



Relog

WAREHOUSE GUIDE

Compiled by Relog
Edition 1

INTRODUCTION TO RELOG

Relog is a specialized consultancy firm focusing on logistics operations and supply chain network optimization.

Our primary area of expertise revolves around the conceptualization and development of tailored, efficiency-driven operational strategies and distribution centre infrastructure solutions for our esteemed clients.

Our comprehensive services encompass guiding our clients through the entire spectrum of needs, from initial solution identification, all the way through to implementation, and addressing every intricacy in between.

Relog was launched in 2019 with a dedicated team of supply chain experts. Together we have more than 130 years of relevant experience in the supply chain and distribution industry. Relog has gone from strength to strength and has established itself as one of the leading intralogistics consulting companies in Africa.

Our projects cover a wide spectrum of industries, scales and levels of complexity. No project is too big or too small, with projects ranging from a small 27sqm micro-fulfilment centre in the parking lot of a mall to a 20,000sqm facility housing the biggest banana ripening facilities in a bustling Nairobi, to a 18,000 pallet, fully automated dark warehouse to the biggest composite distribution centre in Africa measuring in at an impressive 160,000sqm.

Every industry and country have its own unique needs, challenges and customer demands. Industries may differ by the type of goods, throughout velocity, volume, value of goods and technology uptake, but in supply chain there are a few common performance indicators shared across all sectors, such as:

- Availability
- Cost
- Sustainability, and
- Accuracy

By working across different industries, we at Relog take advantage of our vast project experience by adopting best practice methodologies and taking learnings and relevant concepts and learnings from one sector and applying them to another where applicable to ensure that the developed solution is fit-for-purpose and specifically tailored to a customer's unique needs.

At Relog, we make sure that we are solving challenges and not treating symptoms. Logistics and supply chain operations involve dynamic challenges with countless external influences and exceptions. With data-driven exercises and simulations, we find a balance between relevant variables and criteria while being aware of potential real-life situations and constraints.

In design, there are an unlimited number of possibilities which may, at times, seem confusing and overwhelming to the client, but with our experience, we focus on streamlining workable options together with our clients to find a solution that works for them.

In the age of connectivity and increasing customer expectations, businesses need their supply chain to distinguish themselves from the competition and to ensure readiness for ever-changing and dynamic circumstances. By developing fit-for-purpose and optimised distribution activities, we create a platform to support all business operations.

In keeping with this core design philosophy, we leverage sustainable and green design as a competitive edge. This is achieved through streamlining of activities and reducing waste. Supply chain sustainability means creating a future-proof operation. It means learning from the past, looking to the future, and ensuring that the supply chain is geared to support the business's strategic intent.

We at Relog are passionate about what we do. We pride ourselves in the clients we serve and in delivering solutions that work for them. We recently celebrated our 4th birthday and are very proud of the team we have and how far we've come.

We are ready to assist you with any supply chain matters. Should you require further information or want to chat with us about your supply chain needs, please feel free to give us a call at +27 21 816 2000 or send an email to admin@relog.co.za

Let's take your operations to the NEXT LEVEL.

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Consulting and Infrastructure Design



FOREWORD

This guide is designed to provide you with an in-depth understanding of what a warehouse is, why they are important, and the various elements and design considerations that there are. This guide was written by one of the leading intralogistics consulting companies in Africa, Relog, based in Cape Town, South Africa, and is packed with over 130 years of industry experience.

A warehouse is more than just a storage space; it is the backbone of an efficient supply chain, enabling the seamless flow of goods from manufacturers to consumers. The significance of warehouses cannot be overstated. They play a crucial role in inventory management, order fulfilment, and ensuring that products are available when and where they are needed. In a world where customer expectations for rapid delivery are higher than ever, the importance of an efficiently run warehouse is paramount.

Designing a warehouse involves a myriad of considerations. From layout planning and material handling systems to safety regulations and technological advancements, every aspect must be meticulously planned to optimize operations. This guide delves into these design considerations, providing practical advice and best practices to help you create a warehouse that meets your specific needs.

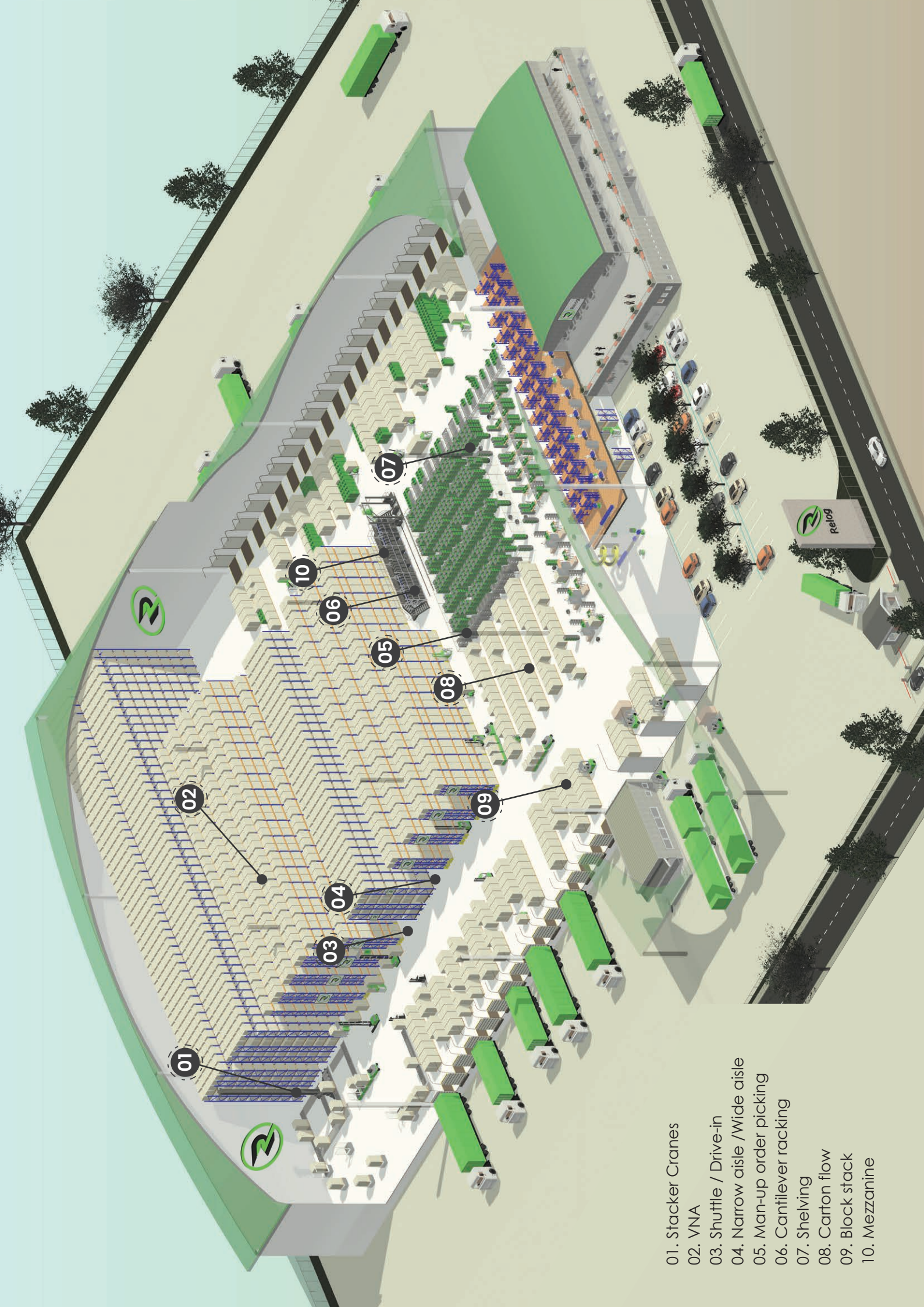
Furthermore, the warehouse industry is continuously evolving, driven by advancements in technology and shifts in consumer behaviour. This guide includes insights from our real-world experience of the industry, highlighting emerging trends and innovations that are shaping the future of warehousing. Whether it's the rise of automation, the integration of AI and robotics, or the push towards sustainability, staying informed about these trends is crucial for staying competitive.

We hope this guide serves as a valuable resource, whether you are new to the world of warehousing or a seasoned professional looking to stay updated with the latest developments. Each talking point has been carefully curated to provide you with actionable knowledge and insights.

Thank you to our well-versed team who have all pulled together to share ideas and concepts to put this guide together. Should you have any queries after reading this guide or would like for one of our knowledgeable engineers to meet with you to discuss your needs, feel free to give us a call at +27 21 816 2000 or send an e-mail to admin@relog.co.za, and we'll set up a no-obligation meeting with you and your team.

Elevate your warehouse with expert solutions
for peak efficiency.





- 01. Stacker Cranes
- 02. VNA
- 03. Shuttle / Drive-in
- 04. Narrow aisle /Wide aisle
- 05. Man-up order picking
- 06. Cantilever racking
- 07. Shelving
- 08. Carton flow
- 09. Block stack
- 10. Mezzanine

WHAT IS THE PURPOSE OF A WAREHOUSE

The purpose of a warehouse or distribution centre extends far beyond storage space for businesses. They form the cornerstone of an efficient supply chain. They are crucial assets that, when managed effectively, can be the difference between great success stories, and the complete collapse of a business. The role of these facilities will differ from business to business, but some of the key elements are as follows:

Storage & Inventory Management

At its core, the primary function of a warehouse is to store and distribute goods. However, this goes beyond merely holding products. Effective storage solutions involve organizing goods in a manner that maximizes space utilization while also ensuring easy retrieval and access to goods that are required. Advanced warehousing systems employ various storage techniques such as shelving, pallet racking, and automated retrieval systems (AS/RS) which aid in this regard.

This organization is also crucial for maintaining optimal inventory levels, which helps in balancing the supply and demand of the market. Efficient inventory management reduces the risk of overstocking or stockouts, both of which can be extremely costly for businesses.

Distribution & Transportation

Another word for a warehouse, is a distribution centre, and that is because they play a critical role in distributing goods. They act as central hubs where goods from different suppliers are consolidated, sorted, and prepared for shipment to their final destinations.

Additionally, strategically located warehouses enable faster and more cost-effective transportation of goods, ensuring that products reach consumers and retailers promptly. This is particularly important in an era where same-day and next-day deliveries are becoming the norm.

Value Added Services

Warehouses are often used as a place to offer a range of value-added services that enhance the overall supply chain efficiency. A good example of this would be applying the price tag to an item of clothing, or adding marketing material into the box in which the goods will be delivered in. By performing these tasks within the warehouse, businesses can streamline operations and reduce the time and cost associated with outsourcing these functions.

Risk Management and Security

Warehouses also play a vital role in risk management and security. They provide a controlled environment where goods are protected from breakages, theft, and environmental conditions. Businesses that sell perishable goods will also require their entire facility, or a portion of it, to be climate-controlled to prevent spoilage. Additionally, robust security measures, such as surveillance cameras, alarm systems, and restricted access protocols, ensure that inventory is safeguarded against theft and unauthorized access.

Protection Against Market Fluctuations

Economic and market fluctuations can have significant impacts on supply chains. Warehouses act as buffers, absorbing the shocks of sudden changes in supply and demand. By holding the correct safety stock, businesses can continue to meet customer orders even during periods of disruption. This helps ensure business continuity and stability. During the recent Covid pandemic, we have seen the instability of supply chains – business with efficient warehousing were able to sustain demand while dealing with the challenges of supply.

Furthermore, with effective forecasting and strategy, warehouses can also enable businesses to opportunistically purchase stock in bulk, providing a competitive edge when executed properly.

Enhancing Customer Satisfaction

In today's competitive market, customer satisfaction is paramount. Warehouses can contribute to this by ensuring timely delivery of products, especially when it comes to e-commerce. Efficient warehousing operations enable faster order processing and shipping, reducing lead times and improving delivery accuracy. Furthermore, the ability to store a wide variety of products ensures that businesses can offer a broader selection to their customers, meeting diverse needs and preferences.

