Advanced Logistic Systems – Theory and Practice, Vol. 20, No. 1 (2026), pp. 28-39
https://doi.org/10.32971/als.2026.003

IMPLEMENTATION PROCESS USING REAL UWB-RTLS

TAMÁS BÁTORI[1] – PÉTER TAMÁS – BÉLA ILLÉS

Abstract: *RTLS (Real Time Location System) is an absolutely booming, dynamically developing technology. Through this work, we have gained unique experience and knowledge that underpins the significance and relevance of this article. In Hungary, a few dozen implementations represent the RTLS market in 2025, which, in my opinion, is on the verge of a huge boom. We have already implemented RTLS technology in several projects, mostly in the production and service logistics systems of Tier 1 supplier companies. The operating systems have partially replaced the previously known barcode and radio frequency semi-automatic data collection devices and radio networks. In addition to using the installed UWB-based RTLS, we have achieved 99.99% operational accuracy and up to 20% resource savings compared to previous barcode-based Auto ID systems. Based on 10 years of practical experience, we have concluded that it is necessary to conduct a feasibility study before every RTLS project in order to ensure that the project will be profitable. We have compiled an implementation process that assists with the implementation steps of RTLS projects and helps to prevent the risks that we have encountered over the past 10 years.*

Keywords: *RTLS, RTLS implementation, RTLS implementation process*

1. INTRODUCTION

In this article, we will first summarize and compile information, best practices, manufacturer-recommended technological implementation procedures, and experiences that help to understand and create a possible design process that we have researched. We will then move on to a series of steps that we recommend as general guidelines that can help to improve logistics processes using RTLS technology. We will develop the implementation steps using inductive reasoning. Inductive reasoning can be described as moving from specific cases towards general principles, which also serve as explanations for the specific cases.

2. STRUCTURE AND CHARACTERISTICS OF REAL RTLS

Based on the system parameters described in the literature [1-2] the devices required for UWB-RTLS are RTLS tags, RTLS anchors, a high-speed information network server (e.g., Ethernet), a high-speed processor RTLS server that performs trilateration and time synchronization, and, of course, some kind of user-friendly interactive interface where we can visualize the final result of the positioning.

The system model shown in Fig. 1 demonstrates the real-time positioning and tracking of a material handling machine (forklift). The RTLS tag was attached to the forklift using a mechanical connection, and anchors were installed on the warehouse ceiling at declared positions with mm accuracy. The anchors are connected to the RTLS server via Ethernet cables based on a star network architecture. Standard UWB communication between the

[1] IBCS Hungary Ltd., Hungary
batori.tamas@ibcs.hu
[2] Prof., University of Miskolc, Institute of Logistics, Hungary
peter.tamas@uni-miskolc.hu
[3] Prof., University of Miskolc, Institute of Logistics, Hungary
bela.illes@uni-miskolc.hu

RTLS tag and the anchors has been set up, and the Ethernet network connection has also been configured. Time synchronization between the anchors and the RTLS server takes place on the Ethernet network, and the data from the UWB signals detected on the UWB-based radio network also flows on this network. The above system is capable of providing the real-time position of the forklift with an accuracy of 30 cm every millisecond. It can be seen that the system ultimately provides users with a visualization where the actual warehouse area is digitized, and the real-time movement and activity of the forklift can be tracked on a map on the screen.

