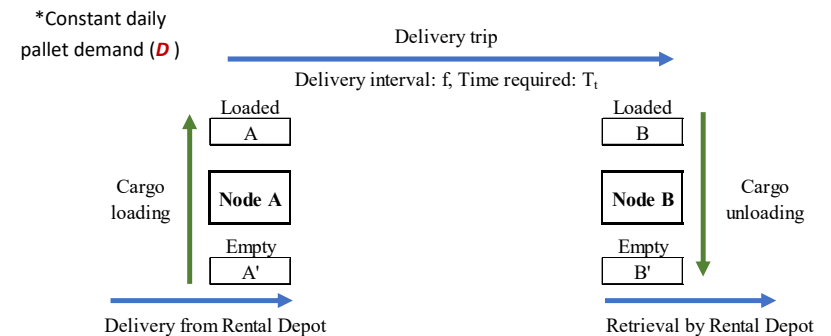
## Model for Using Purchased Pallet



- Time required per trip ( $T_t$ ), and transportation cost per trip ( $C_t$ ) are assumed to be the same for both cases
- Daily cargo loading at A and unloading at B

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## Model for Using Rental Pallet



- $T_A, T'_A, T_B, T'_B$  = **average holding times** at each point
- $T'_A$  and  $T'_B$  for using rental pallet are negligible (Zero)

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## Equations: **Purchased Pallet**

### Total cost

$$1 \quad [C_{P,Total}] \text{ Total cost (Yen/day)} = [PC_P] \text{ Pallet cost (Yen/day)} + [TC_P] \text{ Transportation cost (Yen/day)} + [SC_P] \text{ Storage cost (Yen/day)}$$

### Pallet cost

$$2 \quad [PC_P] \text{ Pallet cost (Yen/day)} = [C_P] \text{ Pallet usage cost per day per pallet (Yen/pallet/day)} \times [D] \text{ Pallet demand (pallet/day)} \times [T_P] \text{ Average storage and transportation time required from A to B and back to A (day)}$$

\*The total costs are compared in units of 'yen per day' at any given time

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## Transportation cost: Purchased pallet

$$3 \quad [TC_P] \text{ Transportation cost per day when using purchased pallet (Yen/day)} = \frac{[C_t] \text{ Transportation cost per trip (yen)}}{[f] \text{ Time interval between delivery trips (day)}} + \frac{[C_t] \text{ Transportation cost per trip (yen)}}{[f'] \text{ Time interval between return trips (day)}}$$

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## Storage cost: Purchased pallet

$$4 \quad [SC_P] \text{ Storage cost per day when using purchased pallet (Yen/day)} = [C_s] \text{ Warehouse rental cost per unit area (Yen/m}^2\text{/day)} \times [S] \text{ Surface area of pallet (m}^2\text{/pallet)} \times \frac{[D] \text{ Pallet demand (pallet/day)} \times \text{Time stored (day)}}{[n] \text{ Number of pallets per stack}}$$

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## Equations: **Rental Pallet**

### Total cost

$$5 \quad [C_{R,Total}] \text{ Total cost (Yen/day)} = [PC_R] \text{ Pallet cost (Yen/day)} + [TC_R] \text{ Transportation cost (Yen/day)} + [SC_R] \text{ Storage cost (Yen/day)}$$

### Pallet cost

$$6 \quad [PC_R] \text{ Pallet cost (Yen/day)} = [C_R] \text{ Pallet rental fee (Yen/pallet/day)} \times [D] \text{ Pallet demand (pallet/day)} \times [T_R] \text{ Average storage and transportation time required from A to B (day)}$$

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## Transportation cost: Rental pallet

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$$[TC_R] = \frac{[C_t]}{[f]}$$

Transportation cost per day when using rental pallet (Yen/day)

Transportation cost per trip (yen)

Time interval between delivery trips (day)

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## Storage cost: Rental pallet

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$$[SC_R] = [C_s] \times [S] \times \frac{[D]}{[n]}$$

Storage cost per day when using rental pallet (Yen/day)

Warehouse rental cost per unit area (Yen/m<sup>2</sup>/day)

Surface area of pallet (m<sup>2</sup>/pallet)