In Summary

Warehouses or distribution centres are dynamic facilities that serve many purposes, that extend far beyond just a storage location. Well run warehouses can reduce costs, improve efficiency, and provide that competitive edge required to thrive in today's market. As consumer expectations continue to rise, the importance of efficient and effective warehousing will continue to grow, solidifying its place as a cornerstone of logistics and supply chain management.

THE MODERN WAREHOUSE

The role of warehousing in supply chain has evolved significantly in recent years. We no longer live in a world where warehouses are simple storage facilities, but rather dynamic hubs of technology, innovation, and efficiency. There are many exciting examples of how this transformation has occurred, but can mainly be summarised as follows:

Technological Advancements

Modern warehouses are embracing a wave of technological advancements that are revolutionizing their operations. Automation and robotics are one of the most impressive technologies that we are seeing in warehouses today, with the rise of autonomous mobile robots (AMRs), automated storage and retrieval systems (AS/RS) such as Miniloads, Autostore, and Stacker Cranes, to name a few examples. These automations and robots help improve accuracy, boost efficiency, and allow for higher throughputs.

In combination with automation and robotics, AI and machine learning algorithms are enabling warehouses to better manage their inventory levels, reduce double handling, and even predict demand. The overall effect is a more streamlined and effective warehouse operation. Additionally, Internet of Things (IoT) devices further enable these kinds of technologies as they can feed real-time data on almost anything and everything within the warehouse.

These technological advancements are transforming warehouses into smart, agile centres that are integral to the modern supply chain.

Data Driven Decision Makings

In the era of big data, warehouses are harnessing the power of data-driven decision-making to truly optimize their operations. Real-time data analytics now play a crucial role in almost every operational aspect, from labour productivity and equipment status to inventory management. By leveraging technologies such as IoT, warehouses can monitor and respond to dynamic conditions swiftly and accurately. With real-time data, warehouse managers can react instantly to anomalies or, even better, address issues before they escalate.

The ability to collect data from all over the warehouse simplifies the analytics required to run operations and makes the results more accurate. Trends and forecasts can be calculated with greater confidence as they are based on real-world, up-to-date data. Processes such as put-away, letdowns, and picking can also be better optimized,

as decisions around these elements are made using real-world data.

This comprehensive use of real-time data enhances operational efficiency, positioning warehouses as crucial players in the modern supply chain. Additionally, the flexibility gained through these technologies allows warehouses to adapt quickly to changing demands and market conditions, ensuring resilience and continuity in operations.

This adaptability makes them not only more efficient but also more capable of handling the uncertainties of a dynamic global market.

Risk Management and Security

Warehouses also play a vital role in risk management and security. They provide a controlled environment where goods are protected from breakages, theft, and environmental conditions. Businesses that sell perishable goods will also require their entire facility, or a portion of it, to be climate-controlled to prevent spoilage. Additionally, robust security measures, such as surveillance cameras, alarm systems, and restricted access protocols, ensure that inventory is safeguarded against theft and unauthorized access.

The Rise of E-Commerce

The rapid growth of e-commerce has had a major impact on warehousing operations, driving the need for quicker and more accurate operations. Consumers expectations have soared, and businesses need to up their game and meet these expectations to survive this e-commerce boom. Warehouses now require specialised areas within to accommodate for the rise in customer specific

Real-time data analytics now play a crucial role in almost every operational aspect.

SITE DEVELOPMENT PLANNING

orders that consist of 1 or 2 items, rather than fulfilling multiple stores entire orders. This requires major changes to picking, sorting, packing, and shipping processes. This again talks to the technological advancements we touched on earlier.

Sustainability Practices

As with most things in today's world, we cannot have a conversation about modern trends and practices without incorporating sustainability. When it comes to warehousing, companies are investing large amounts of money into green initiatives such as solar panels and battery storage, energy efficient lighting and HVAC systems, as well as implementing sustainable principles in their packaging processes, such as reducing the number of virgin boxes used.

It's important to remember that sustainability is not only about green initiatives, but also about reducing unnecessary expenditure. One of the biggest expenses in distribution, is the transport of goods from Point A to Point B. Where possible, companies are trying to optimise their transport routes as well as consolidate their shipments. Not only does this reduce transport expenses, but it also has significant positive impact on the company's carbon footprint, becoming one of the ultimate sustainable practices to implement.

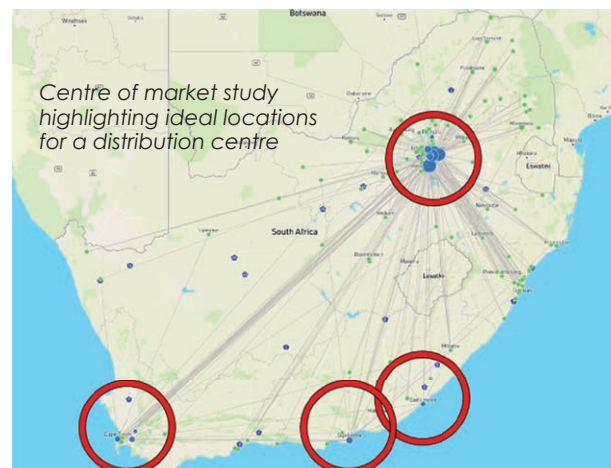
In Summary

Supply chains have evolved and will continue to do so, but effective warehousing strategies and principles will always remain essential to a well-run supply chain. Businesses that can adapt and implement these trends within their warehouses will ultimately gain that competitive edge. When faced with the opportunity of developing a new greenfields facility, there are many factors to consider in ensuring that the facility will offer

operational efficiency and future scalability. The site development plan, or SDP, is the blueprint for the future of the site and ensures that the base principles of the site are documented and maintained throughout the life of the facility. In this section, we will mention a few brief factors to consider when designing your facility.

Location

The right location for the facility is a key factor in the larger supply chain. When considering a new facility, a network study is vital to ensuring your facility is placed in the most optimal location to be close to your centre of market and that is easily accessible for suppliers to minimize transportation costs and delivery times. The site should have easy access to highways, rail lines and or seaports and airports, depending on the nature of your business. One also needs to consider the current zoning of the land, and apply for rezoning timeously if required, to ensure the parcel of land can be developed. Lastly the access to the site should allow for easy and safe ingress and egress for trucks, employee vehicles, customer collections, and delivery vans.

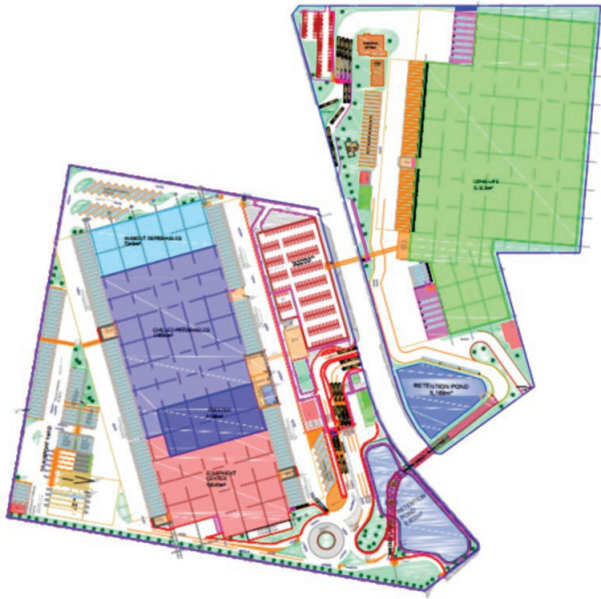


Site Layout and Size

Once the ideal location of a site has been determined, one needs to consider the size of the facility and what other value-adding operational functions you would want to fulfil on the site, e.g. washing of trucks, vehicle refuelling, asset returns centre, etc. The sizing of the facility should ideally also consider future growth prospects of say 10-20 years so that the site can accommodate future phases of development to avoid outgrowing the site too soon and having to incur the cost of developing multiple sites in close proximity.



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Long Term Concept Site Development Plan indicating phasing and extent of development.

Once the immediate and future size of the facility is determined, a suitable land parcel size can be determined. Although it differs between the different municipalities, typical coverage allowed on a site varies between 50%-70%. One needs to be careful of not maximizing on building footprint and neglecting sufficient marshalling yard space for trucks to move efficiently and safely on site. Ensure there is sufficient space on site for truck manoeuvring, docking/parking and offloading – this avoids congestion and improves vehicle turnaround times, which ultimately benefits the ongoing operational efficiency of the facility ensuring a sustainable development.

Once a suitable piece of land has been identified and the building blocks are known, the blocks can be placed on site. Depending on the geographical location of the chosen site, the building orientation needs to be considered to maximize on the use of natural light, to maximize the return on the investment of solar panels, ensure proper drainage and to avoid excessive wind blowing into the facility. These elements will ensure minimizing on overall energy costs.

While considering the orientation, keep in mind the plan for the future growth in terms of building size of the operational capacity. If space is limited, one should consider options for internal expansion of the facility by means of mezzanines, high density storage or automated systems. As part of the operating of the site, people and administrative functions are required to operate the facility. The flow of people on site should be carefully considered to ensure the

safe passage of people onto site and into the operation. This includes sufficient parking space and public transport access, preferably separated from truck traffic.

Warehouse Parameters

The warehouse should be designed in such a manner to suit the operational height clearance required for respective areas. Only once the operational requirements are clearly defined, one can define the building heights. The building height should allow for maximum vertical height to suit racking and storage systems to increase storage capacity. A development may need to meet a height restriction as imposed by municipalities to suit the surrounding landscapes. However, a roof is typically sloped from a low height to the maximum eaves height, either at a certain pitch or a curved roof. The lower areas are generally utilised for receiving and dispatch areas since these generally do not need excessive heights, and the higher regions of the building is more suitable to benefit from the height and maximise on storage. Again, it depends on the type of operation and operational needs. Some types of operations such as flow through or cross-dock operations only utilise the floor area and not the vertical height since product simply flows through the facility and is not stowed away.

Warehouse Design Elements

Once the site development plan has been defined with a suitable erf size and conceptual building sizing and setout, one can dive into the detailed design elements of the warehouse(s) itself.

Dock and Door Interface

One of the most critical elements in any warehouse is the dock- and door interface. A poorly designed or inappropriate interface can cause many headaches and result in inefficient and ineffective processes, as pallets, machinery and even people cannot move in a productive manner. The dock interface dictates the height of the building in relation to the surrounding yard levels.

The range of vehicle types and ways of loading is vast and differs between the various industries and operations. One needs to understand the preferred way goods are received and how goods will be dispatched to suit your customer's needs.

Rear-loading is where goods are loaded or offloaded from the rear or back of the vehicle, typically done by means of a dock leveller or similar type of equipment. The dock leveller provides a suitable

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interface with the warehouse and the vehicle loading or offloading the goods. Since the deck of the vehicles being loaded or offloaded vary in height, typically 1.2-1.6m above the road surface, a dock leveller can offer the transition from a vehicle being higher or lower than the warehouse floor, forming a ramp for forklifts or other loading equipment to move between the building and the dock leveller with fair ease. The dock leveller's working range is typically 300mm above or 200mm below the dock height and come in various lengths and widths to suit. We therefore need to understand the type of vehicles and their heights, whether those are supplier vehicles or our own/3rd party fleet, to be certain that we can accommodate most scenarios for ease of loading.



Typical dock leveller (Credit Maxiflex)

Although preferred, dock interfaces could be external to the main warehouse envelope. These are called loadhouses and are generally retrofitted to existing warehouses to add the capability of rear-loading to the facility. They are however not as robust of course as a purpose-built concrete dock interface.



Typical load house external to the warehouse

When designing a refrigerated facility, one needs to consider that dock levellers do not seal the building off from the external temperatures. In that case it is important to note the position of the dock door in relation to the dock leveller. In conventional ambient buildings, the dock door rests on top of the dock leveller. In a refrigerated facility, the door will be mounted behind the dock leveller, separating the external temperatures from the internal chilled temperatures. Some facilities have a double door system where there is a 2nd door on top of the dock leveller, creating an airlock of sort over the dock leveller. Refrigerated facilities' dock levellers are in many cases fitted with dock seals or dock shelters to seal the building off from the outside world once a truck is docked up against the building, avoiding warm air blowing into the building and similarly avoiding cold air exiting from the refrigerated chamber.