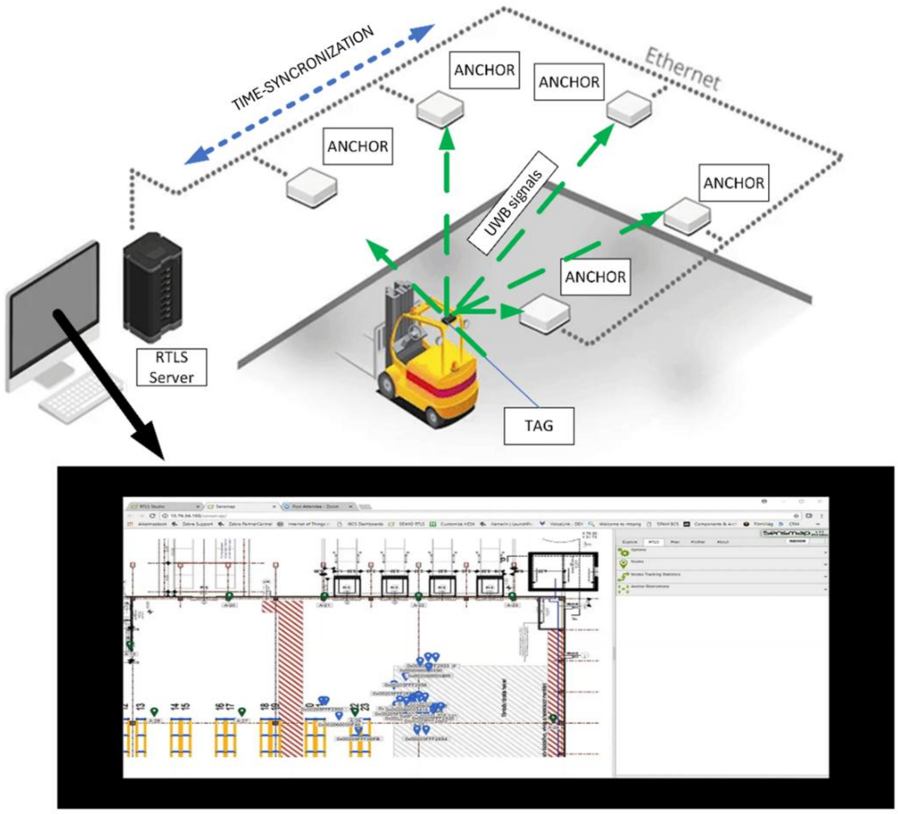

Figure 1. Basic components of UWB-RTLS

We will describe and expand on the concept of the RTLS server, as so far we have only mentioned the server's tasks of rapid position calculation and time synchronization. In reality (based on the literature [3-7] and my own experience), this RTLS component has several tasks, but first I will introduce the software-based building blocks of the server.

3. Components of the RTLS Server

Based on our examination of the RTLS Server, we divide the software-based logical components that arise after installation into two types (components and services) (based on my experience, individual RTLS manufacturers [3-7] refer to these components differently, but they have the same functional role):

- **RTLS "Core" software core**: an independent algorithm that automatically processes signals and information received via the familiar radio principle, which requires enormous computing power and high processor speed, and which is used to generate the x, y, z coordinates of any object moving in the RTLS and equipped with an RTLS tag. and stores them in a large RTLS database (traceability) according to a specific regularity, naturally with a time stamp. This part operates independently of the other software components, and its speed is critical. Its operation cannot be interrupted by queries or other switches or options that would slow down the calculation algorithm.
- **RTLS "Core" database:** A database of historical and time-stamped position data generated based on the activity of the aforementioned "Core software core." All subsequent queries based on tracking or position queries are "fed" from this database.
- **RTLS Application Server:** any application server that provides functions or services that deliver data, reports, and analyses to connected users based on data stored in the RTLS database. It also uses its own database, which is physically separate from the Core, but this is significantly smaller in size and load and contains buffer data for larger format reports and queries, in order to speed up queries.
- **API (Application Programming Interface):** A connector (interface) suitable for retrieving and querying information not covered by the application server service set, which provides data from the RTLS database to other external systems based on predefined requests. Typical related logistics information systems are WMS or FFMS, which usually communicate with the RTLS application server via the API.

4. BASIC SERVICES OF THE RTLS APPLICATION SERVER

The range of services available on the Application Server varies from one RTLS manufacturer to another (some manufacturers do not provide this component for their systems), but the basic services offered by the 8-10 best-known manufacturers [3-7 to help display logistics data can be summarized as follows:

- **Basic settings:** Here you need to specify the basic functions and settings of the RTLS you want to use; unique identification of anchors and entry of their geometric positions (x, y, z), unique identification of RTLS tags, radio UWB protocol to be used, setting update times, authentication, encryption, etc.
- **Layout designer:** Generally, all RTLS Application Servers support 2D visualization, which allows the dynamic movement of RTLS tags to be tracked on a digitized flat "copy" of the warehouse. For this service, the necessary units of measurement (distances, time) must be set in the system, and the floor plan of the logistics unit must be integrated into the system digitally and to scale. Passable and prohibited logistics routes must be defined, along with their restrictions (width, height, etc.). This floor plan (warehouse map) will be the bottom layer of the visualization, on which the objects to be tracked will move. It is necessary to specify with mm accuracy and mark on the digital floor plan the location, numbering, and marking system of the physically fixed anchors in the visualization.

