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FORKLIFT HANDLING RISK MANAGEMENT IMPROVEMENT DIRECTIONS APPLIED IN INDUSTRIAL AND AGRICULTURAL ENVIRONMENTS

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Abstract: Nowadays, the equipment and technology development direction must align with risk management standards that SME's and farmers must implement (ANCSI, BS OSHA, ISO, etc.) to assure: operator safe environmental work conditions, diminish multi–hazard events, and reduce the cargo handling accident percentage estimated at 32%, from which 24% are forklift rollovers and 8% falling loads. Those risks generate considerable effects on: cargo damage; forklift damage; operator injuries; transport, logistics, warehousing, Wholesale and Retail process efficiency. To diminish those percentages, especially from loads falling and instability, INMA researchers will propose some forklift handling risk management improvement directions and technically designed strategies to comply with industrial and agricultural needs, and to promote innovative products dedicated for forklift extension cord system. The SWOT Analise presented is reflecting the general technologic tendencies and eventually threads that can influence the innovative forklift extensions market share and profit.
Keywords: forklift, extensions, cargo handling, safety, industrial logistic, management risk

1. INTRODUCTION

According to EUROSTAT and the International Laboure Organization statistics, in the European Union, around 5,000 people die/year from work-related accidents, and around 60,000 people from occupational diseases. The estimations shows that a large percentage of accidents and diseases can be prevented and reduced, but it is necessary, first, to identify the hazards and assess the risk factors and estimate the probability of their occurrence, which will lead to the creation of a risk matrix. Following the assessments, high-risk sectors were identified, such as: construction, chemical and petroleum industries, health and medical services, as well as agriculture. But from a legal point of view, ensuring occupational health and safety becomes a requirement for all organizations in any field of activity, as in other management systems such as ISO 9001 and ISO 14001. So, these international standards contain requirements of an occupational health and safety management system, along with guidelines, that allows an organization to improve its performance in preventing occupational injuries and illnesses was OHSAS18001, and in 2017, ISO 45001 was adopted.

Implementing these regulations enhance the SME's reputation, credibility and decrease risks on European market place, so the investors and partners evaluate them as reliable company and business partner. DINCONSTRUCT METPROFIL is one of companies that integrate in the forklift machine in the technologic flow process especially the operator driving systems, for this reason the company policy commitment to safe & healthy & sustainable work environments; increases organizational resilience through proactive risk management and continuous improvement; ensures compliance with current best practices but also positions your organization as a leader in occupational health and safety; reduced accident figures due to the systematization of all activities relevant to occupational health and safety, implicit lowering the insurance costs; reduced health risks, leading to cost reduction & material losses due to the reduction of the number of accidents; bur also ensures legal compliance, builds stakeholder trust, and simplifies global operations by standardizing practices.

For this reason, DINCONSTRUCT METPROFIL SRL planned to develop significantly improve device that can be easily adapted to a wide class of forklift machines, that in Romania are mainly powered by diesel motors and human operated serving the logistic sector of industry.

A sustainable business opportunity was identified in line with SMART & Autonomous technologic developments in order to confer versatility and safe working environmental for motor/electric forklifts. So, the DINCONSTRICT as mechanical structure manufactures and user have a strategic