Example of dock shelters

We no longer live in a world where warehouses are simple storage facilities, but rather dynamic hubs of technology, innovation, and efficiency.



Creating future
proof operations

SITE DEVELOPMENT PLANNING

Many rear-loaded vehicles are fitted with tail lifts. These are convenient for delivery where the place of delivery does not have dock levellers in place to offload. Tail lifts come in different configurations, mostly being cantilever or tuck-under. The dock interface at your warehouse needs to consider the type of vehicle and tail lift. Docks may be designed with cut-under's to allow the cantilever type tail lift to be recessed underneath the dock leveller while offloading goods onto the dock leveller.



Example of a cantilever tail lift.

The marshalling yard leading up to the building or dock face is generally sloped away from the building to allow for water run off away from the building. The slope however is minimal to achieve a close-to-level loading interface and to avoid the body of the truck to clash with the vertical face of the building.

Alongside the dock interface, there are other factors to consider which may be critical to the build. One may consider different safety enhancements such as vehicle guides (steel or concrete), dock lighting systems, vehicle restraints and edge protection. Side-loading is where goods are loaded or offloaded from the side of the vehicle. These are typically superlinks or tautliners. The vehicle is offloaded by a forklift operating at the same grade or level as the warehouse, often referred to as the on-grade area. The forklift will run between the warehouse staging and the vehicle to load or unload stock to and from the warehouse ready for dispatch or receiving.

Bulk goods or straight loads from production are often associated with these types of vehicles since they offer the best payload per vehicle and is within the maximum road ordinates for general freight (22.5m).

On-grade or side loading areas are usually covered by means of canopies to provide cover for the truck and the forklift in wet conditions. Since this interface

is level with the warehouse, it is important that the doorways are covered to avoid water ingress since it is on the same level of the warehouse floor. The yards are therefore also sloped away from the building to avoid water entering the building.



Forklift offloading a side-loaded vehicle.

Building Heights

With the cost of land and developments increasing, the height of warehouses have increased over the years. The cost of building a building higher is not a linear equation and becomes more cost effective per square meter of development. To expand a warehouse's footprint is much more costly to do. Again, this is very dependant on the type of operation – not all operations require high roofs and storage.

The development of higher buildings have also driven the need for equipment that are able to lift higher. Reach trucks and turret trucks typically used for high storage can now comfortably lift to 13-15m. If you consider the clearances required above the racked storage and the depth of the structural building trusses, conventional buildings generally approach overall heights of over 30m at the crest of the roof.

Due to the growing need for both residential and industrial spaces, the two spaces have become more and more entwined with urban developments, resulting in the drive for more aesthetically pleasing buildings to suit the landscape. As part of this need, curved warehouse roofing is becoming more prevalent, providing a softer look to these monstrous buildings. Curved warehouse roofs are not only aesthetically pleasing, but also assist to keep the overall height of the roof lower compared to conventional pitched roofs and provide further benefits in terms of structural loading and weather elements.

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Example of a curved roof (Pick n Pay Eastport).

Columns are an integral part of the structural design of the warehouse. The larger the span of the columns, the larger the columns need to be and the deeper the roof truss support becomes to manage the larger spans. While it may seem like a futile exercise, columns take up valuable warehouse space and it too needs careful consideration of how the structural grid is designed and columns are placed. The column spacing is generally aligned with the optimal space required for the racking aisles. Again, depending on the type of operation and equipment used, the aisles will vary from one warehouse to the next. If columns are not optimally placed, one would end up with racking aisles that are wider than needed and columns that are potentially exposed, wasting valuable warehouse space, reducing potential storage capacity and risking damage to structural infrastructure.

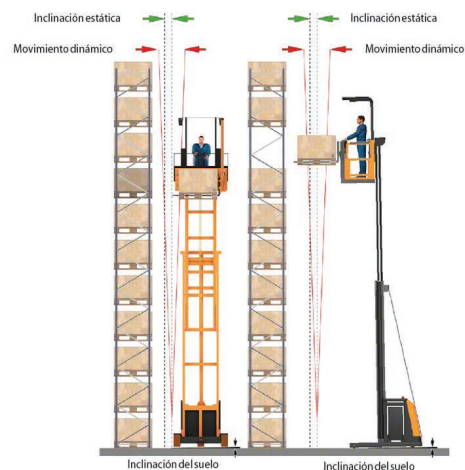
Flooring and Floor Joints

Good flooring is critical to the smooth operation of a warehouse, impacting everything from safety and productivity to equipment lifespan and cost-efficiency. A good quality warehouse floor equates to a reasonable portion of the budget. Its importance cannot be overlooked and it is very worthwhile spending slightly more to ensure the longevity of the warehouse floor.

When designing the facility, the load bearing of the racking and dynamic loading of forklifts and reach trucks, need to be known to ensure the floor is designed accordingly and can allow for the load of the storage required. A high quality floor will prevent buckling, cracking or failing under these high loads.

The floor also needs to be designed to a certain specification defined by its flatness and levelness.

There are various specifications, codes and flooring guidelines to which structural engineers design these floors. Again the operation defines the type of floor design required. As an example, a wide aisle operation's floor design will differ from that of a VNA type operation, where trucks follow a defined path of movement and lift to very high heights. Any deviation on ground level, may cause excessive misalignment at the upper most reach of the machine.



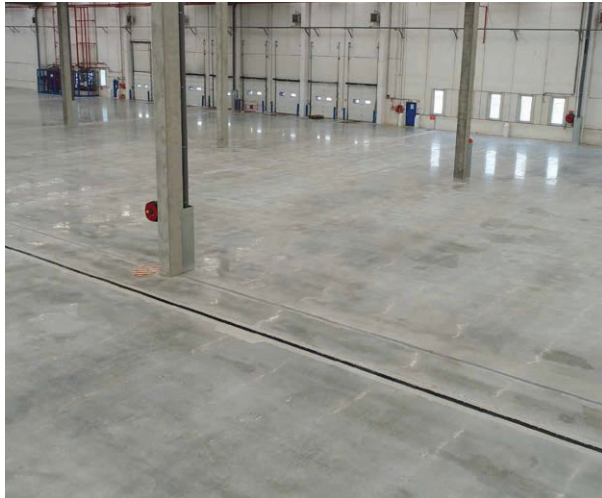
The effect of uneven surfaces at height.

Floor joints are a pivotal element as part of the floor design. Floor joints form the perimeter of a network of floor slabs creating the overall warehouse floor footprint. Concrete expands and shrinks under different temperatures; there is a lot of movement in the early life of a concrete floor. The joints can open up and close allowing movement of the concrete floor to avoid restricting the movement of the slab which may result in cracks. It is also the point where the heavy load of machines are transferred from one slab to another. If joints are not specified for the correct loads and interfaces, the floors will curl or crack at these points and will consequently lead to ongoing damage to machines and excessive downtime in operations to repair these cracks. There are various joints on offer on the market, from straight joints to wave joints, each offering different benefits and potential flaws. Detailed discussions with the structural engineer is required to ensure the right type of joint at the right cost point is installed to suit your warehouse operations.



Example of a cosine joint.

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Example of a straight edged joint.

Lighting

Warehouses can become dark and dingy spaces. But it shouldn't be. Lighting has a significant impact on the overall functionality, operational efficiency, and safety of a warehouse. Lighting even has an impact on the morale of warehouse employees.

Lighting technology has vastly improved over the years, moving from old sodium halide lights to efficient LED lighting. The cost of LED's were prohibitive until recently, but as the technology has improved, it is the de facto standard for warehouses, offering little maintenance, efficient cost of running and long life spans.



LED Linear Highbay Fixture.

Proper lighting provides significant benefit to productivity, worker safety, operational costs, and even the accuracy of tasks such as picking and packing. Intelligent lighting systems, coupled with sophisticated sensors, are providing even more benefit to the operational running costs of lighting, being able to adjust its output based on the level of natural light in the building and to switching on and off based on activity within the aisles.

Depending on the type of operation, a lux level of 200 lux or higher is aimed for in the warehouse. Where there are fine picking and packing operations, one can target as high as 300-400 lux.

Remember to take into consideration that LED's output reduces roughly 15% over the 5 - 7 year lifetime of the fitting. Therefore ensure the specification of the light will still be able to maintain the minimum required specification at the end of the life of the fitting to remain compliant and keeping the workplace safe.



Bright working environment improves many factors.

Fire Protection and Smoke Detection

A key element of your supply chain is the goods that are being stored in your warehouse or distribution centre. It is therefore imperative that your stock is protected from risks such as fire. Fires can cause significant damage to property, disrupt operations and pose serious risks to human life. Therefore, national building regulations dictate the need for fire sprinkler protection at roof level to avoid the spread of fires to other parts of the building and to neighbouring properties.



Smoke plumes from a Walmart warehouse in America.

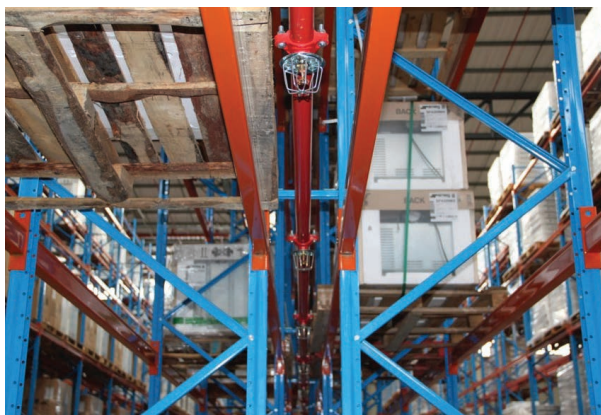
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early warning of potential fires, giving the warehouse employees time to safely evacuate the building before the fire spreads or conditions become more dangerous.

Effective fire suppression helps to avoid the spread of fires to other parts of the building, minimizing the amount of stock that is destroyed in the part of the warehouse that caught fire.

When exceeding certain heights in the racking storage, one is also compelled to install additional fire protection within the racking system, referred to as in-rack sprinklers. In-rack sprinklers play a significant role in the design of the racking system and must be considered for clearances and placement of sprinkler heads to avoid the risk of knocking these when putting away and retrieving pallets.

There are also more sophisticated, but expensive fireprotection solutions to avoid in-rack sprinklers referred to as ESFR (Early Suppression Fast Response). These systems are roof mounted sprinklers which delivers more water to conventional roof sprinklers but generally requires the need for additional pump sets and fire water storage due to the large volume of water that is required. It is suitable for racking systems up to 12m and avoids any in-rack sprinklers, allowing much more flexibility in the racking design and able to alter racking setups without any concerns around in-rack sprinklers.



In-rack sprinkler.

There are various fire protection standards, both local and international, that can be incorporated as part of the build. Insurance companies have onerous requirements with regards to fire sprinkler and smoke detection and will request for you to adhere to a certain standard or specification. It is important to understand their requirements and to involve a qualified mechanical engineer specializing in fire protection to design a system that complies

with building regulations and to said standard, and also rationalizes the minimum specification of protection to remain compliant while minimizing the investment required.

Building Protection

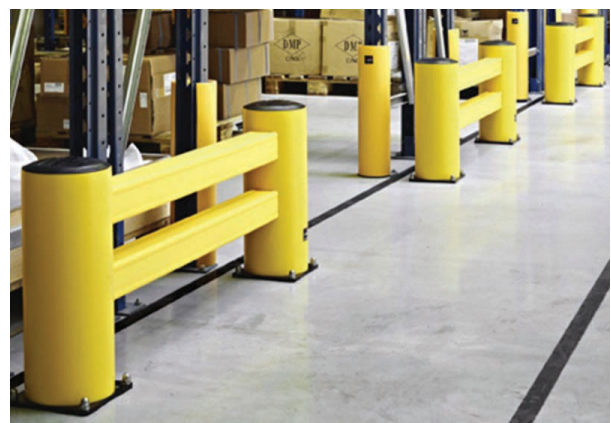
With large trucks and forklifts roaming around in a warehouse, the building infrastructure is exposed to the risks of being knocked and damage. It is critical to protect the building infrastructure and place suitable protection in these areas.

