System 1: Selective Pallet Racking (SPR)

System Elements

0

Storage system:	Pallet rack, wide-aisle, single-depth	
Forwarding system:	Reach Truck	
Picking System:	Allocation:	static
	Movement:	two-dimensional
	Goods removal:	manual
	Delivery:	central

Attributes

Storage density	low
Ground space utilization	low
Manpower requirements	high
Investment costs	medium
Product range	large
Flexibility (regarding product range)	high
Running costs (e.g. maintenance)	medium
Volume expandability	high
Throughput expandability	high
Susceptibility to disruption	low

Specification

- The only limiting factor for the expansion potential are
- Long access time
- Storage densitiy depends on the building of the unit loads
- Avable with withdrawel devices

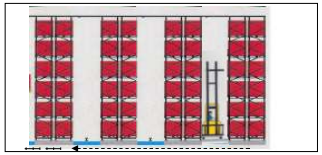
Suitability examples

Industry and trade
Buffer stock

Other Criteria	
Warehouse Condition	AC, NAC, CR, FZ
Product Type	All
Aisle Distance (m)	3-4m
Max Height (m)	12m

Order Profile	Perentage	
Pallet	> 50%	
Outer	> 50%	Level 1 only
Loose	0%	
No Pallets / Batch	1 or more	

System 2: Very Narrow Ailse (VNA) & Truck



System Elements

Storage system:	Pallet rack, narrow aisle, single-depth
Forwarding system:	Very narrow aisle truck
Picking System:	-

Attributes

Storage density	high
Ground space utilization	medium
Manpower requirements	medium
Investment costs	medium
Product range	large
Flexibility (regarding product range)	medium
Running costs (e.g. maintenance)	medium
Volume expandability	medium
Throughput expandability	low
Susceptibility to disruption	low

Specification

- Operational safety because there is only one person in
- Long access time
- Storage densitiy depends on the building of the unit
- Investments for the aisle safety are necessary

Suitability examples

Industry and trade
Buffer stock

Other Criteria	
Warehouse Condition	AC, NAC, CR
Product Type	All
Aisle Distance (m)	2.2-2.8m
Max Height (m)	12m

Order Profile	Perentage	
Pallet	> 50%	
Outer	> 50%	Level 1 only
Loose	0%	
No Pallets / Batch	1 or more	

System 3: Very Narrow Ailse (VNA) & Man-Up Order Picker

System Elements

Storage system:	Pallet rack, narrow aisle, single-depth	
Forwarding system:	Automated storage and retieval system man up	
Picking System:	Allocation:	static
	Movement:	two-dimensional
	Goods removal:	manual
	Delivery:	central

Attributes

Storage density	high
Ground space utilization	medium
Manpower requirements	high
Investment costs	medium
Product range	large
Flexibility (regarding product range)	medium
Running costs (e.g. maintenance)	medium
Volume expandability	medium
Throughput expandability	medium
Susceptibility to disruption	medium

Specification

- Operational safety because there is only one person in the aisles
- Better access time than trucks because of the diagonal movements
- Investments for the aisle safety are necessary
- High building ground requirements

Suitability examples

Industry and trade

Other Criteria	
Warehouse Condition	AC, NAC, CR
Product Type	All
Aisle Distance (m)	2.2-2.8m
Max Height (m)	12m

Order Profile	Perentage
Pallet	> 50%
Outer	0%
Loose	0%
No Pallets / Batch	1 or more

System 4: Automatic Storage Retrieval System (ASRS)

System Elements

Storage system:	Automated storage and retrieval system
Forwarding system:	Automatic Cranes
Picking System:	-

Attributes

Storage density	high
Ground space utilization	medium
Manpower requirements	low
Investment costs	high
Product range	large
Flexibility (regarding product range)	low
Running costs (e.g. maintenance)	high
Volume expandability	medium
Throughput expandability	low
Susceptibility to disruption	high

Specification

- Operational safety because there is no person in the aisles
- Better access time than trucks because of the diagonal
- Storage densitiy depends on the building of the unit loads
- Investments for the aisle safety are necessary
- High building ground requirements