- **Navigation subsystem:** A map-based route planning system equivalent to a standard outdoor GPS, which can guide the operator along planned warehouse routes. The navigation system can handle all RTLS tag information in the warehouse at once, and any "relationship" between RTLS tags can be defined using navigation. Its operation is similar to the "public transport" control model used in everyday life, where the system transmits traffic congestion and closures to other transport users based on collected traffic data so that they can avoid these "traffic jams."
- **Creating Virtual Zones (Geofence) in RTLS:** A virtual zone is any closed geometric plane shape in the RTLS visualization that we want to examine and analyse from a certain perspective in the applied logistics process. To be precise, it is not the zone itself, but the objects entering or leaving it that can be tracked with an RTLS tag. It is virtual because we work with a copy of the real closed geometric area in the warehouse in the digital twin, in the RTLS visualization, without disturbing the real area. It is worth interpreting and defining (creating) real areas where some kind of transactional activity takes place in the real warehouse as virtual zones. Typical examples of such zones are: the entry (receiving) zone, the exit (dispatch) zone, the picking zone, physical areas distinguished in terms of the electronic kanban process, the production service zone, the danger zone, the safety zone, etc. The virtual zone as a unit has a special role in the operation of RTLS, because different triggers or events can be assigned and linked to the zones created on the application server, which start/stop automatically when an RTLS member enters/exits a virtual zone or stays there for a specified period of time. For example, when leaving a storage zone, an automatic delivery note is generated in the associated accounting system using the associated triggers, or the RTLS may send an automatic telephone alert to the driver of a material handling vehicle entering a restricted zone. The virtual zone gets its name from the fact that it does not exist in reality (at least it is not actually physically demarcated or marked in the intralogistics unit), but it does exist on the RTLS application server and can be created/deleted/ modified/moved with a few clicks on the previously designed layout. In addition, an unlimited number of virtual zones can generally be created.

The virtual zone (geofence) is the cornerstone of RTLS technology. The layout created on the RTLS application server and the use of virtual zones already provide a wealth of information, which can be visualized and simulated for logistics users. The RTLS virtual zone can be created in the digital twin with just a few clicks and settings and then adapted to the actual physical process in a matter of moments. This gives us an opportunity that is unmatched among technologies. With all other RTLS technologies, such a change would require rewiring, reinstalling hardware devices, rethinking warehouse material flows, special training, etc. The basic testing services of RTLS include a few visualization tools typically used in logistics, which we have collected in the following section.

5. BASIC QUERY SERVICES SUPPORTING LOGISTICS USERS

5.1. Analysis of time spent in zones

With the help of virtual zones that can be created in unlimited numbers on the RTLS application server, it is possible to measure the exact time that a material handling device/goods (stock)/workforce spends in a specific location or dedicated zone. This allows productive/non-productive periods to be separated from each other.

5.2. Measuring the operational efficiency of the fleet (material handling equipment)

RTLS tags attached to material handling equipment can be used to optimize the overall efficiency of the fleet by identifying and correcting periods of inactivity. The data can also be used to compare the efficiency of individual vehicles and drivers. The device can also help to identify overloads.

5.3. Heat Maps: Identifying Blocking Factors and Bottlenecks

Heat maps enable us to ensure a high level of process transparency by revealing the distribution and density of warehouse traffic, as well as the exact location of weak points or bottlenecks causing delays. The essence of heat maps is that we use different colours to mark the most frequently used positions from the route data provided by RTLS tags. The more frequently a physical point is used, the stronger the colour used to mark it on the warehouse layout.

5.4. Spaghetti map: Is the fleet operating efficiently and flowing smoothly?

The essence of the spaghetti map is that it shows the exact route of a material handling device or goods on the layout in real time, as well as historical position data for a given time period. The routes of multiple machines/materials in the warehouse can be displayed on a common layout using different colours. The map reveals the possibilities or obstacles to the continuous flow of the fleet in order to optimize further processes [8]. It identifies inefficiencies in the layout of the area/work, wasteful transportation, and activities that do not add value and can be reduced.