While a warehouse cannot be entirely fool proofed, the following are typical elements that we attempt to protect:

- Building and mezzanine columns
- Warehouse walls exposed to machine traffic
- Loading Doors and dock levellers
- Exposed water downpipes
- Fire equipment
- Racking aisle ends
- Work stations and offices
- People walkways



Building Column Protection.



Racking Protection.

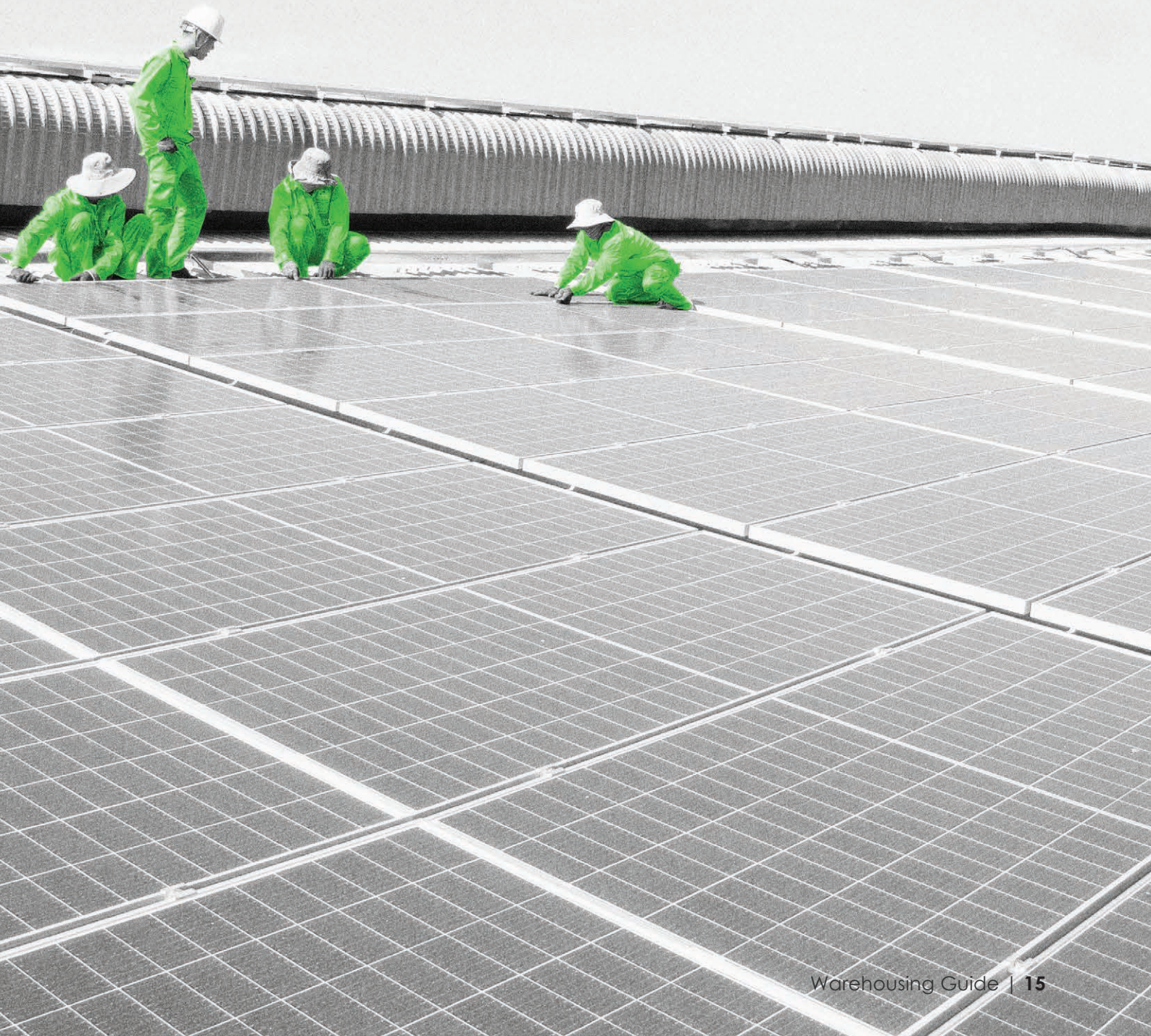
Solar and Electricity Backup

The South African market has struggled with unreliable electricity generation and has led to the almost mandatory requirement of electrical generator backup. Warehouses are the backbone of a successful supply chain and cannot afford to be interrupted, else downstream operations are negatively affected and affects customer facing service levels. Full generator backup on warehousing operations are very common and the space should therefore be allowed when planning the building footprints and operational space.

Similar to LED lighting, solar technology has vastly improved over the years, resulting in the increase in the demand and the reduction of the capital cost. In Southern Africa, sunlight is in abundance, and the return on the investment can be ratified in a very reasonable timeframe.

Warehouses have wide open roof spaces and are ideal for the fitment of solar. Ensure that the roof is designed in such a manner to support the weight of solar panels without compromising the structural integrity. Referring to the site development planning, if the building is placed in such an orientation to optimise on the benefit of solar energy, the business case for such an investment is further improved.

Alongside the generators, solar provides backup during the day, and inverter and battery farms can supplement the demand during the evenings should there be failures.



SITE DEVELOPMENT PLANNING

Site Security

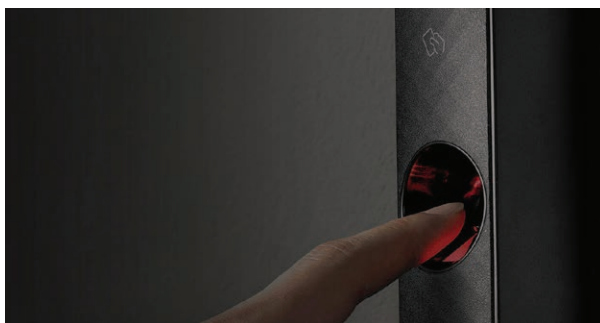
With the recent riots experienced in Durban in 2022, we have seen that large warehouses have been the targets for creating unrest and disruptions, potentially cutting off critical food supplies to stores. Ever since, the risk of looting and unrest has led to businesses revisiting their site security and levels of protection on site.



Site perimeter fence with electric wiring.

When designing the warehouse, ensure that the perimeter of your site is well-lit and protected by means of fencing and decent CCTV and surveillance, monitored either in-house or by experienced 3rd party security firms. Additional security measures must be considered at the weak points such as gate and staff entrances.

Site Access may also be controlled by means of biometric readers allowing access to staff in designated areas only and avoiding unsolicited access to areas that are high risk areas for theft and pilferage.



Fingerprint readers to control access or monitor time and attendance.

When designing a warehouse or distribution centre, selecting the right storage solutions is crucial to optimizing efficiency and space utilization. Warehouse racking systems and advanced storage technologies play a significant role in this process, offering various options to meet different operational needs. From traditional adjustable pallet racking to sophisticated automated systems, each solution provides unique benefits in terms of storage density, accessibility, and equipment requirements. Additionally, considerations such as flooring, lighting, and fire safety are essential to consider when selecting a storage type.

Block Stack

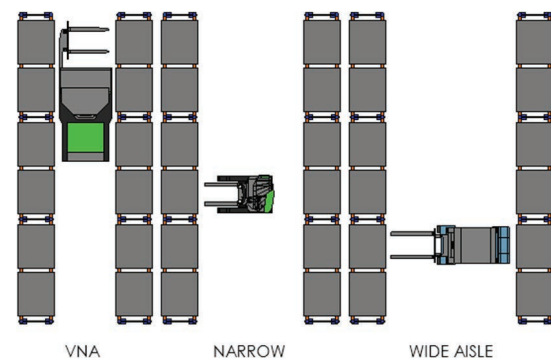
Block stacking is a basic and cost-effective pallet storage method where pallets are stacked directly on the warehouse floor without additional infrastructure. Ideal for environments with low SKU counts and high throughput, it allows flexible row depths and heights, typically up to 5-6 meters obviously depending on the product's weight and stability. While it offers high-density storage and quick setup, block stacking can become inefficient in managing FIFO or batch control, leading to a phenomenon known as "rat holing" and reduced floor utilization. Safety concerns also arise if stacking rules are not followed, increasing the risk of pallet collapse.

Warehouse racking solutions offer a wide variety of options tailored to different operational needs, from basic to highly sophisticated systems. We will not give a brief description of each of the most common pallet racking types:

Adjustable Pallet Racking (APR)

This is the most widely used warehouse storage system due to its versatility. The system is built with vertical uprights connected by horizontal beams, allowing easy access to individual pallets. APR can be tailored into three main configurations:

- Wide Aisle (WA)
- Narrow Aisle (NA)
- Very Narrow Aisle (VNA)



Each of the above systems provides different levels of storage density and requires specific types of equipment. Wide Aisle (WA) setups are best suited for operations with lower height and volume, allowing for a combination of manual picking and machinery in the aisles. Narrow Aisle solutions, which utilize reach trucks, offer a more space-efficient storage option, increasing storage density while maintaining operational flexibility for both ground-level picking and machine movement. Very Narrow Aisle (VNA) systems, characterized by their compact aisles and high storage capabilities, use specialized equipment, with a focus on full pallet retrievals and piece picking in dedicated machine-only aisles.

STORAGE SOLUTIONS

Double Deep Racking Systems

To further increase your rack density, one can look at introducing double deep adjustable pallet racks (for wider aisle applications). These racks increase storage density by allowing two pallets to be stored back-to-back in wider aisles. This system requires specialized lift truck attachments to access the second pallet which reduce weight capacity due to the extended reach and limits operations to LIFO. It also demands skilled operators to safely manage the off-centre loads and avoid tilting risks.



Example of double deep rack with special mast lift truck.

Mobile racking

This type of racking maximizes warehouse floor space by mounting conventional racking on electronic mobile bases that move along rails, always allowing full selectivity without the need for multiple aisles. It's ideal for environments like cold rooms where space and refrigeration costs are high. Mobile racking requires precise installation and can be costly due to its mechanical components.



Mobile Racking during installation.



Schematic of mobile racking with a single aisle.

Push-back racking

This is a high-density storage solution that stacks multiple pallets behind each other, increasing storage capacity by using a LIFO principle where pallets are added and retrieved from the same aisle. This system is typically installed against a wall and relies on forklifts to push pallets back in a row, with depth limited to 3 - 4 pallets and a height of up to 6 meters. It comes in two types:

cart/shuttle push-back, which uses inclined rails and gravity to move pallets on individual carts that nest within each other, and roller push-back, which uses inclined rollers to do the same thing. While efficient, this type of racking requires careful management of pallet speed to prevent accidents.



Schematic of mobile racking with a single aisle.

Pallet Flow Racking

This racking type is ideal for high-volume throughput and batch control, utilizing gravity to manage an unlimited depth of pallets. Unlike push-back racking, which stores pallets in a limited depth of 3 - 4 units, pallet flow operates on a FIFO principle with pallets fed from one side and rolling forward on inclined rollers to the front. It features safety mechanisms like pallet separators and brake rollers to control pallet movement, offering a more sophisticated and safer option compared to push-back racking. However, it requires well-maintained pallets to avoid issues with them getting stuck or jammed.



Pallet Flow Racking with solid rollers.

STORAGE SOLUTIONS

Drive-in/Drive-through

These racking systems are high-density storage solutions suited for a low variety of SKUs with high volumes per SKU. Drive-in racking operates on a LIFO principle, where both picking and replenishment occur from the same side, while drive-through racking uses a FIFO principle, allowing operations from opposite sides. Both systems use rails instead of beams to support pallets, and forklifts or reach trucks drive into the racking to place pallets from the back to the front. Despite their efficiency, these systems pose safety risks due to the confined spaces within the racking structure, requiring skilled operators to navigate carefully to prevent potential rack collapses.



Example of a LIFO drive-in racking system.