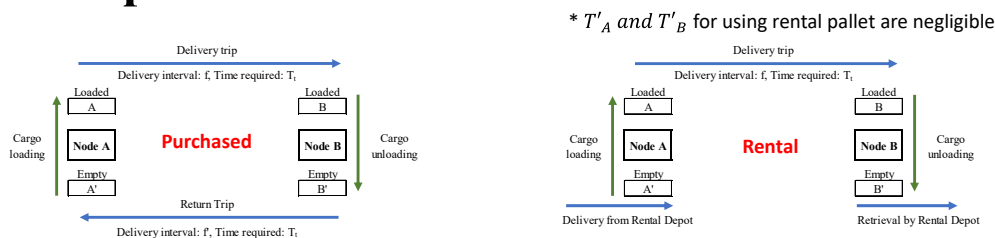
Pallet demand (pallet/day)

Time stored (day)

Number of pallets per stack

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## Comparison



		Total Cost					
		Pallet		Transport		Storage	
		Purchased	Rental	Purchased	Rental	Purchased	Rental
Cost	Purchasing price/ Service life	Rental fee	Both Delivery and Return	Only Delivery	Same		
Time	$T_A+T'_A+T_B+T'_B+2T_t$	$T_A+T_B+T_t$			$T_A+T'_A+T_B+T'_B$	$T_A+T_B$	

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## Parameters used in Calculation

Variable Name	Symbol	Value	Unit	Remarks
Pallet demand	D	20	pallet/day	
Warehouse rental cost	$C_s$	40.40	yen/m <sup>2</sup> /day	Japan, Kanto region
Surface area of pallet	S	1.21	m <sup>2</sup> /pallet	T11 Type (JISZ0601)
No. of pallets per stack	n	10		
Purchasing price		7000	yen/pallet	Nippon Pallet Pool Co.,Ltd.
Service life		3650	day	10 years
Pallet rental fee	$C_R$	8	yen/pallet/day	Nippon Pallet Pool Co.,Ltd.
Distance between node A and B		30	km	
Time required per trip	$T_t$	0.04	day	calculated with average travel speed of 30km/h
Transportation cost per trip	$C_t$	28120	yen	10 ton class *

\*Reference: Japan Trucking Association<sup>(7)</sup>

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# List of Analysis Done

1. Cost Breakdown vs Average Holding Time
2. Total Cost vs Average Holding Time
3. Effect of Pallet Rental Fee ( $C_R$ ) on turning point
4. Turning point vs Pallet Rental Fee ( $C_R$ )
5. Effect of Transportation Cost on Turning Point
6. Turning point vs Distance between Nodes( $T_t$ )

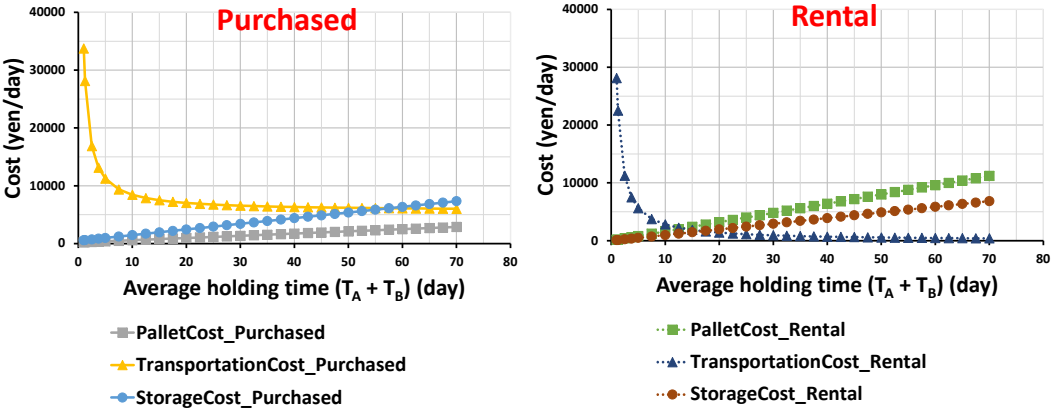
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# List of Analysis Done