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vision identifying and creating upgraded innovative products which answer to logistic chine needs and challenges, in this way is focuses on sustainable growth by diversifying its products portfolio assuring its income, increase operational efficiency and workflow, and also staff health safety.
Today forklift equipment's are part of large industrial & logistic workflow management, each operation is very important in manufacturing industrial, food industry and large-scale logistic sector (that is based the e-commerce and SMART Shops), because is necessary to rise safety factor and reduce hazard rate. Due to technologic development in Robotics & ITC sector, were designed and produced several industrial forklifts models that can be unframed in two categories: operator and autonomous /driverless forklift machine.
Until now, were identified two main equipment's types present in the market, like: motor/electric forklift and Automated Guided Vehicles (AGV's).
In traditional Romanian warehouse operations, forklifts are indispensable for transporting heavy goods, stacking pallets, and performing various material handling tasks. These machines, typically operated by human drivers, are crucial for maintaining efficient workflows in e-commerce and manufacturing industries.
The AGV's area designed to follow pre-defined indoor paths using floor markers or digital maps (Indoor Lightweight Reach-Truck Automated Guided Forklift). One market are present many companies that developed and interconnected AVG's fleet that can be managed using a unique interface to increase operational efficiency and workflow as: AiTEN's, Grenzebarch, Kuka, AMS, VisionNavRobotics, etc.
The AiTEN's fleet, Figure 1, create a flexible and adaptable logistic system combining AMR series (TT, TP- laser SLAM navigation technology, TD - conveying process, and TX - high-precision robotic arms) and AGF's units (APx/APe series Dual-Mode Automated Guided Forklift for Heavy-Weight Pallet Transport; AE series Indoor Counterbalance Automated Guided Forklift; AL/ALV series pallet truck; AM/AS/ASK pallet stacker; AE counterbalanced forklift; AR/AVK reach Truck and ATS tugger). AR series equipment, that features high lifting capacity and spatial adaptability that can be integrated with Working Management Standards (WMS) and other systems without changing existing processes or infrastructure. Usually is an automatically planning the optimal path and autonomously completing cargo handling and stacking tasks, providing an efficient solution for enterprise material handling. [2]

Figure1. AITEN – Automated Guided Vehicles and Autonomous Mobile Robots [1,6]

Usually, Autonomous Mobile Robots (AMR's) navigate dynamically with AI, adapting to obstacles and changes in the environment. In Fig.2 is presented Kuka AMR fleet management processes that uses a software to optimizes the tasks of AMR's, thereby minimizing costs. Advanced AI algorithms are used so the software analyzes current transport jobs, positions, and charge levels in real time, so avoid all obstacles in real time. This AMR's collet data from the vehicle software and it dynamically adapts the routes of the robots in order to avoid collisions. Also, in the case of

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conversions or maintenance work on production systems, the corresponding areas can simply be disabled in the fleet management map. The AMR's then automatically search for alternative routes.

Figure 2. Kuka AMRs platform using conventional automated guided vehicle systems (AGVs) and AI managed to optimize workflow.[3]

On Romanian market are several AMRs manufacturers, as Mecalux, designed to integrate versatile load handling devices that can be easily integrated in all types of storehouses. Their models form a multifunctional float that covers a wide range of handling loads, from boxes, trays and packages to shelves and pallets. Their use contributes to the dynamization and flexibility of the internal flow of goods in multiple intra-logistics operations, increasing the productivity, safety and efficiency of the warehouse. The novelty of these models lies in the fact that they combine three concepts: forklift equipment, conveyor belts and electro-cars, so that the palletized load can be easily and safely handled. This management method gives the warehouse greater flexibility and scalability, without affecting the safety of the operator and the load.

Figure 3. Mecalux AMRs versatile float [4]