Shuttle Racking

Shuttle/mole racking is a high-density storage solution designed for efficient handling of high-turnover goods stored in full pallets. Unlike drive-in racking, shuttle racking uses a remote-controlled shuttle, or "mole," to move pallets in and out of the system, enhancing safety by eliminating the need for forklifts to navigate within the racking. The shuttle operates on specially designed rails within the racking system, lifting and placing pallets in their designated positions without user intervention for navigation. It can operate on either a FIFO or LIFO basis, making it a versatile and safe option for managing high-volume inventory.



3D schematic of a shuttle rack installation.

Cantilever Racking

This type of is designed for storing long, irregular items like pipes or boards that don't fit conventional racks. It features vertical uprights with horizontal arms extending outward, allowing for uninterrupted horizontal storage space. The arms can be adjusted to accommodate different item lengths and are commonly used in production facilities for raw materials or long finished goods.

Small Item Storage

Mezzanines

A mezzanine floor is an intermediate level built within a warehouse to maximize vertical space without expanding the building. Custom-made and scalable, mezzanines offer growth potential within the same facility, reducing the need for relocation and minimizing downtime. While mezzanines are flexible and can be relocated, careful planning is essential to ensure they fit operational needs and comply with structural and safety requirements. Key considerations include point loads, fire regulations, lighting, and council approvals, making the guidance of a structural engineer crucial for a successful installation.

The different types of typical mezzanines:

- **Structural Supported Mezzanine**

- o Built on steel frames and columns
- o Independent of the main warehouse structure
- o Ideal for storing heavy items and integrating with other storage solutions



Structurally supported mezzanine.

- **Rack Supported Mezzanine**

- o Use underlying racking to support mezzanine floor, provided racking can support the load
- o Ideal for storing small to medium-sized products with dense storage space
- o Goods can be moved with low-level machines like hand pallet jacks, trolleys, and roll cages

STORAGE SOLUTIONS



Example of a carton flow installation on a mezzanine floor.

Shelving

Shelving is a light-duty storage system made from thin sheet metal, featuring sides, dividers, and backing boards. It is commonly used in small picking areas and on mezzanine floors for slow-moving and small goods. Like carton flow racking, shelving offers easy access to many storage locations and utilizes space efficiently due to its slender design. It can support weights up to 100 - 150kg per shelf, typically on the ground or first level. However, replenishing storage locations can be challenging, as spaces must be emptied before they can be refilled. There are two main types of shelving, which, while similar in construction, have distinct differences.

- **Bolted Shelving**

- o Assembled with nuts and bolts
- o Very durable and sturdy
- o Time consuming to install
- o Not very flexible or adjustable

- **Boltless Shelving**

- o Features pre-punched holes on angled
- o Simple and quick to install
- o Easy adjustable to different heights
- o Risk of shelves popping out of position (this is mitigated with newer designs)

Decking

Decking is an accessory for racking systems that adds extra storage levels within existing racks, increasing storage density in a compact area. It's useful for storing irregular, loose, or smaller items and can be adapted to accommodate various storage needs. Decking is flexible and can be rearranged as necessary, but it may affect in-rack sprinkler systems and fire protection, so consultation with a fire engineer is advised to ensure compliance with safety regulations.

There are three common types of decking utilised in the warehousing environment:

- **Solid Wooden Decking**

- o Usually constructed from treated pine
- o Most common and economical solution
- o Pre-assembled wooden decks
- o Quick and easy to install
- o Slats can be close to one another for a solid deck if needed

- **Wire Mesh Decking**

- o Constructed from pre-pressed or welded wire mesh
- o Provides a strong and durable storage platform
- o Ideal for boxed items or totes
- o Not suitable for small or loose parts
- o Reduced fire risk as water can easily permeate and non-combustible

- **Solid Metal Slats**

- o Most expensive type of decking
- o Ideal for heavy-duty products, which require a smooth surface
- o Easy to clean



Example of wooden decking.

Mini Racking

Mini racking is a scaled-down version of standard pallet racking, designed for smaller items and boxes. It features light-duty frames and beams, with multiple levels for increased storage density, and is typically half as deep as standard racking to facilitate easier access in smaller spaces.



STORAGE SOLUTIONS

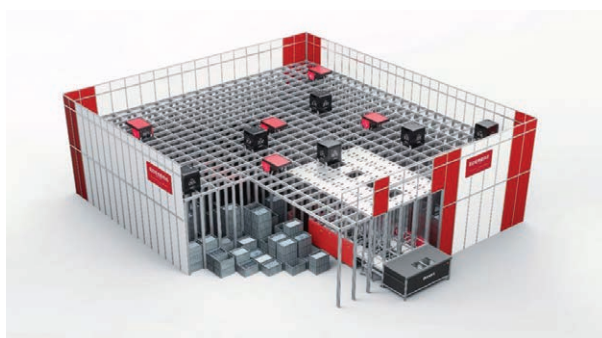
Automated Solutions

3D shuttle Solutions

Solutions like Eurofork and SMS, enhance storage efficiency by moving in three dimensions, unlike traditional shuttles that operate on a single horizontal plane. While conventional shuttles are limited to moving pallets within one level, 3D shuttles can navigate both horizontally and vertically, allowing them to access multiple levels of racking. They achieve this through a vertical lift mechanism, which moves the shuttle between different heights, and horizontal shuttle cars that position it within each level. This capability allows for more effective use of vertical space and improved inventory management, making 3D shuttle systems ideal for high-density storage environments.

Cube Solutions

Cube or crate storage solutions, like AutoStore and Powercube, are advanced automated storage and retrieval systems (AS/RS) that combine high-density storage with robotic technology. These systems feature a modular grid structure where uniform bins are stacked in vertical columns. Robots handle the movement of these bins, operating around the clock with minimal downtime. Goods are either fed into or picked from the system at dedicated stations. The modular design allows these systems to fit various building shapes and expand easily by adding more modules and robots. Ideal for single items, small goods, and slower movers, such solutions are commonly used by distributors in the fashion and accessories industries.

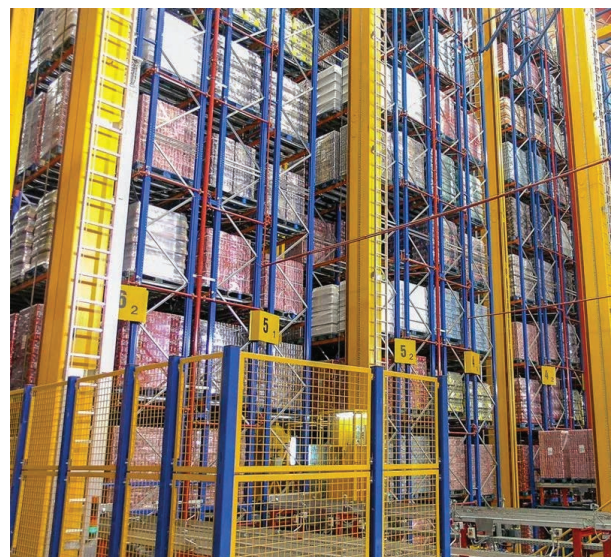


Schematic of an AutoStore installation.

Crane Solutions

Automated Storage and Retrieval Systems (AS/RS) cranes are sophisticated machines designed to enhance storage density and efficiency in warehouses. These cranes, such as stacker cranes and Miniloads, operate within narrow aisles to move

goods with precision and speed. Stacker cranes handle large pallets, achieving high throughput rates, while Miniload cranes manage smaller items like bins and cartons. Both types are managed by advanced Warehouse Control Systems (WCS), which direct their movements and ensure safety. Notably, AS/RS cranes operate in a closed system, eliminating direct human interaction within the aisles and allowing for uninterrupted, automated operations that maximize space and streamline retrieval processes.



Typical AS/RS Crane System.

An automated storage solution, ensuring a constant flow of products from the warehouse slots to the pick stations.



Understanding the nuances can unlock additional capabilities.

STORAGE SOLUTIONS

GTP Solutions

Goods-to-person (GTP) solutions, streamline order fulfilment by bringing items directly to the picker, minimizing travel time and increasing efficiency. These systems utilize a combination of automated technologies such as conveyors, shuttles, robotic arms and AMRs to transport goods from storage locations to picking stations. By reducing the need for manual handling and moving, GTP systems enhance productivity and accuracy, making them ideal for environments with high order volumes and complex inventory needs. Their integration into warehouse operations supports faster and more efficient order processing, meeting the demands of modern logistics.



A picker picks from a tote bin brought to a pick station by an AMR and tote AS/RS solution.

Sortation

Advanced sortation systems leverage cutting-edge technology to streamline the sorting process and enhance efficiency. These systems often utilize high-speed conveyors, robotic arms, and sophisticated software to accurately direct items to their designated locations. Technologies like cross-belt sorters, which use individual belts to move items to specific lanes, and tilt-tray sorters, which tilt trays to drop items onto chutes, offer precise and fast sorting capabilities. Additionally, automated guided vehicles (AGVs) and smart sortation systems with AI-driven algorithms further optimize performance by adapting to real-time conditions and demand fluctuations, ensuring swift and accurate order fulfilment in complex logistics operations.



Conventional cross belt sorter



Sorting and picking operation powered by AMR technology.

Other Considerations?

When designing a warehouse or distribution centre, several factors beyond racking systems must be considered. Flooring must accommodate the load and movement of vehicles and high-lifting machinery, with attention to height tolerances. Proper lighting is essential for various tasks, with higher lux levels in picking areas and clearance to avoid obstructions. Fire safety involves meticulous planning of detection systems, sprinklers, and adherence to regulations. Additionally, ensuring that racking systems are installed correctly and can handle warehouse conditions is crucial for safety and efficiency. Integrating these elements into the storage design is vital for a safe, functional, and compliant operation.

In Summary

Selecting the right storage solutions is essential for optimizing warehouse and distribution centre efficiency. Options range from basic block stacking to advanced automated systems like 3D shuttles and cube solutions. Traditional racking systems, including adjustable pallet racking, double deep, and mobile racking, offer varied benefits in storage density and accessibility. For high-density needs, push-back, pallet flow, and drive-in/through racks are ideal, while shuttles and GTP systems enhance order fulfilment and efficiency. Small item storage solutions, such as mezzanines and shelving, add flexibility, while automated systems, including AS/RS cranes and sortation technologies, streamline operations. Considering factors like flooring, lighting, and fire safety is crucial to creating a functional and compliant warehouse environment.

MATERIALS HANDLING EQUIPMENT

Material handling equipment (MHE) plays a crucial role in the efficiency and safety of supply chain operations. Choosing the right equipment is essential to ensure that tasks are completed effectively. While lift trucks are a common tool, the complexity of operations often requires specialized solutions. Before replacing or purchasing new equipment, it's important to reassess your operational needs and stay informed about market developments. Factors like the type of product being moved, the frequency of movement, and the operating environment should be considered. Additionally, evaluating the variety of available lift trucks and other MHE, including considerations for fuel type, operating environment, lift capacity, and aisle width, can help narrow down the options. This approach ensures that you select the most suitable equipment for your specific requirements, balancing efficiency, cost, and safety. We will not delve deeper into the main types of MHE on the market:

Pallet Trucks

Pallet trucks are versatile and cost-effective lift trucks designed to transport heavy loads over short distances on smooth surfaces. Commonly used in warehouses, production, and manufacturing environments, they can operate in both wide and narrow aisles. Different pallet trucks are available to suit various operations, depending on the volume, weight, and distance of the products being moved. In the following sections, we will explore the different types of pallet trucks available and their specific applications.

Manual Pallet Trucks

- More commonly known as Hand Pallet Jacks (HPJ)
- Versatile workhorses, used in numerous operations
- Ideal for offloading trucks via dock levellers or moving things from point A – B
- Can lift loads up to 2 ton to a height of 120mm
- Best suited to medium loads over a short distance
- Cost is roughly R3,000-6,000



Basic hand pallet jack common in any facility.

High Lift Pallet Trucks

- Manually operated like a HPJ
- Enables higher lift heights than HPJ up to 800mm
- Due to increased lift height, maximal weight capacity is 1 ton
- Suited for pallets without bottom stringers (Euro pallets).



High lift pallet truck.