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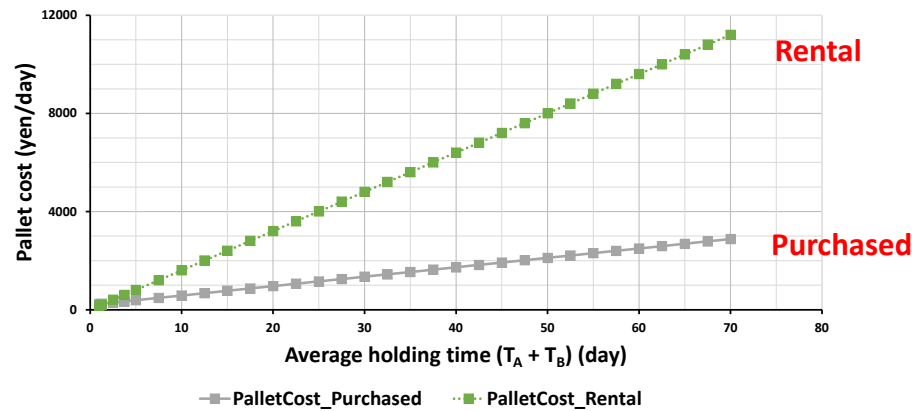
# Cost Breakdown vs Average Holding Time



$Total\ cost = Pallet\ cost(PC) + Transportation\ cost(TC) + Storage\ cost(SC)$

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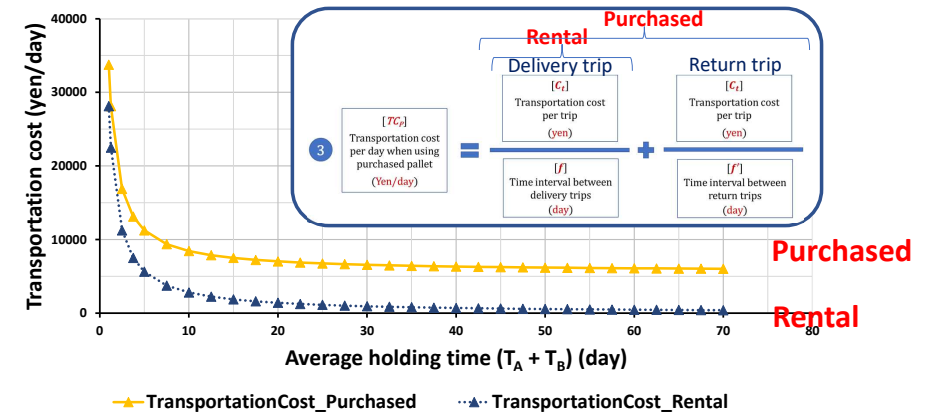
## Cost Breakdown vs Average Holding Time



$PC_P$  showed a lower increase rate than  $PC_R$

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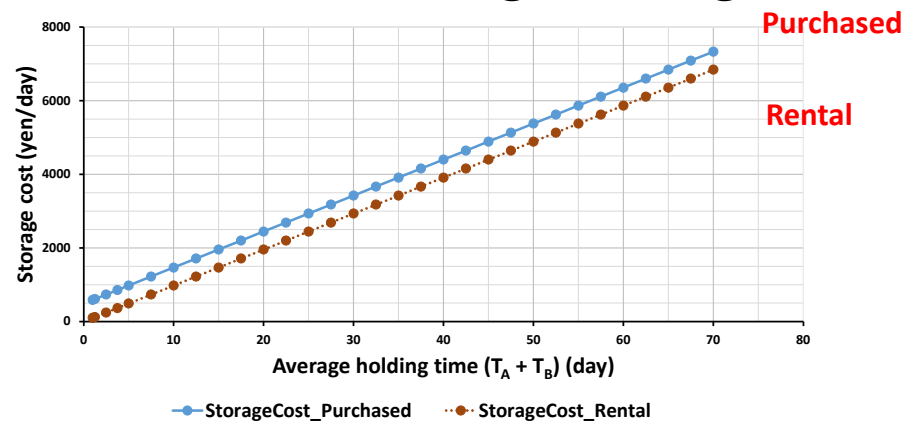
## Cost Breakdown vs Average Holding Time