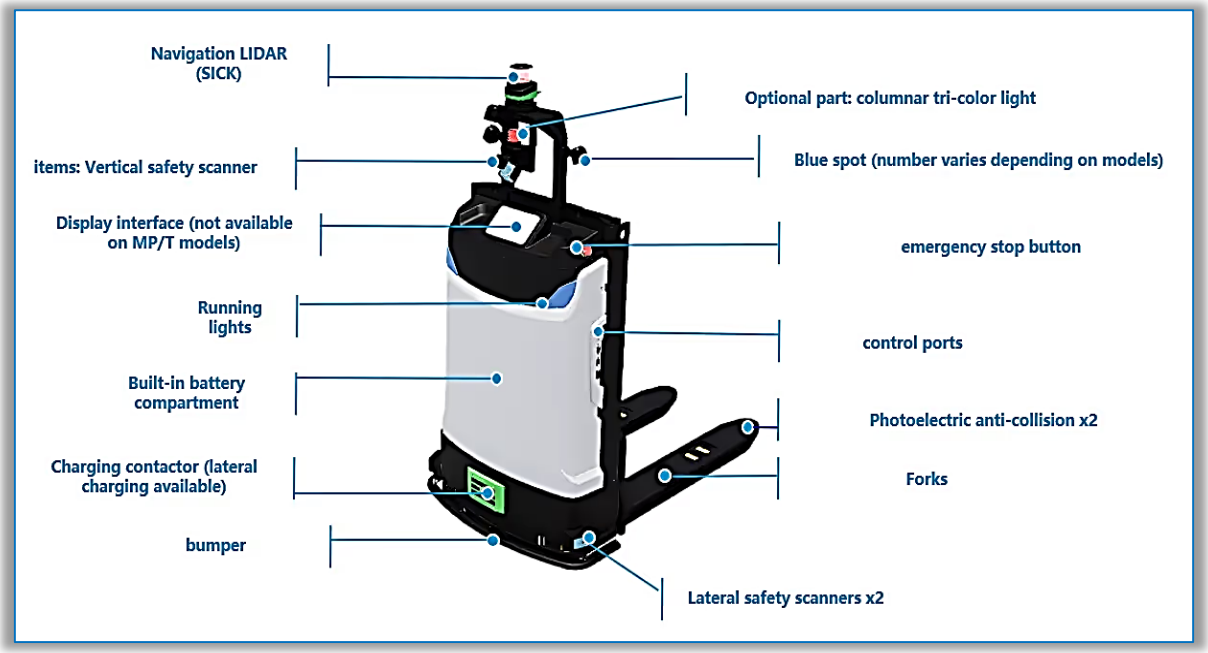

Figure 4. AITEN Robotics – Automated Guided Vehicles with Forklift. [1, 6]

Autonomous Guided Forklifts (AGF's), Fig.4, are enhanced forklifts capable of both horizontal and vertical loads with high accuracy. Their development strategy combines AMR robots (last generation sensors and electric propulsion and WMS/ERP software for industrial logistics with AI systems, that incorporates automated guided forklift (that incorporates LiDAR, cameras, inertial

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measurement units and large category of sensors to navigate and handle loads) and forks for lifting to minimize human labor costs 24/7, rising process productivity, increasing human & products safety. So, the intelligent automated process is designed optimize the work flow to warehouse/self-services shops using intelligent reconfiguration software, generating real time reports and logistic flow charts, and implementing high safety standards by implementing advanced algorithms, to operate without human drivers, enhancing warehouse efficiency, safety, and cost-effectiveness.

One Romanian innovative company is Force Lift that sells dedicated logistics processes & develops autonomous/dedicated solutions that offer unparalleled economic efficiency, increased productivity, advanced safety and guaranteed reliability. [5]

In the next part will be made a short annualize of the most modern, innovative and update forklift equipment's & machines & accessories, that can be successfully used in commerce, construction, agricultural and food industry, to underline the investment opportunity and development.

2. MATERIALS AND METHODS`

A complex and systematic analysis was made, starting for forklift equipment's to their accessories, from conventional motor-forklift to modern material handling systems (AVG's, ARM's and AGF's), see Table 1, because one marketplace is commercialized a large variate and is important to know the main alternatives, compatibility and alternatives of forklifts in Industry 4.0 and warehouses.