Electric Pallet Trucks

- Also known as powered pallet trucks (PPT)
- Lift capacity ranges from 1.5-3 tons
- Lift heights similar to manual pallet trucks
- Battery powered and more ergonomic, allowing for high manoeuvrability
- Simple controls and design negate the need for a license
- 2 types, walk-behind and ride-on
- Walk-behind requires operator to walk behind the truck and steer
- Ride-on allows the operator to stand on a platform and drive the machine to its destination, usually used to offload inbound stock in a high throughput facility
- Cost depends on many factors but ranges from R150,000-225,000



Walk-behind pallet truck.

MATERIALS HANDLING EQUIPMENT



Ride-on pallet truck with standing platform.

Pallet Stackers

Pallet stackers are designed to transport and stack heavy loads over short distances on smooth surfaces, allowing for the lifting and stacking of pallets on top of one another. They can lift loads between 1 ton and 3 tons to heights ranging from 2,000mm to 4,700mm. Available in both walk-behind and ride-on versions, pallet stackers are versatile, operating in wide and narrow aisles, and some models can even handle very narrow aisle and low-level racked storage solutions.

Manual Pallet Stackers

- Use a hydraulic system to lift the load, which requires the operator to manually crank the mechanism
- Cost-effective solution
- Suitable for operations with low demand for pallet stacking
- Require the operator to manually manoeuvre the equipment and load
- Not commonly found in lift truck fleets
- Price range: R20,000-30,000



Manual Pallet Stacker.

Electric Pallet Stackers

- Eliminate the need for manual lifting and manoeuvring
- Available in walk-behind and ride-on versions
- Walk-behind require the operator to walk and steer manually, offering lower throughput capacity.
- Ride-on allow the operator to use the battery-powered motor for both lifting and driving, providing higher throughput and better ergonomics.
- Ideal for low-level operations with infrequent stacking
- Lighter than reach trucks, could potentially be used on mezzanine floors
- Simple controls and design negate the need for a license
- Cost ranges from R180,000 - 280,00



Electric pallet stacker.

Order Pickers

Order pickers are designed specifically for picking customer or store orders from various storage solutions. These lift trucks are commonly used for handling less-than-pallet loads, such as individual cartons or cases. Some variations are also capable of put-away tasks or retrieving full pallets from racked storage solutions. While there is no specific manual version, different types of electrically powered order pickers are available to meet diverse operational needs. The next paragraphs will give more insight into the different types of order pickers.

MATERIALS HANDLING EQUIPMENT

Low-level Order Picker

The low-level order picker (LLOP) is essential for high throughput picking operations, commonly used in FMCG and retail sectors. Designed to efficiently transport both load and operator through various picking tasks, LLOPs can carry up to 3 pallets or 5 roll-cages, with fork lengths ranging from 1,000mm to 3,100mm. They typically have a load capacity of 2 to 2.5 tons. Unlike powered pallet trucks (PPTs), where the operator faces the load, LLOP operators face away from the load, with the controls positioned accordingly. The average pick rate is 120 - 160 cases per hour. Variations include models with lifting platforms, ergonomic forks, pick-to-light frames, or detachable ladder trolleys for enhanced accuracy and reach. These trucks are best suited for wide or narrow aisle storage due to their fork length and cost between R220,000 and R300,000.



Low Level Order Picker.

Man-Up Order Picker

The man-up order picker (MUOP) is designed to perform similar functions as a low-level order picker (LLOP), such as picking cartons or cases, but differs significantly in its design and capabilities. Unlike the LLOP, which operates in wide or narrow aisles up to 2,500mm high, the MUOP is built for very narrow aisle (VNA) storage and can reach heights of up to 12,500mm. The operator's cab lifts with the forks, allowing access to high racked storage to pick cases and place them onto a pallet. MUOPs are suited for low to mid-volume operations with a high SKU range and a case pick rate of 40-60 cases per hour. Variations include walk-through models for picking large or bulky items. These advanced machines offer high building cube utilization but come with higher maintenance costs and downtime due to their complexity. MUOPs typically have a lift capacity of 1,000kg to 1,500kg and cost between R750,000 and R1,150,000.



Walk through man-up order picker.

Turret Truck

The turret truck is an advanced variation of the man-up order picker (MUOP) designed for very narrow aisle (VNA) operations. Unlike standard MUOPs, turret trucks feature forks that can swivel 90° to the aisle, allowing them to operate in aisles as narrow as 1,800mm. This capability enhances their functionality for putting away and retrieving full handling units, such as pallets or stillages. Some models can reach impressive heights of up to 17,000mm, making them the highest-reaching unsupported mast lift trucks available. However, their complexity and advanced features make them costly, ranging from R2,000,000 to R3,100,000. Due to their proximity to stock (as close as 75mm), maintaining a flat floor is crucial to prevent sway-induced damage and ensure safety.

Reach Trucks

Reach trucks are highly popular lift trucks used in warehouses worldwide, designed to carry loads within their wheelbase, making them ideal for narrow aisle rack solutions. They are commonly used to store and retrieve pallets in high bay racking up to 14,000mm and are also effective for block stacking or moving bulk volumes onto mezzanine structures. Reach trucks are essential for operations requiring frequent high bay lifting and maximizing storage density, making them prevalent across industries like automotive, pharmaceuticals, FMCG, and e-commerce.

MATERIALS HANDLING EQUIPMENT

Over the years, numerous variations of reach trucks have been developed, including seated or standing models, tilting cabs, freezer cab versions for cold environments, and even outdoor variants. Additionally, an array of accessories, such as weight indicators, in-fork cameras, and height selectors, can be added to customize these trucks. Due to the wide range of options, pricing varies, but a standard 1.6-ton reach truck with a 9,000mm lift height typically costs between R625,000 and R900,000.



Reach truck in action.

Lift Height, Capacity and Deration

Reach trucks commonly have a lift height of around 9,000mm, though models offer lift heights ranging from 2,700mm to 14,000mm. These trucks also vary in lifting capacity, from 500kg to 2,700kg. However, it's crucial to consider deration—the decrease in lifting capacity at higher heights. For example, a reach truck with a 1,600kg capacity may only lift 400kg at its maximum height of 14,000mm due to mast construction and load centre dynamics.

Mid-level reach trucks typically have dual mast systems, while high-level ones may feature triple or quad masts. The number of mast stages impacts closed mast height and visibility through the mast. As reach truck technology advances, features like automatic height adjustments, speed control, and alert systems enhance safety and efficiency.

Floor Requirements

To maintain stability, reach trucks are designed with low ground clearance, making them best suited for smooth, solid concrete floors, ideally FM2 standard. Uneven floors can compromise the truck's stability and the safety of the load, potentially leading to stock falling or even the truck toppling. Additionally, rough surfaces or exposed floor joints can cause premature wheel wear, increasing maintenance costs.

Forklifts & Counterbalance Truck

Forklifts, also known as counterbalance lift trucks, are highly versatile and widely used across various industries. They can handle heavy loads ranging from 1 to 3.5 tons and lift them to heights of up to 7,000mm. Their design features a counterbalance system that positions the weight behind the rear wheels, allowing them to lift bulky loads with a load centre that would tip other lift trucks. However, their size limits their operation to aisles wider than 3,500mm.

Forklifts are ideal for tasks such as loading and unloading trucks and block stacking, though they are typically used alongside other specialized lift trucks in high-volume operations. With numerous models, propulsion options, and attachments available, forklifts can be tailored to various needs. Prices for a standard 2 to 3.5-ton electric forklift with a 7,000mm lift height range from R450,000 to R600,000, making them a suitable choice for facilities that need a reliable lift truck for occasional use.

The added advantage.



MATERIALS HANDLING EQUIPMENT



Common counter balance forklift truck.

Tow Tractors & Trailers

Tow tractors are ideal for high-volume operations that require moving multiple handling units over long distances or between separate facilities on the same premises. Unlike forklifts they have no forks, these tractors are equipped with high-torque engines and towing hooks, enabling them to pull several mobile handling units simultaneously.

Available in various propulsion types, tow tractors are commonly battery-powered for indoor use. They are versatile and can also assist with low-level order picking, especially when dealing with trolleys rather than pallets. Basic models, such as small battery-powered walkie tow tractors, are designed for short-distance towing and tasks like loading and unloading.

Tow tractors typically offer towing capacities between 1,000kg and 3,000kg, with specialized models capable of towing up to 40 tons. A new 3,000kg battery-powered tow tractor generally costs between R220,000 and R275,000. To ensure effective operation, it's crucial that trailers are compatible and follow the tow tractor's path smoothly.



Tow tractors are common in production facilities and production lines.

Trailers

Trailers play a crucial role in maximizing the versatility and efficiency of tow tractors. Over the years, various trailer options have been developed to meet different operational needs, ranging from simple airport baggage trolleys to sophisticated automotive component carriers.

For operations involving significant turning and manoeuvring, such as navigating tight corners, it's essential to pair the tow tractor with a purpose-built trailer. These specialized trailers are designed to follow the exact path of the tow tractor, minimizing trailer drag and optimizing operational efficiency. In contrast, for operations with minimal manoeuvring requirements, a simple mobile handling unit with a standard trailer arm may suffice.

The cost of trailers varies widely based on their intended use, load capacity, accessories, and manufacturer, making it difficult to provide a precise estimate.

Pallet Shuttles

Pallet shuttles are remote-controlled under-pallet carriers that navigate along a rail system within a high-density storage setup. They are commonly used in conjunction with lift trucks or automated conveyor systems to efficiently manage inventory.

These systems are designed for high-volume operations with limited SKU diversity, maximizing storage density with lanes that can range from 5 to excess of 20 pallets deep, depending on operational needs. They are particularly effective in temperature-controlled environments where space and operating costs are at a premium.

Pallet shuttles are electrically powered, either by batteries or high-powered capacitors, and can be single or multi-directional, with lift capacities up to 1,800kg. They support both FIFO and LIFO storage principles and are typically integrated into systems with many storage lanes but few shuttles. Costs for a single pallet shuttle unit range from R420,000 to R600,000, depending on the model and manufacturer. They can be manually or automatically moved between lanes as needed.

Manual Pallet Shuttles

In the pallet storage process, a lift truck operator first retrieves a pallet shuttle from either another storage lane or a dedicated parking bay and positions it in the desired storage lane. The operator then places the pallet onto the shuttle and uses a

MATERIALS HANDLING EQUIPMENT

to control it. The shuttle lifts the pallet, moves it to the next available position in the lane-determined by its sensors-and lowers it onto the rails. After storing the pallet, the shuttle returns to the front of the lane for the operator to either load another pallet or remove it.



Manual Pallet Shuttle

Automatic Pallet Shuttles

The main function of an automatic shuttle is like a manual one, with the key difference being how it is placed into and removed from storage lanes. In an automated system, shuttles are moved between levels and lanes using a pallet stacker crane or vertical lifts, eliminating the need for a lift truck. Some systems may also use 4-way travel shuttles for this process.



Example of a 4-way shuttle.

Automated Vehicles & Mobile Robotss

Automated Guided Vehicles (AGVs) and Automated Mobile Robots (AMRs) are both material handling solutions designed to operate without human intervention, but they function quite differently. AGVs are akin to trains, constrained by predefined tracks or pathways, which guide them between specific points. In contrast, AMRs are more versatile, like ride-hailing cars, capable of navigating freely and adapting their routes based on real-time conditions, even if the start and end points are the same.

Automated Guided Vehicles (AGV)

Automated Guided Vehicles (AGVs) are versatile material handling solutions available in various forms, designed to automate tasks typically performed by conventional lift trucks, such as forklifts and reach trucks. They operate using fixed guidance systems, which can include wires, QR codes, magnetic strips, or lasers, and are programmed to follow specific routes. While AGVs are adept at repetitive tasks and can function 24/7 without the need for breaks, they are constrained to predefined paths and cannot navigate around obstacles without intervention. Sophisticated AGVs are equipped with obstacle detection and avoidance features, but they may require manual intervention or redirection if obstacles are encountered.

AGVs are ideal for operations that involve consistent movement of loads between fixed points or for automated storage and retrieval in controlled environments. However, their fixed-path limitations and the complexity of guidance systems can make them less suitable for highly dynamic or complex operations. The capacity, height, aisle width, and cost of AGVs are influenced by their base lift truck, guidance system, and control software.