$TC_P$  showed a much lower decrease rate than  $TC_R$

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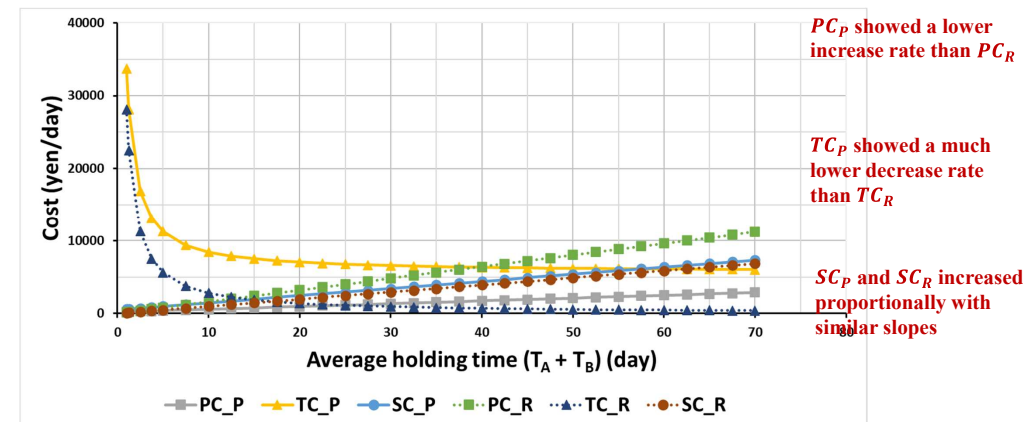
## Cost Breakdown vs Average Holding Time



$SC_P$  and  $SC_R$  increased proportionally with similar slopes

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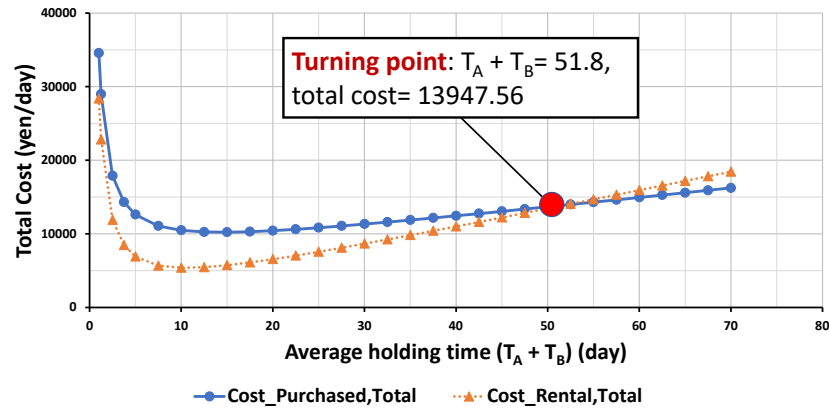
## Cost Breakdown vs Average Holding Time



Total cost = Pallet cost(PC) + Transportation cost(TC) + Storage cost(SC)

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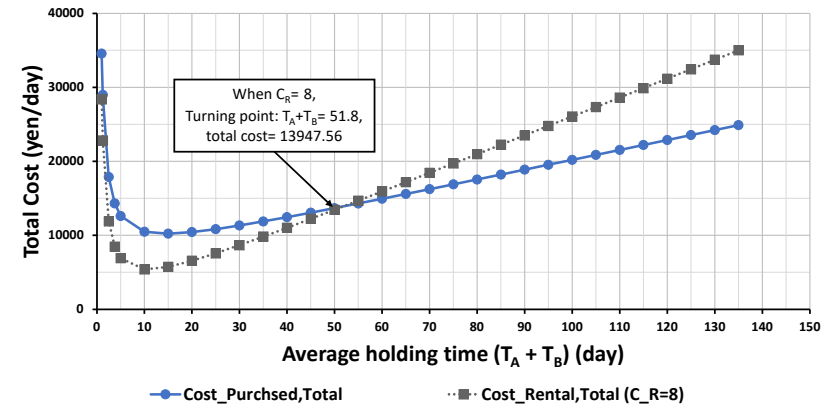
## Total Cost vs Average Holding Time



- Total cost of using rental pallet became more than the purchased pallet at “the turning point”.
- Renting is favorable if estimated holding time is before turning point, and the opposite for Purchasing.