Tabel 1. Motor–forklift, AVG, ARM and AGF technologic assessment

System Type Analise	Technologic Assessment bases			
	Advantages	Disadvantages	Engineering Assess	Management Assess
Conventional Motor Forklift	•Lower initial cost than automated systems. •Highly flexible, can operate in changing environments. •Suitable for a wide range of loads and pallet types. •No complex automation infrastructure required. •Fast implementation and easy to relocate. •perform multiple tasks (loading, unloading, stacking, transport).	•Requires trained operators. •Higher labor costs. •Greater risk of hazards accidents and human error. •Productivity depends on operator skill and availability. •Fuel consumption or battery charging costs. •Higher emissions and noise for internal combustion models.	Mature technology, robust mechanical and hydraulic systems, easy maintenance, proven reliability, but performance depends on human operation.	Lower capital cost but higher operating and labor costs. Suitable for small and medium–sized warehouses with variable workflows.
AVG's	•Reliable for repetitive transport tasks. •Consistent performance with minimal human intervention. •Lower labor costs. •High operational safety on fixed routes. •Suitable for continuous operation.	•Limited flexibility due to fixed navigation paths. •Route modifications require reprogramming or infrastructure changes. •Stops when the path is blocked. •Less suitable for dynamic environments.	Uses guided navigation (magnetic tape, QR codes, laser reflectors), simple control systems, high repeatability, limited adaptability.	Good return on investment for repetitive, high–volume operations with stable layouts.
AMR's	•Flexible navigation using sensors and AI. •Dynamic obstacle avoidance. •Easy to redeploy when layouts change. •Minimal infrastructure requirements. •Excellent for smart warehouses and Industry 4.0 applications.	•Higher purchase cost. •More complex software and maintenance. •Requires reliable wireless communication. •Payload capacity may be lower than forklifts.	Uses LiDAR, cameras, SLAM (Simultaneous Localization and Mapping), AI–based path planning, advanced sensing and control.	High flexibility and scalability, making it ideal for facilities with changing production or warehouse layouts.
AGF's	•Fully automates lifting, transporting, and stacking pallets. •High positioning accuracy. •Operates 24/7 with consistent productivity. •Reduces labor costs and workplace accidents. •Integrates with warehouse management systems (WMS).	• Highest initial investment. • Complex installation and system integration. • Requires standardized pallets and warehouse layouts. • Maintenance requires specialized technicians. • Less adaptable to highly unstructured environments.	Combines autonomous navigation with forklift hydraulics, precision lifting systems, and advanced fleet management software.	Best suited for highly automated distribution centers and manufacturing plants where maximum productivity, accuracy, and labor reduction justify the higher investment.

In industrial and agriculture is needed high lifting technical equipment's and for this reason is considerate an essential comparative working parameter that's makes the difference in cost/return revenues, see Tabel 2.

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Tabel. 2. Comparative Annalise of motor–forklift and AGF's

Aspect	Forklift	AGV's
Operation	Human–operated Require skilled operators and regular maintenance	Autonomous or semi–autonomous Use laser guidance, magnetic tape, QR codes, LiDAR, cameras, or SLAM navigation
Load Capacity	High power. Lifting medium to very heavy loads (1–50+ tones)	Usually light to medium loads (up to several tones, depending on model)
Flexibility	High; suitable for changing tasks Suitable for dynamic and unstructured environments.	Best for repetitive, predefined routes Ideal for repetitive material transport. Suitable for indoor conditions.
Initial Cost	Moderate	High
Operating Cost	Higher (labor, fuel/electricity, maintenance)	Lower labor cost but higher software and infrastructure costs
Safety	Depends on operator skill and training	High, with collision avoidance sensors, obstacle detection, automatic routing and automatic braking
Productivity	High but operator–dependent	Very high for repetitive 24/7 operations
Applications	Loading/unloading, stacking, outdoors (diesel/LG) or indoors (electric) warehouse operations	Automated warehouses, manufacturing lines, hospitals, logistics centers Equipped with sensors for collision avoidance and automatic routing.
Loading Management Process	Lower initial investment. Greater flexibility for mixed operations. Higher labor and training costs. Increased risk of operator–related accidents	Higher capital investment. Lower long–term operating costs. Consistent productivity with minimal human intervention. Improved inventory accuracy through digital integration.
Maine Standards	International Organization for Standardization ISO 3691–1 – Safety requirements for industrial trucks. Occupational Safety and Health Administration OSHA 29 CFR 1910.178 – Powered industrial trucks. Industrial Truck Standards Development Foundation ANSI/ITSDF B56.1 – Safety standard for powered industrial trucks.	International Organization for Standardization ISO 3691–4 – Safety requirements for driverless industrial trucks and their systems (includes AGVs and Autonomous Mobile Robots used in industrial environments). International Electrotechnical Commission IEC 61508 – Functional safety of electrical/electronic systems. International Organization for Standardization ISO 12100 – Risk assessment and risk reduction for machinery.

A more complex structure that is usually is used in Havey industry and agriculture bulk loading are used motor-Forklift under difficult environmental conditions (dusty, gravel, windy, raining, heat, etc.) and their standards, regulations and technical specifications must ensure large number of criteria (starting from safe design, manufacture, operation, inspection, and maintenance), which are usually used at powered industrial trucks. The most widely recognized standards are presented in Tabel 3.