Suitability examples

Industry and trade
Buffer stock

Other Criteria	
Warehouse Condition	AC, NAC, CR
Product Type	All
Aisle Distance (m)	2.2-2.8m
Max Height (m)	40m

Order Profile	Perentage
Pallet	> 50%
Outer	0%
Loose	0%
No Pallets / Batch	1 or more
Pallet Quantity	30000 or more

System 5: Double Deep Rac

System Elements

Storage system:	
Forwarding system:	
Picking System:	

Attributes

Specification

Suitability examples

Other Criteria	
Warehouse Condition	
Product Type	
Aisle Distance (m)	
Max Height (m)	

Order Profile	
Pallet	
Outer	
Loose	
No Pallets / Batch	

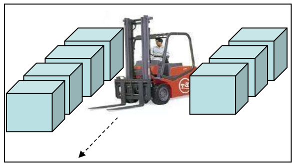
…king (DDR)

Double Deep Reach Truck	

…her Criteria
AC, NAC, CR, FZ
All
3.6-4m
8m

Perentage
> 50%
0%
0%
2 or more

System 6 Ground Storage



System Elements

Storage system:	Ground line storage, unstacked	
Forwarding system:	Forklift	
Picking System:	-	

Attributes

Storage density	low
Ground space utilization	low
Manpower requirements	medium
Investment costs	low
Product range	small
Flexibility (regarding product range)	high
Running costs (e.g. maintenance)	low
Volume expandability	high
Throughput expandability	high
Susceptibility to disruption	low

Specification

- Limited filling level if only one SKU in one canal
- Low requirements regarding the warehouse
- The storing of different SKU's in one canal causes
- A large stock might cause longer access time for

Ability for

- Open spaces and constructions with low headroom
- Short-term storing and intermediate buffering
- Seasonal goods

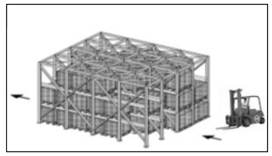
Suitability examples

Building material
Beverage
Paper, barrels, tires

Other Criteria	
Warehouse Condition	AC, NAC, CR, FZ
Product Type	All
Aisle Distance (m)	3-4m
Max Height (m)	3m

Order Profile	Perentage	
Pallet	> 50%	
Outer	> 50%	Level 1 only
Loose	0%	
No Pallets / Batch	1 or more	

System 7 Drive-Through Rack



System Elements

0

Storage system:	Drive-through rack
Forwarding system:	Forklift
Picking System:	-

Attributes

Storage density	high
Ground space utilization	medium
Manpower requirements	medium
Investment costs	medium
Product range	small
Flexibility (regarding product range)	low
Running costs (e.g. maintenance)	low
Volume expandability	high
Throughput expandability	low
Susceptibility to disruption	low

Specification

- Does not allow free placement

Ability for

- Given headrooms that can not be used completely
- Storagements with high operating costs (e.g.
- Seasonal goods
- A delivery volume of at least 20 pallets per article

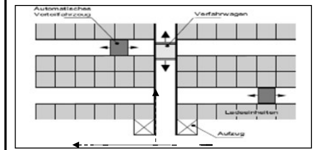
Suitability examples

Buffer store in inbound/outbound

Other Criteria	
Warehouse Condition	AC, NAC, CR
Product Type	All
Aisle Distance (m)	3-4m
Max Height (m)	8-12m

Order Profile	Perentage
Pallet	> 50%
Outer	0%
Loose	0%
No Pallets / Batch	5 or more

System 8 Shuttle Storage System



System Elements

0

Storage system:	Shuttle storage system with aisles	
Forwarding system:	1 shuttle per level + 1 traversing carriage per level + elevator + forwarding system pre zone	
Picking System:	Allocation:	dynamic
	Movement:	one-dimensional
	Goods removal:	manual
	Delivery:	decentralized

Attributes

Storage density	medium
Ground space utilization	low
Manpower requirements	low
Investment costs	high
Product range	large
Flexibility (regarding product range)	low
Running costs (e.g. maintenance)	high
Volume expandability	low
Throughput expandability	low
Susceptibility to disruption	medium