Automated Pallet Stacker with vision systems.

Autonomous Mobile Robots (AMR)

Automated Mobile Robots (AMRs) are available in a range of sizes and designs, typically smaller than AGVs and not derived from existing lift trucks. Unlike AGVs, which are constrained to fixed paths, AMRs leverage sophisticated software and advanced sensory technologies to navigate their environment dynamically. Equipped with various sensors, cameras, and lidar, AMRs use AI-driven software to learn and adapt to their surroundings, enabling them to reroute in real-time to avoid obstacles or congestion. Their versatility makes them ideal for applications such as fine-pick operations, low-level goods-to-person systems, and sorting tasks.



Compiling
comprehensive
specifications to
suit the operation.

MATERIALS HANDLING EQUIPMENT

The cost and capabilities of AMRs vary depending on factors like load capacity, sensory technology, and software sophistication, making them well-suited for complex and dynamic warehouse environments where flexibility and real-time decision-making are essential.



AMR's in a mobile shelf operation.

Container Handling

A large volume of consumer and work-in-progress goods are transported globally in steel containers. To handle these containers, various material handling equipment (MHE) solutions are required for tasks such as stacking, de-stacking, loading, and unloading onto or from trucks or railway cars. Different types of container handling solutions are available to meet diverse operational needs and environmental conditions. Below we will explore some of the main types of MHE for containers:

Heavy-Duty Forklift

- Handle loads up to 40 tons
- Capable of lifting a 40ft containers up to 6000mm
- Typically, diesel powered due to torque requirements
- Generally used outdoors due to size Reach Stacker
- Evolution of heavy-duty forklifts designed specifically for shipping containers
- Has clamping mechanism instead of forks for secure container handling
- Lifts up to 40 tons
- Can stack containers 4 high and 2 deep
- Allows stacking in condensed areas
- Cube configuration of stacks can limit accessibility and increase double handling

Container Handler

- Performs similar tasks to reach stackers although have less reach capability
- Can create stacks 4 high but only 1 deep
- Able to work in narrower aisles
- Lower storage density compared to reach stacker



Container Reach stacker in action.

Container Jack

- Cost effective tool for lifting container onto or off trucks
- Place one on each of the corner of container
- Uses telescopic legs to lift container
- Eliminates the need for reach stacker or heavy-duty forklift



Manual container jack.

In Summary

Material handling equipment (MHE) is pivotal in driving efficiency and safety within supply chain operations. Selecting the right MHE-whether it's pallet trucks, stackers, order pickers, or automated systems-requires a thorough understanding of operational needs, load capacities, and environmental factors.

Pallet trucks and stackers offer solutions for varying lift heights and capacities, catering to different warehouse setups and operational demands. Order pickers and reach trucks excel in specialized tasks such as picking and high-bay storage. Automated Guided Vehicles (AGVs) and Autonomous Mobile Robots (AMRs) bring advanced capabilities to dynamic environments, with AMRs offering greater flexibility and real-time adaptability. Additionally, container handling equipment, including heavy-duty forklifts and reach stackers, is crucial for managing large volumes and ensuring efficient container operations. By carefully evaluating these options and aligning them with specific requirements, businesses can enhance operational efficiency, safety, and overall cost-effectiveness in their material handling processes.

MATERIALS HANDLING EQUIPMENT

Reverse Logistics

With the focus on more sustainable supply chains and circular economies, reverse logistics have become an important design element in the supply chain. Reverse logistics is the process of moving goods from their final destination back through the supply chain to capture value or to ensure proper disposal. It typically involves the return of assets from stores such as pallets, rollcages, dollies and bins. It also provides the opportunity for the warehouse or distribution centre to become a central hub for waste disposal and recycling taking advantage of the volumes. Finally, it may also involve the return of products from customers for purposes such as returns, repairs, or disposal.

These are one of the building elements to consider as part of your distribution centre planning, depending on the type of industry you operate in.

Returnable Transit Packaging (RTP)

Returnable transit packaging refers to durable, reusable containers, pallets, crates, or other types of packaging design to transport goods multiple times within a supply chain. Unlike disposable packaging or dispatching units, RTP's are intended to be returned, cleaned and reused, making it more sustainable and cost effective. RTP's help to reduce waste, lower packaging costs and improve logistics efficiency.



Nestable totes or trays.



Collapsible bins efficient for return transport.



Rollcages, boosting efficiency and turnaround times at distribution and store level.



MATERIALS HANDLING EQUIPMENT

After goods have been dispatched on these RTP's to store, it is important to recover these to use it as many times as possible. Many of these are unfortunately lost in the supply chain due to theft or poor management, but can also potentially be traced depending on the value of the asset.

RTP's are emptied at store level and then returned to the distribution centre on the same vehicle doing the delivery, allowing the vehicle to add value rather than travelling back empty.

At the distribution centre they are received, recorded, sorted into their respective types, and reused within the operation for the next goods to be dispatched to stores. This process is repeated daily. Depending on the type of goods that are being transported, it may required to wash the RTP's before it can be reused, for safety and hygiene reasons.

For this reason, return centres have also become washing plants ensuring that trays are cleaned and ready for its next trip. Although very costly, the scale of the operation may warrant the need for this type of equipment to ensure the RTP's are available for reuse, which in turn allows the pool of trays to be minimized, keeping it close the source of where it is required.



Typical traywash machine.



Infeds of a traywash machine.

Packaging materials were often simply disposed of and ended up in landfills. We have seen the impact this has had on our climate and the environment. It is now a sharp focus and imperative step in the supply chain to recover as much of these materials as we can and to dispose of it in a responsible manner.

Goods packaged in carton boxes or plastic wrapping are in most cases decanted or unpacked at the store level, generating large amounts of recyclable materials. Rather than the stores having to deal with waste, taking up valuable back of house space and warranting the need for expensive equipment to dispose thereof, it is collected and sent back to the distribution centre on the same delivery vehicle having to return back to the source in any event.

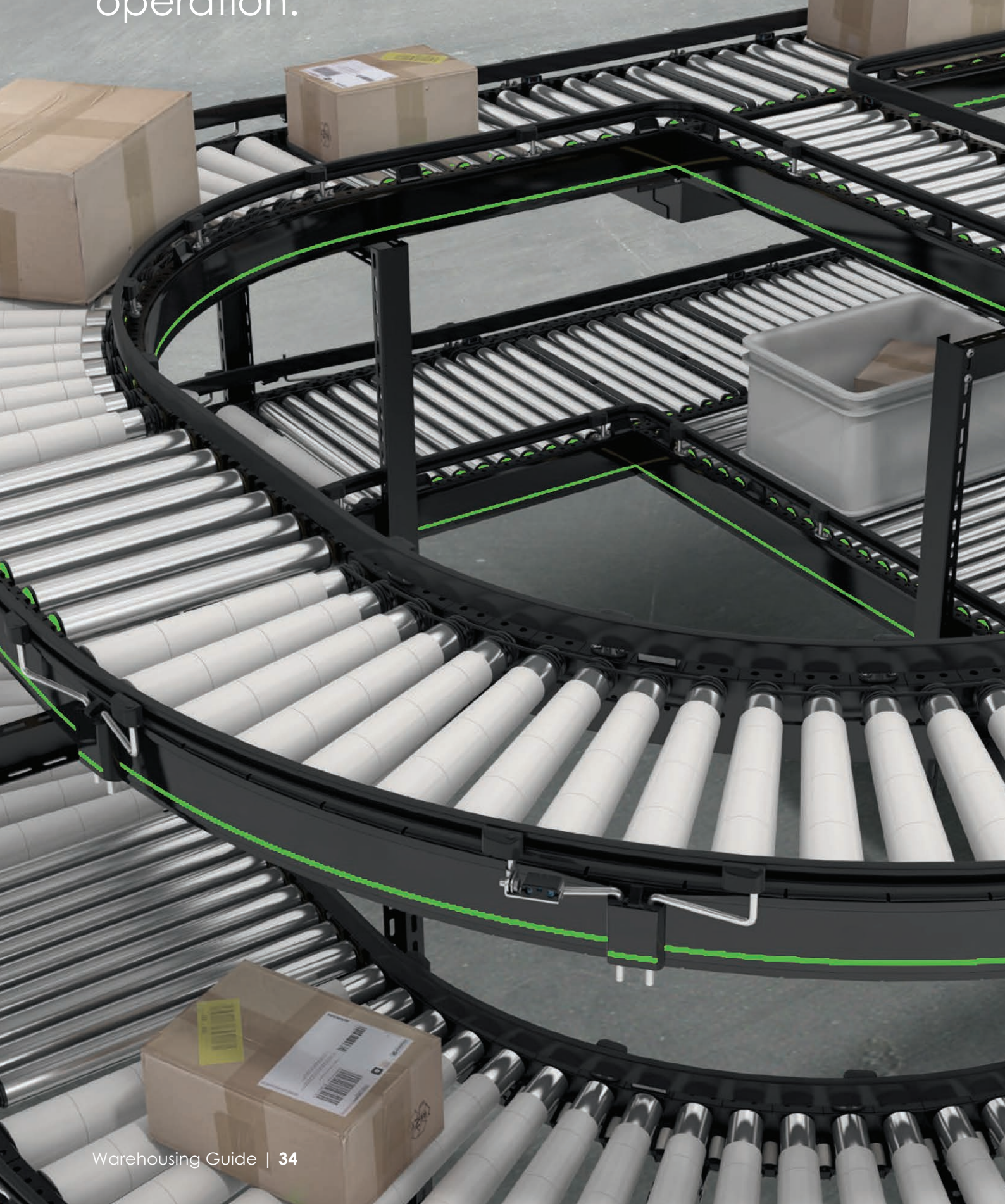
Distribution centres can leverage on the scale or volume of recyclable materials from the many end customers, and invest in proper technology to recycle goods efficiently. Depending on the recyclable materials market's demand, a recycling operation can generate profit from potential buyers of these waste materials and can reinvest this money back into the business.

Equipment such as balers are used to compact and bale the cardboard and plastic to make it more efficient for transporting purposes to paper mills or similar. The waste is sorted into different grades and types of materials, and then processed. Once there is sufficient number of bales to dispatch, a vehicle full of recyclable waste is loaded and sent off to the paper mills, or even exported to other countries.



Typical cardboard baler.

Compiling comprehensive specifications to suit the operation.



SOFTWARE AND BUSINESS INSIGHTS

In the dynamic world of warehouse operations, leveraging a range of different management software is an easy way to boost efficiency and performance. Effective software integration into the larger business ecosystem enhances data collection and provides greater visibility into warehouse and business processes, enabling more informed decision-making. Fleet Management, Inventory Management, Warehouse Control Systems (WCS), Warehouse Management Systems (WMS), Enterprise Resource Planning (ERP), Warehouse Execution Systems (WES) and Labor Management Systems (LMS) to name a few, each play a crucial role in streamlining processes and enhancing accuracy. By utilizing these diverse tools, businesses can improve operational efficiency, reduce costs, and respond more effectively to market demands.

Enterprise Resource Planning (ERP) Systems

These systems sit at the top level of the warehouse software pyramid. They integrate various business processes into a unified platform, offering a comprehensive view of an organization's operations. Key features include real-time data access and the integration of financials, supply chain management, and other critical business functions. An ERP system enhances decision-making, streamlines processes, and provides a holistic view of business performance, which helps organizations operate more cohesively and efficiently.

Warehouse Management Systems (WMS)

These systems are comprehensive solutions designed to oversee and optimize a wide range of warehouse processes. These systems manage critical transactions within the warehouse, such as receiving, put-away, replenishment, picking, packing and shipping. By focusing on operations within the "four walls" of the warehouse, WMS ensures that every aspect of warehouse management is streamlined and efficient. Features like real-time inventory tracking, efficient order processing, and advanced space utilization allow businesses to manage warehouse resources effectively.

Warehouse Control Systems (WCS)

A WCS is integral to managing and optimizing automated material handling within a warehouse or distribution centre. The primary function of a WCS is to control material handling and flow operations, ensuring that equipment such as conveyor belts, sorters, and automated storage systems perform efficiently. WCS manages the flow of materials and products, coordinating their movement through the warehouse.