Tabel 3. Motor–forklift standards.

Standard	Organization instated	Scope
ISO 3691–1:2023	International Organization for Standardization	Safety requirements and verification for self–propelled industrial trucks, including forklifts.
ISO 5053–1	International Organization for Standardization	Terminology and classification of industrial trucks.
ISO 22915 Series	International Organization for Standardization	Verification of truck stability under various operating conditions.
ISO 6055	International Organization for Standardization	Overhead guards for forklifts—performance and testing requirements.
ISO 2330	International Organization for Standardization	Fork arms—technical specifications and testing methods.
ANSI/ITSDF B56.1	Industrial Truck Standards Development Foundation	Safety standard for low–lift and high–lift powered industrial trucks (widely used in North America).
OSHA 29 CFR 1910.178	Occupational Safety and Health Administration	Regulations for forklift operation, operator training, inspections, and workplace safety.
EN 16307 Series	European Committee for Standardization	European safety requirements for industrial trucks.

More over for motor-forklift optimization and adaptation to constructions & industrial warehouses (widely used in warehouses, logistics, construction, timber, and steel industries, Figure 4) were designed removable fork extensions (also called fork extenders or fork sleeves) to fitted over standard forklift forks and to handle longer or larger loads. In this way is increases the effective fork length, allowing operators to: lift long pallets or oversized loads; improve load support for bulky materials; and reduce product damage caused by insufficient fork engagement. The advantage that it provides their usage is: increased support for long loads; reduced pallet deflection; improved handling of irregular materials; easy installation and removal and lower cost

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compared with purchasing a forklift with longer forks. But also have limitations, like: reduced residual load capacity due to increased load center; increased bending moment on the forks and mast; reduced maneuverability in confined spaces; higher risk of instability if used incorrectly and may require recalculation of the forklift's rated capacity.

Figure 5. Motor–forklift extensions and their industrial exploitation [10–19]

Usually, their construction is made from high-strength structural steel (e.g., ASTM A36 or equivalent structural steels) under the form of welded box-section; assuring a closed or open-bottom designs and locking with pin or heel-retaining mechanism by the fork plate, to prevent accidental longitudinal movement. So, accessorizing the motor-forklift were created some mechanical versatile engineering solutions to their increase exploitation fields and adapt to a larger variety of loads, as is it presented in Tabel 4.

Tabel 4. Motor–forklift extension and their exploitation fields

Type	Characteristics	Typical Applications
Closed–bottom extensions	Highest strength and rigidity	Heavy industrial loads
Open–bottom extensions	Lower weight, easier installation	General warehouse operations
Telescopic extensions	Adjustable length	Variable load sizes
Custom heavy–duty extensions	Designed for specialized industries	Steel, timber, precast concrete

To assess handling loads risks using extensions and safety operational hazards is necessary to make a management analysis (benefits, risks, international standards and regulations govern the safe use of fork extensions and forklift attachments). According to engineering evaluation criterion the extension presents: high structural strength (when is designed and certified correctly); excellent ease of installation; high-cost effectiveness; low to moderate maintenance requirements; high safety standards when the loading limits are followed according to standards, excellent flexibility and significant impact on forklift capacity - is recondited to be reevaluated.

Tabel 5. Motor–forklift extension and management assessment

Benefits	Risks	Operator Safety Considerations
Lower investment than purchasing dedicated long forks. Increased operational flexibility. Reduced equipment downtime. Improved warehouse productivity. Better utilization of existing forklift fleet. Closed–bottom extensions	Incorrect installation. Overloading beyond the revised capacity, or cargo slipping Additional operator training requirements. Increased inspection and maintenance needs. Potential regulatory non–compliance if non–certified attachments are used. Highest strength and rigidity.	Ensure the extension is securely locked. Never exceed the revised rated capacity. Fully insert the original fork into the extension. Keep loads centered. Inspect extensions for cracks, deformation, corrosion, or worn retaining pins before use.
International standards &regulations		
29 CFR 1910.178(a)(4)	Requires that modifications or additions affecting capacity and safe operation receive manufacturer approval and that capacity plates be updated.	
ANSI/ITSDF B56.1	Safety requirements for powered industrial trucks, including attachments.	
ISO 3691–1	Safety requirements for industrial trucks and their attachments.	
ISO 2330	Technical specifications and testing requirements for fork arms.	
ISO 5057	Inspection and repair of fork arms in service.	