Ability for

- Storagements with high operating costs (e.g. refrigerated
- Automated storage for picking purpose

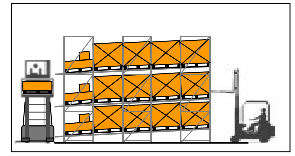
Suitability examples

Buffer store for production

Other Criteria	
Warehouse Condition	AC, NAC, CR
Product Type	All
Aisle Distance (m)	1.5m
Max Height (m)	8-12m

Order Profile	Perentage
Pallet	> 50%
Outer	0%
Loose	0%
No Pallets / Batch	1 or more
Quantity	10000 or more

System 9: Drive Through Racking with Forklift & Order Picker



System Elements

0

Storage system:	Gravity flow-through rack with roll conveyor	
Forwarding system:	Forklift and order picker	
Picking System:	Allocation:	static
	Movement:	two-dimensional
	Delivery:	central

Attributes

Storage density	high
Ground space utilization	medium
Manpower requirements	high
Investment costs	medium
Product range	medium
Flexibility (regarding product range)	low
Running costs (e.g. maintenance)	medium
Volume expandability	high
Throughput expandability	high
Susceptibility to disruption	medium

Specification

- One type of article per row is advantageous
- Requires uniform pallet measurements
- Laborious picking process if partial takings
- Pallets need a stable centre of gravity

Ability for

- Goods dispatch centre
- Distribution warehouse with pickings
- allgemein sperriges Gut

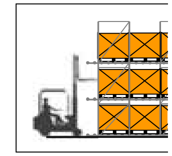
Suitability examples

Seasonal goods
Central warehouse for food

Other Criteria	
Warehouse Condition	AC, NAC, CR
Product Type	All
Aisle Distance (m)	3-4m
Max Height (m)	8-12m

Order Profile	Perentage
Pallet	> 50%
Outer	0%
Loose	0%
No Pallets / Batch	5 or more

System 10: Drive Through Rackin…



System Elements

0

Storage system:	
Forwarding system:	
Picking System:	

Attributes

Storage density
Ground space utilization
Manpower requirements
Investment costs
Product range
Flexibility (regarding product r…
Running costs (e.g. maintenar…
Volume expandability
Throughput expandability
Susceptibility to disruption

Specification

- One type of article per row i…
- Requires uniform pallet mea…
- Laborious picking process if …
- No ram pressure

Ability for

- Goods dispatch centre
- Distribution warehouse with…
- allgemein sperriges Gut

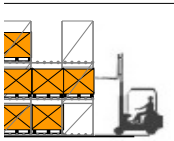
Suitability examples

Seasonal goods
Central warehouse for food

Other Criteria
Warehouse Condition
Product Type
Aisle Distance (m)
Max Height (m)

Order Profile
Pallet
Outer
Loose
No Pallets / Batch

ıg with Forklift



Powered flow-through rack with roll or chain conveyor	
Forklift	
Allocation:	static
Movement:	one-dimensional
Delivery:	central

	high
	medium
	high
	high
	medium
range)	low
ace)	high
	low
	low
	medium

s advantageous
surements
partial takings

pickings

AC, NAC, CR
All
3-4m
8-12m

Perentage
> 50%
0%
0%
5 or more

System 11: Mobile Rack

System Elements

0

Storage system:	Mobile pallet rack	
Forwarding system:	Order picker	
Picking System:	Allocation:	static
	Movement:	two-dimensional
	Goods removal:	manual
	Delivery:	central

Attributes

Storage density	high
Ground space utilization	high
Manpower requirements	high
Investment costs	high
Product range	large
Flexibility (regarding product range)	high
Running costs (e.g. maintenance)	medium
Volume expandability	high
Throughput expandability	low
Susceptibility to disruption	medium

Specification

- Several narrow picking corridors can be opened
- It is recommended to use one corridor for 8 rack
- It is possible to keep the goods under lock and key

Ability for

- Products with a low turnover ratio
- Slow movers
- Long term storage of products that are rarely used