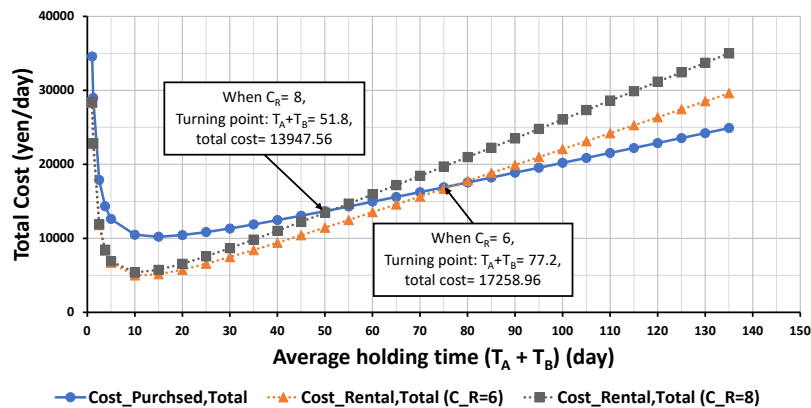
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## Effect of Pallet Rental Fee ( $C_R$ ) on Turning Point



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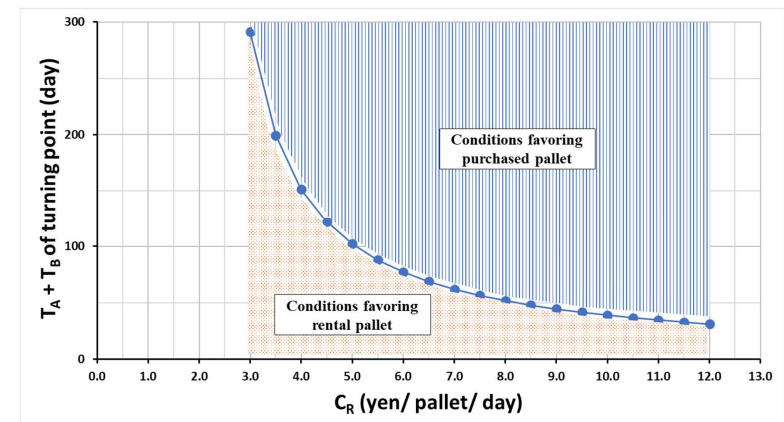
## Effect of Pallet Rental Fee ( $C_R$ ) on Turning Point



- When  $C_R=8$ , Turning point is around  $T_A+T_B = 51.8$
- As  $C_R$  decreases, the time before the turning point increases.

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## Turning Point vs Pallet Rental Fee ( $C_R$ )

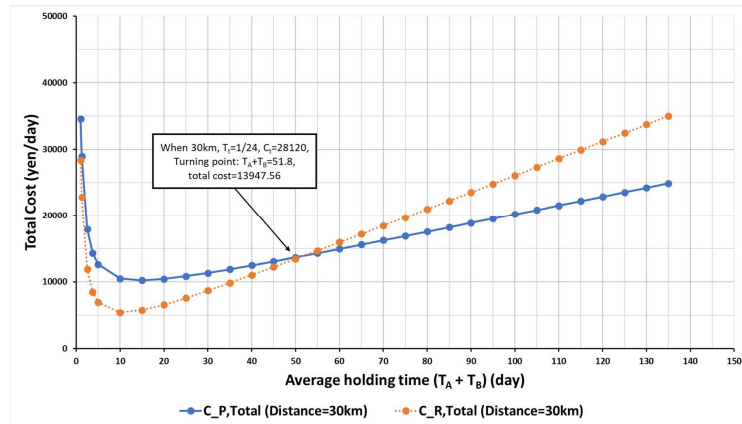


- When  $C_R=8$ , Turning point is around  $T_A+T_B = 51.8$ .
- As  $C_R$  increase, the Turning point decreases.