Beyond the technologic state of art developments of the forklift extensions is necessary respond to Safety Management System- SMS, an organization framework designed to manage safety risks and ensure effective decision making bade on 4 pillars: Safety Policy that must include Emergency response planning (ERP); Safety Risk Management (Hazard Identification, Risc Assessment by using an Risk Matrix and Risk Mitigation plan that is implementing controls to lower the risk impact ALARP); Safety Assurance (Performance monitoring , internal Audits and management of Change)

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and Safety Promotion (by: training and education plan; safety communications and safety culture). It allows organizations to find hazards, evaluate risks and respond before things get worse. Because of new rules and the need to look after employees, safety must now be managed in a formal way.[20]
Traditional safety programs often focus on "fixing what broke" (reactive), but the modern SMS focuses on "predicting what could break" (proactive and predictive), same standard used by the world's safest industries, including aviation (ICAO Annex 19) and oil & gas, and is closely aligned with ISO 45001 standards for occupational health and safety. In manufacturing industry, in steel manufacturing SME's is used together with Lean and Six Sigma methods. To reduce downtime, the company follows a single system that includes machine maintenance, handling chemicals and team member safety training. [20 - 22]
In tables 1, 2 and 5, the only technical risk that can be lowered using safer extensions are: operator handling cargo error, cargo slipping and overloading, all this factors depends on operator experience, trainings and skills. If, the cargo transportation is made outdoor also is added also the capacity to adapt to dynamic and unstructured environments, fact that can rise the hazard accident generation. These factors are part of Risk Matrix and to direct them in a more predictable and low impact zone is necessary to reducing dependence on the operator's work capacity and experience by adopting forklift extensions provided with safety systems to prevent cargo slipping, mechanism that will be designed according to requirements of heavy environmental exploitation conditions.
This aspect is also identified in statistical analyses and reducing the percentage of accidents caused by load handling—risks is a priority because are classified as most common, the estimated rate is 32% and includes 24% forklift tip-overs and 8% falling loads. [23].
This product development strategy is also implemented by other companies, a necessity for developing a high-performance anti-slip system for transported loads—by manufacturers such as GHEKO, GenieGrips, and HESKINS—as well as for mitigating risks of any kind arising from multi-hazard situations. The technical aspect must be also combined with Safety Promotion activities in order to apply realistic SMS.
To assure that the development of innovative forklift extensions represents an opportunity the SWOT analysis it was necessary to be made for business, engineering, logistics, or operations management point of view, and justify the technical necessity and business opportunity applying the newest and innovative techniques develop innovative & improved parts/accessories.

Tabel 6. Detailed SWOT analysis to develop forklifts innovative extension from engineering and management perspective.

STRENGTHS			WEAKNESSES		
GENERAL	ENGINEERING ASPECTS	MANAGEMENT ASPECTS	GENERAL	ENGINEERING ASPECTS	MANAGEMENT ASPECTS
S.1–High load–carrying capacity with reliable hydraulic lifting systems.	Efficient hydraulic and mechanical systems provide high lifting performance.	Reliable high loads maneuverability	W1–High initial investment and marketing costs.	Hydraulic performance, battery degradation, and tire wear require regular maintenance.	High capital investment, marketing and lifecycle costs.
S.2–Improves material handling versability and reduces manual labor.	Design improved adaptive forklift accessories/extensions provided with safety systems	Reduces labor costs, handling time & cargo safety.	W2–Requires trained and certified operators.	Operators must be qualified according to forklift technologic complexity	Highly trained certified operators according to forklift category
S.3–Available for electric, diesel, LPG, and hybrid models for increasing versability and dimension applications.	Electric forklifts reduce emissions and operating noise. Cargo safety and operators.	Hight flexible configurations and versatile loads management systems	W3–Limited maneuverability in confined spaces for larger models.	Warehouse loads management and organization (innovative depository systems)	Highly functional workflows and cargo management schedules to minimize depository costs
S.4–Robust design with advanced safety features (load stability and position control).	Strong structural design ensures reliability and lower hazards risks	Predictable service and maintenance procedures. Low hazard risks assurance	W4–Battery charging time (electric forklifts) or high fuel consumption can reduce productivity.	Mechanical failures can lead to downtime but also the energy refill and availability	Downtime directly affects supply chain performance.