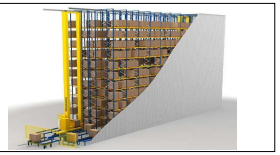
Suitability examples

Archive
Spare parts

Other Criteria	
Warehouse Condition	AC, NAC, CR
Product Type	All
Aisle Distance (m)	3-4m
Max Height (m)	8-12m

Order Profile	Perentage
Pallet	> 50%
Outer	0%
Loose	0%
No Pallets / Batch	5 or more

System 12 High Bay Pallet Rack



System Elements

0

Storage system:	High bay rack, single-deep	
Forwarding system:	Reach Truck	
Picking System:	-	

Attributes

Storage density	high
Ground space utilization	medium
Manpower requirements	low
Investment costs	high
Product range	large
Flexibility (regarding product range)	medium
Running costs (e.g. maintenance)	high
Volume expandability	medium
Throughput expandability	low
Susceptibility to disruption	high

Specification

- Operational safety because there is no person in the aisles
- Limited expandability (only whole lanes)
- Inflexible regarding different handling units (because of
- High need of forwarding system

Ability for

- Multiple shift operations

Suitability examples

Industry and trade
Buffer stock

Other Criteria	
Warehouse Condition	AC, NAC, CR
Product Type	All
Aisle Distance (m)	3-3.4m
Max Height (m)	8-12m

Order Profile	Perentage
Pallet	> 50%
Outer	0%
Loose	0%
No Pallets / Batch	1 or more

System 13: Flow Rack

System Elements

0

Storage system:	Carton Flow Rack	
Forwarding system:	Manual handling with conveyor belt (picker stays at his position)	
Picking System:	Allocation:	static
	Movement:	one-dimensional
	Goods removal:	manual
	Delivery:	central

Attributes

Storage density	medium
Ground space utilization	high
Manpower requirements	high
Investment costs	medium
Product range	medium
Flexibility (regarding product range)	low
Running costs (e.g. maintenance)	low
Volume expandability	medium
Throughput expandability	high
Susceptibility to disruption	high

Specification

- Requires uniform goods measurements
- Goods movement during the storing

Ability for

- Goods dispatch centre
- Distribution warehouse with pickings
- allgemein sperriges Gut

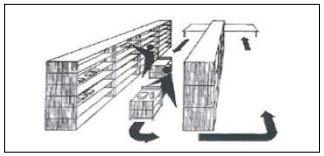
Suitability examples

Seasonal goods
Central warehouse for food

Other Criteria	
Warehouse	AC, NAC, CR
Product Typ	All
Aisle Dista	3m
Max Heigh	3m

Order Prof	Perentage
Pallet	0%
Outer	0%
Loose	> 50%
No Pallets	0

System 14 Shelf Rack



System Elements

0

Storage system:	Shelf rack	
Forwarding system:	Picking trolley	
Picking System:	Allocation:	static
	Movement:	one-dimensional
	Goods removal:	manual
	Delivery:	central

Attributes

Storage density	low
Ground space utilization	low
Manpower requirements	high
Investment costs	low
Product range	large
Flexibility (regarding product range)	high
Running costs (e.g. maintenance)	low
Volume expandability	high
Throughput expandability	high
Susceptibility to disruption	low

Specification

- Huge selection of accessories available
- Limited picking possibilities on the top and at the bottom of the
- A large circulation area is needed
- A high filling degree is possible

Ability for

- A various product range

Other Criteria	
Warehouse	AC, NAC, CR
Product Typ	All
Aisle Dista	2m
Max Heigh	3m

Order Prof	Perentage
Pallet	0%
Outer	0%
Loose	> 50%
No Pallets	0

System 15 High

System El

0

Storage system:
Forwardin g system:
Picking System:

Attribute s

Storage den
Ground spa
Manpower
Investment
Product ran
Flexibility (re
Running cos
Volume exp
Throughput
Susceptibilit