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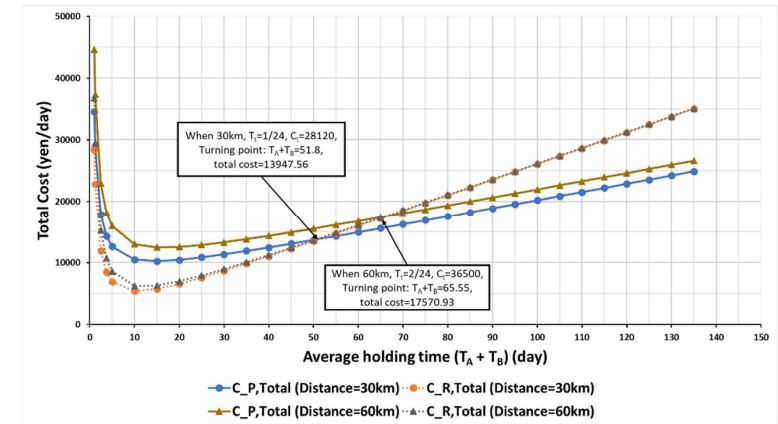
## Effect of Transportation Cost on Turning Point



\* $C_t$ : the transportation cost per trip  
 $T_t$  = Time required per trip (day)

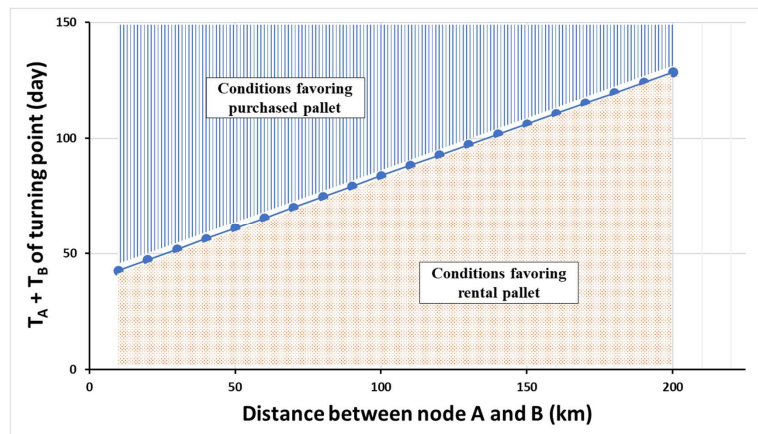
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## Effect of Transportation Cost on Turning Point



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## Turning Point vs Distance travelled



$T_t$  = Time required per trip (day)

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## Conclusion (1)

- pallet costs, transportation costs and storage costs may show different trends under each condition
- the total costs can be compared, and the **turning point** can be referred to support the choice between purchased pallet and rental pallet
- Since the model doesn't include some factors such as pallet loss rate and pallet transfer cost (for different pallet owners), using rental pallets might be more preferable than the calculation results.

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## Conclusion (2)

- long holding time → purchased pallet
- short holding time → rental pallet
- The average holding time of the turning point **changes exponentially** with the change in pallet rental cost
- Effect of transportation cost on the total cost  Effect of transportation cost on the total cost
  - when using **purchased pallet**-
  - when using **rental pallets**-

which makes **rental pallets** more desirable in the future, as the transportation costs in Japan are predicted to rise, due to the **lack of manpower** and **increase in fuel prices**.

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## Further studies

- applying actual logistics data and compare the results
- considering more types of costs related to the usage of pallet:
  - cost of equipment used together with pallets
  - labor wages
  - maintenance and
  - disposal fees and so on.

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## References

- 1) Statista. "Global pallet market size 2019-2027." <https://www.statista.com/statistics/1228432/global-pallet-market-size/>
- 2) UPR Corporation. "物流パレットのサイズ・積み方・材質の種類を解説." [https://www.upr-net.co.jp/info/pallet/pallet\\_size.html](https://www.upr-net.co.jp/info/pallet/pallet_size.html)
- 3) 一般社団法人 日本パレット協会. "パレットとは (その1)." <http://www.jpa-pallet.or.jp/about/>
- 4) JPR 日本パレットレンタル株式会社. "レンタルパレットサービス: 製品・サービス." [https://www.jpr.co.jp/demand/internal\\_rental/rental.html](https://www.jpr.co.jp/demand/internal_rental/rental.html)
- 5) レフォルモ株式会社. "必要な時に必要な枚数だけ借りるレンタルパレットサービス 物流業務 (保管、輸送、荷役) に最適なブラパレット." <https://rental-pallet.net/>
- 6) 日本パレットプール株式会社. "コスト比較." <https://www.npp-web.co.jp/about/cost.php>
- 7) 国土交通省. 一般貨物自動車運送事業に係る 標準的な運賃の告示について. 2020. <https://www.mlit.go.jp/common/001340658.pdf>

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**Thank you for your attention**

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