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S.5–High reliability and long service life with preventive maintenance.	Advanced cargo control systems improve versability and safety.	Enhances operational efficiency and workflow.	W5–Component wear (hydraulic systems, tires, forks, mast) increases maintenance requirements.	Performance decreases if maintenance schedules are neglected.	
S.6–Compatible with mostly warehouse fleet and management strategies	Ease in implementation and versatile with forklift fleets.	Improves warehouse productivity and inventory movement.	W6–Downtime due to equipment failure affects operations.		
OPPORTUNITIES			THREATS		
GENERAL	ENGINEERING ASPECTS	MANAGEMENT ASPECTS	GENERAL	ENGINEERING ASPECTS	MANAGEMENT ASPECTS
O.1–Development of improved extension model that can used also in AGV's and AI–assisted forklifts.	Funding grants to develop innovative & improved accessories & safer working –arts	Appling to grants for develop dedicated management assessing tools & hazard risks	T.1–Competition from automated guided vehicles (AGV's) and autonomous mobile robots (AMR's).	Dynamic market sector with large players with strategic RDI program and financial support	Competition & compatibility from international players in automated cargo handling systems.
O.2–Adoption of lithium–ion batteries for faster charging and longer operating life for agriculture & industry use	Easy to implement in AVG's and robotics systems for smart shops assuring operational efficiency.	Decrees deadtimes in recharging and energy optimization strategies	T.2–Increasing safety regulations and cargo assurance costs.	Increase prototype investments to comply with new regulations/ standards	Rising operational costs (fuel, electricity, maintenance) and product risks management.
O.3–Integration with Industry 4.0, IoT, and predictive maintenance technologies.	Versatile and versatile accessories, that can provide Smart sensors and IoT enable predictive maintenance	Management strategy based on accelerating dynamic loading reports that are validate in relevant working conditions	T.3–Rising costs of raw materials, sensors, part acquisition, fuel, and energy.	Environmental regulations encourage replacement of internal combustion forklifts.	
O.4–Growing logistics, e–commerce, and warehouse industries increase demand.	Fleet management software improves equipment utilization.	Growth in e–commerce and manufacturing increases demand.	T.4–Supply chain disruptions affecting spare parts and production.	Assurance of contractual assistance in system malefactions and spare parts	
O.5–Improved model designs to enhance operator productivity and safety.	Develop innovative antiderapant extensions for loads stability and safety	Implement of innovative forklift accessories and safety criteria to avoid hazard risks	T.5–Workplace accidents leading to legal liabilities and insurance costs.	Strict occupational safety regulations.	Modification of hazards accidents risk regulations and preventing additional insurance cost
O.6–Expansion into sustainable and zero–emission material handling solutions	Sustainability initiatives encourage investment in electric forklifts	Manufacturing increases demand and adaptation to sustainable and zero–material industry	T.6–Economic downturns reducing industrial and construction activities	Rapid technological advances may make older models obsolete	Economic fluctuations may reduce investment in new equipment.

3. RESULTS

Using the Table 6 is build the Quantitative situational Analysis (TO-WS), that makes it easier & faster to build consensus, prioritizing a complex situation involving great number of options (developed by Terrence Metz).[24] Quantitative view displays the foundation for justifying actions. Consequently, actions that currently work well are potentially reinforced and renewed alongside new actions that get approved and developed.