Specifica tion

- Huge selec
- Limited pic
- A large circ
- A high fillir

Ability for

- A various p

Warehouse
Product Typ
Aisle Dista
Max Heigh

Order Prof
Pallet
Outer
Loose
No Pallets

ı Bay Shelf Rack

ements

Shelf rack	
Order picker	
Allocation:	static
Movement:	two-dimensional
Goods removal:	manual
Delivery:	central

sity	medium
ce utilization	high
requirements	high
costs	medium
ge	large
egarding product range)	high
ts (e.g. maintenance)	low
andability	high
expandability	high
y to disruption	low

tion of accessories available
king possibilities on the top and at the
culation area is needed
g degree is possible

roduct range

Other Criteria
AC, NAC, CR
All
1.8-2.5m
8m

Perentage
0%
0%
> 50%
0

System 16 Bin Rack

System Elements

0

Storage system:	Bin rack	
Forwarding system:	Picking trolley	
Picking System:	Allocation:	static
	Movement:	two-dimensional
	Goods removal:	manual
	Delivery:	central

Attributes

Storage density	low
Ground space utilization	low
Manpower requirements	high
Investment costs	medium
Product range	large
Flexibility (regarding product range)	low
Running costs (e.g. maintenance)	low
Volume expandability	high
Throughput expandability	high
Susceptibility to disruption	low

Specification

- Double-deep storagement possible

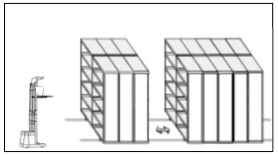
Ability for

- Picking purpose

Other Criteria	
Warehouse	AC, NAC, CR
Product Typ	All
Aisle Dista	2m
Max Heigh	3m

Order Prof	Perentage
Pallet	0%
Outer	0%
Loose	> 50%
No Pallets	0

System 17: Mobile Shelving



System Elements

0

Storage system:	Mobile shelf rack	
Forwarding system:	Order picker or Torlley	
Picking System:	Allocation:	static
	Movement:	two-dimensional
	Goods removal:	manual
	Delivery:	central

Attributes

Storage density	high
Ground space utilization	high
Manpower requirements	high
Investment costs	high
Product range	large
Flexibility (regarding product range)	high
Running costs (e.g. maintenance)	medium
Volume expandability	high
Throughput expandability	low
Susceptibility to disruption	medium

Specification

- It is possible to keep the goods under lock and key
- It is recommended to use one corridor for 8 rack

Ability for

- Products with a low turnover ratio
- Slow movers
- Long term storage of products that are rarely used

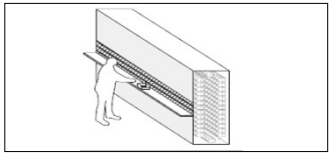
Suitability examples

Archive
Spare parts

Other Criteria	
Warehouse	AC, NAC, CR
Product Typ	All
Aisle Dista	3m
Max Heigh	3m

Order Prof	Perentage
Pallet	0%
Outer	0%
Loose	> 50%
No Pallets	0

System 18: Vertical Carousel Storage



System Elements

0

Storage system:	Circulating shelf storage	
Forwarding system:	Chain conveyor	
Picking System:	Allocation:	dynamic
	Movement:	one-dimensional
	Goods removal:	manual
	Delivery:	central

Attributes

Storage density	high
Ground space utilization	high
Manpower requirements	medium
Investment costs	high
Product range	medium
Flexibility (regarding product range)	low
Running costs (e.g. maintenance)	high
Volume expandability	low
Throughput expandability	low
Susceptibility to disruption	high

Specification

- Protecting against unauthorized access, theft, fire,...
- Ergonomic design of the storing and picking place
- Not suited for rush orders or fluctuating performance

Ability for

- Small to medium picking quantities
- Continuous order intakes without high order frequencies
- High specific personnel costs
- Assamblies, bins, files, long good
- Small parts like tools

Suitability examples

Engineering, pharmaceuticals

Other Criteria	
Warehouse	AC, NAC, CR
Product Typ	All
Aisle Dista	3m
Max Heigh	3m-12m

Order Prof	Perentage
Pallet	0%
Outer	0%
Loose	> 50%
No Pallets	0