A crucial aspect of WCS is its ability to integrate seamlessly with Warehouse Management Systems (WMS). This integration ensures that data flows smoothly between systems, providing a unified view of warehouse operations. While the WMS handles broader warehouse processes, the WCS focuses on optimizing material handling tasks. This collaboration maximizes efficiency, reduces errors, and improves overall productivity in the warehouse.

Warehouse Execution Systems (WES)

WES represent a modern advancement that integrates features from both Warehouse Management Systems (WMS) and Warehouse Control Systems (WCS). WES not only manage automated equipment but also incorporate labour and order management functions, offering a more comprehensive solution for warehouse operations. They create optimal plans based on real-time conditions, addressing challenges such as equipment failures or staffing shortages. By combining the broad management capabilities of WMS with the real-time control of WCS, WES provides valuable insights and flexible task management, making them an effective tool in any warehouse and help with adapting to the dynamic operational demands of the modern day.



Typical software hierarchy.

Comprehensive
solutions designed
to optimize
warehouse processes.

SOFTWARE AND BUSINESS INSIGHTS

Fleet Management Systems (FMS)

They play a crucial role in the broader warehouse architecture by managing the transportation aspects that connect the warehouse with the outside world. These systems are designed to optimize the operation of a company's transportation assets, including route planning, vehicle tracking, maintenance scheduling, and fuel management. Within the context of warehouse operations, fleet management systems ensure efficient delivery and distribution of goods by providing real-time insights into vehicle performance and logistics. They help coordinate the movement of products to and from the warehouse, ensuring timely and cost-effective transportation. By integrating fleet management with warehouse systems, businesses can reduce transportation costs, and improve delivery reliability, making these systems integral for seamless supply chain management.

Inventory Management System (IMS)


These systems are essential for maintaining smooth and efficient warehouse operations by offering detailed control over stock levels and movement. These systems are designed to track inventory from receipt to dispatch, handling tasks like real-time stock monitoring, demand forecasting, and automatic reorder notifications. By keeping accurate records and predicting future inventory needs, they help avoid stockouts and excess inventory.

This precise management ensures that warehouses can respond effectively to customer demand and optimize storage space. Integrated with other warehouse technologies, inventory management systems drive operational excellence and support a more agile and responsive supply chain.

Labour Management System (LMS)

These systems are essential for maximizing workforce productivity in warehouse operations. These systems are designed to handle various aspects of labour management, such as scheduling, monitoring performance, and analysing productivity. LMS provides detailed tools for labour forecasting, task allocation, and tracking of work hours, ensuring that employees are efficiently matched with the appropriate tasks. Additionally, LMS can monitor individual and team performance metrics, providing valuable insights into areas where training or improvements may be needed. This targeted management approach not only boosts overall productivity but also helps lower labour costs, improve employee satisfaction, and ensure compliance with labour regulations. When integrated with other warehouse management systems, LMS enhances resource allocation and coordination, leading to a more responsive and efficient warehouse operation.



A photograph of three Jungheinrich forklifts in a warehouse. The forklifts are green and black, with the Jungheinrich logo visible on the side of each. They are positioned in a row, facing forward. The background shows high industrial shelving units filled with boxes, typical of a large warehouse environment. The lighting is bright, highlighting the forklifts and the surrounding infrastructure.

Connect your systems. Elevate your warehouse efficiency. Seamlessly integrate operations for precision, speed, and control.

Interconnection between systems

In a warehouse, integrating various software systems like Fleet Management, Inventory Management, WCS, WMS, ERP, WES, and LMS enables a tightly coordinated operation. For example, when a WMS receives an order, it can automatically check stock levels and direct WCS to move the necessary items, while simultaneously informing the LMS to allocate workers for picking and packing. The WMS can then update the ERP system with inventory and financial details, ensuring accurate tracking of goods and costs. Fleet Management software can schedule the most efficient delivery routes based on real-time data from the WMS, ensuring timely and cost-effective shipments. By connecting these systems, warehouses can maintain accurate inventory counts, optimize labour schedules, streamline material handling, and ensure that deliveries are planned and executed efficiently. This level of integration reduces errors, enhances efficiency, and provides a comprehensive view of the warehouse's operations, allowing for more precise control and quicker responses to any issues that arise.

In Summary

The integration of diverse warehouse management software systems is crucial for achieving efficient and streamlined operations in today's complex warehouse environments. Each system offers unique functionalities that address specific aspects of warehouse management. While not every warehouse requires all these systems, the right combination can be tailor-made to meet the specific needs of any operation. By selecting and integrating the most relevant tools, businesses can create a customized solution that enhances operational efficiency, reduces costs, and ensures they can adapt quickly to changing demands and market conditions. This tailored approach allows warehouses to stay competitive, maintain high standards of accuracy, and respond swiftly to both opportunities and challenges in the supply chain.

OPERATIONAL MODELS OF WAREHOUSES

In today's competitive market, the efficiency of warehouse operations is more crucial than ever for maintaining a robust supply chain. As businesses evolve and consumer demands shift, the way warehouses operate must adapt to keep up. Different operational models cater to various types of inventories, order volumes, and customer requirements, making it essential to choose the right one for your specific needs. By understanding the unique characteristics, benefits, and challenges of each model, you can better align your warehouse operations with your business goals.

Conventional Warehousing

The conventional style of warehouse operations is grounded in traditional methods of storage and picking. This model follows a systematic approach where goods are first received, then put away into designated storage locations, and later picked to fulfil orders. The process typically flows through several stages:

- Receiving
- Put-Away
- Handling
- Picking
- Packing
- Staging
- Dispatch

The conventional style offers notable benefits, such as flexibility in handling a wide range of products and ease of implementation. It's particularly well-suited for businesses with diverse product lines and lower order volumes, where personalized handling and storage are priorities. However, this model does come with challenges, including higher labour costs and potentially slower order fulfilment compared to more automated systems. While it may not be ideal for handling large volumes of fast-moving goods, the conventional style remains effective for warehouses that need a balanced approach to flexibility and operational management.

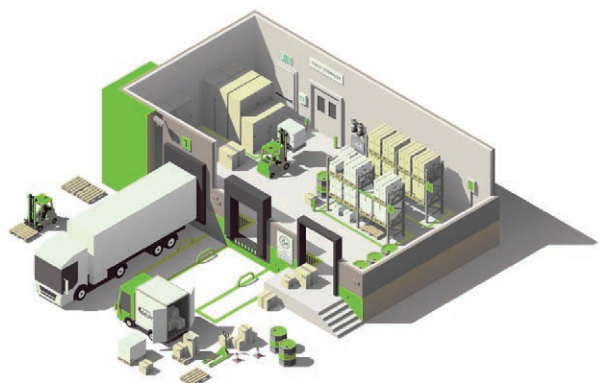


Cross Docking

Cross-docking is an innovative warehouse operational model that focuses on minimizing storage time by moving goods directly from inbound to outbound transportation. This model involves several critical steps: receiving goods, sorting them based on their destinations, loading them onto outbound vehicles, and shipping them out, all with minimal time spent in storage.

The benefits of cross-docking are significant. It reduces storage costs by eliminating the need for extensive warehousing, speeds up delivery times by streamlining the flow of goods, and improves inventory turnover by keeping products in constant motion. However, successful cross-docking requires precise coordination and relies heavily on advanced technology to ensure shipments are aligned.

Cross docking is suitable for immediate transfer of goods from inbound shipments to outbound vehicles without any or very short-term storage. Pallets may be broken down and reorganized, but not at the SKU level, as found with a flow through distribution model. Despite its challenges, cross-docking offers substantial efficiency gains and cost savings, making it an attractive option for businesses dealing with fast-moving and time-sensitive products.



Flow Through

Flow-through picking is a warehouse operational model that emphasizes the seamless movement of goods through the facility. In this model, products are received, sorted staged immediately for picking, packing, and shipping without long-term storage. This approach is very similar to cross docking, except items are staged in short term storage areas and has value added services involved between receipt and shipping.

OPERATIONAL MODELS OF WAREHOUSES

This approach reduces the time products spend in the warehouse and maximizes the speed of order fulfilment. Flow-through warehouses are organized with speed in mind, featuring clear paths for warehouse vehicles, efficient sorting systems, logical layouts based on highest demands, and automated scanning technology for accurate tracking. The combination of efficient design and modern technologies allows flow-through warehouses to save time and money compared to long-term storage.

The key benefits include reduced inventory holding costs, faster order processing, enhanced order accuracy, improved inventory turnover, decreased floorspace requirement and the flexibility to scale operations in response to changing demands.

This model is particularly well-suited for e-commerce operations with high-mix, low-volume orders, perishable goods suppliers needing to maintain product quality, and high-volume manufacturers requiring rapid order fulfilment during peak times. Despite the need for precise organization and forecasting, flow-through picking offers significant advantages in terms of speed and efficiency, making it an ideal choice for dynamic, fast-paced warehouse environments.

In Summary

In today's fast-paced market, selecting the right warehouse operational model is crucial for maintaining an efficient and effective supply chain. Whether it's the flexibility and traditional approach of conventional warehousing, the rapid movement and cost efficiency of cross-docking, or the streamlined processes of flow-through picking, each model offers distinct advantages tailored to different business needs.

However, no single model may fully meet the needs of every warehouse operation. A combination of these principles can be the key to optimizing warehouse performance. By integrating the structured approach of conventional warehousing with the speed and efficiency of cross-docking and flow-through systems, businesses can create a hybrid model that maximizes flexibility, reduces costs, and enhances customer satisfaction. This tailored approach ensures that your warehouse operations are not only efficient but also adaptable to the ever-changing demands of the market, giving your business a competitive edge.



SUMMARY

We trust this guide has provided insight into the complexity and myriad of elements to consider in the development and design of a warehouse or distribution centre. Unlock the full potential of your business with our expert design and consulting services. Whether you're looking to create an innovative warehouse layout, optimize workflows or implement cutting-edge logistics solutions, our team is here to bring your vision to life. We specialise in designing efficient, scalable and cost-effective spaces that maximize productivity and align with your operational needs.

From concept to completion, we provide tailored, end-to-end design solutions that enhance functionality and elevate your business performance. Partner with us to ensure your facility is future-ready and let our expertise drive your success.

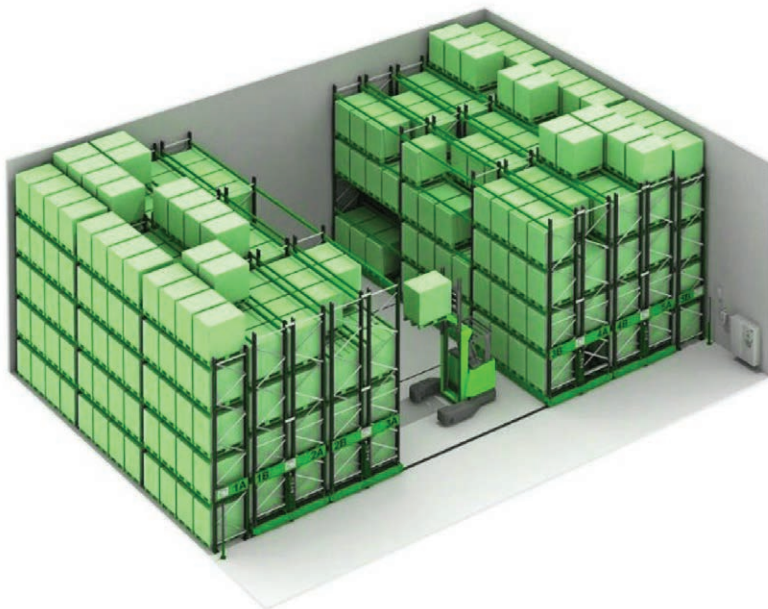
Unlock your warehouse's potential with expert design and tailored solutions. From concept to completion, we create efficient, scalable spaces that drive your success.





T: +27 21 816 2000
E: admin@relog.co.za
www.relog.co.za

Suite B, Platteklouf House Tygerberg Office Park, 163 Uys Krige Dr, Platteklouf 1,
Cape Town, 7500, South Africa



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