In this way the organization will build and implement strategies to develop improved products and new projects, based on activities and process indicators. Easch key measures are identified based on table 7, and its impact is evaluated according the score registered. This evaluation is made base on key questions specific to each category (Strengths, Weaknesses - internal factors that can be controlled and viewed by competitors and outsiders, but Opportunities and Threads- external factors that cannot be controlled and their frequently represent trends.). Reducing the list to the top three factors (applying Categorizing logic and then use *PowerBalls* for prioritizing) using these concepts:

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— Opportunities provide means that the product to have success. The most favorable are identified with slily faces (O1, O4 and O5).
— Threats, represent the most worrisome aspects and is required to make a strategy to avoid them or to build a defense, especially when is combined with weaknesses, identified in the Tabel 7, with lightnings (S3 and S4).
— Weaknesses can be corrected, by taking the necessary measure to decrees their impact or eliminated them, like W1
— The Strengths represents the core competence and usually must be leveraged.

Tabel 7. TO–WS analysis of forklifts extension product development.

			Internal Factors														Sum EF
			Strengths							Weaknesses							
			S1	S2	S3	S4	S5	S6	Sum S	W1	W2	W3	W4	W5	W6	Sum W	
External Factors	Opportunities	O1	x	x	x	x	x	x	6	x	x	–	–	–	–	2	8
		O2	x	–	x	x	–	–	3	x	–	–	x	x	–	3	6
		O3	–	–	–	x	x	x	3	x	x	–	–	–	–	2	5
		O4	x	x	x	x	–	–	4	x	x	x	x	–	–	4	8
		O5	x	x	x	x	x	x	6	–	–	–	–	–	–	0	6
		O6	–	–	–	–	–	–	0	–	–	–	–	–	–	0	0
		Sum O	4	3	4	5	3	3		4	3	1	2	1	0		
	Threats	T1	x	–	x	x	x	x	5	x	x	x	x	–	–	5	9
		T2	x	x	x	x	x	x	6	x	x	–	–	x	–	3	9
		T3	–	–	x	–	–	x	2	x	–	–	–	–	–	1	3
		T4	–	x	x	x	x	–	4	x	–	–	x	x	x	5	8
		T5	x	x	x	x	x	–	5	–	x	x	–	x	–	3	8
		T6	–	x	x	–	–	–	2	x	–	–	x	–	x	3	5
		Sum T	3	4	6	4	4	3		5	3	2	3	3	2		
Sum IF			7	7	10	9	7	6		9	6	3	5	4	2		

The scores presented in Table 7, represents the influence of the internal and external factors on the product success on market. Based on it can be made internal strategies to eliminate weaknesses that have a negative impact on Opportunities (developing a RDI department/team; implement new skills in marketing division; create an operator training team for costumer upskill, etc.).
Regarding the Threads that influence the product development is a more complex view:
— Threads that influence the Strength, like T1, T2 and T5 that bring colds on the products. So, to decrees this factor is necessary to create partnerships with partners that can lower the score (service providers, assurance companies, etc.) and creating attractive optional packages for customers at preferential price that can include:
— ccustomized technical assistance
— guaranteed parts provider
— insurance policies at an attractive price service customized for buyers at preferential costs.
To assess the impact factor for each category is nectary a more in-depth study of the forklift market and logistic companies needs and identifying real obstacles in the legislation. This part of Annalise will be subject of further research.

4. CONCLUSIONS

In this chapter are made general conclusions regarding the aspects presented in this paper , so from table 1 were drawn two conclusions: forklifts are valued for their robust mechanical design, hydraulic efficiency, and increasing integration of automation technologies, but they require consistent maintenance and periodic component replacement (engineering perspective); and also forklifts improve productivity, reduce handling time, and support efficient warehouse operations (management perspective).
In construction and Havey industry the forklifts remain the preferred solution for heavy-duty, flexible material handling, while AGV's provide superior performance in highly automated, repetitive logistics operations. In practice, many modern warehouses adopt a hybrid approach, where AGV's handle routine transport tasks and forklifts perform heavy lifting, loading/unloading,

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and non-standard operations. This combination improves productivity, safety, and overall operational efficiency while supporting Industry 4.0 and smart manufacturing initiatives. However, organizations must carefully manage acquisition costs, maintenance, operator training, safety compliance, and technology upgrades to maximize return on investment, but also the benefit packages that be provided so to lower the external threads.

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