We emphasize and assume that although RTLS manufacturers may offer different additional services for their systems, the services listed above can be considered essential in the RTLS market in 2025. It is possible that the installation of an RTLS server alone may solve a particular logistics need. In most cases, however, this is not the case; integration with WMS or FFMS may also be necessary to solve a given logistics problem. In any case, one important element of the implementation steps to be compiled at the end of the article is a preliminary examination of the issue.

6. Classification of RTLS application areas

There are no declared recipes for how RTLS can be adapted most effectively to provide precise and reliable support for logistics, material, or value flow processes. However, nearly a decade of experience in installing these systems has provided us with sufficient experience and maturity to outline the possibilities, processes, company locations, and tools where RTLS provides significant support to users. We also draw on publications already presented in the literature [3, 4, 9, 10]. We have identified three distinct uses for RTLS, which we summarize in this chapter.

6.1. Operation tracking (process tracking)

A common feature of different types of manufacturing processes is that they are operated based on incoming requests (orders) and execute the production plan prescribed on the basis of those requests. During execution, manufacturing activities are usually controlled by some kind of MES (Manufacturing Execution System), which recording data generated during the manufacturing processes, such as machine performance, materials used, production times or downtimes, errors, and quality data. This data is then analysed to identify areas for improvement and optimize manufacturing processes.

MES helps with production planning, resource allocation, and scheduling of manufacturing processes, and MES also provides production support tasks. It monitors processes in real time and allows for immediate handling of deviations. Before the 2010s (and still in most MES systems today), real-time measurement followed the Industry 3.0 standard (automated systems), using fairly complex installed cabling systems and special data communication over robust data buses. Typically, a PLC or computer-based central server is the most important controller in these manufacturing systems.

If changes are needed in the production procedure (operations) in an Industry 3.0-based system, this can be done by replacing sensors, rewiring, reinstalling, and modifying the central control program. This entails significant costs and downtime, not to mention the loss of production due to the transition.

This is where RTLS brings the most important development in operation tracking. if RTLS is used as an independent measurement system to track products/materials/tools, then the entire material flow process continues to operate without damage or changes during/alongside/after any operational changes, and real-time production data can be collected on the entire material flow. Furthermore, the physical design of RTLS is significantly less expensive than the construction of an MES measurement data collection subsystem. Of course, we must never forget the advantage that, instead of discrete data tied to discrete spatial positions (0-D, [9]), we have access to space-independent historical data that can be broken down to the millisecond with the help of the RTLS server.

Advantages of using RTLS for operation tracking;

- **Reduced search time:** Worksheets or parts can easily get lost in large, open production areas with bulk storage. RTLS provides users with the real-time position of all assets on a digital layout.
- **Optimized material flow:** Production bottlenecks, overstocking, and waiting (stock shortages) can be avoided and continuously monitored. The combination of RTLS and automation ensures FIFO and just-in-time delivery to production.
- **Trigger-linked automated operations:** Virtual zones can be defined in the production hall to automate alerts, workflows, machine settings, and even trigger automatic accounting entries in the ERP system.
- **Quality assurance:** With complete transparency, i.e., who? what? when? and where? fewer errors, smooth audits, and reliable product quality can be achieved.
- **Smarter planning:** Real-time location tracking monitors the status of every order, and the fulfilment of every order is stored in a historical database, which can be used as a basis for optimized planning later on (using Big Data and AI, for example).

6.2. Human resources monitoring

Logistics relies on people, workers (not just machines and equipment), as maintenance staff, operators, loaders, unloaders, and drivers are involved in every logistics process. It is also important to address the issue of occupational safety, as even one accident is too many in a logistics facility. In order to prevent or analyse occupational accidents, it is essential to know the history of workers' movements with decimetre precision. This is where an established RTLS covering the entire physical logistics process comes in handy. RTLS, which tracks employee movements, can therefore be used primarily for accident prevention and investigation, but there are also many other advantages to using the technology in this way.

- The RTLS tag attached to employees can also replace paper-based employee time records with automatic, **digitized real-time time records**.
- By applying an appropriate and authorization-based digital rule system, it is possible to create **entry and exit permissions** at physical production/logistics workplaces using the RTLS tag attached to the employee and the virtual zones created at the entrances/exits, thus ensuring the elimination of unauthorized intrusions/entries/ leaving the workplace. As a further development of the system, it is also possible to link access to spatial movements performed earlier in time. (e.g., a security guard can only enter a given plant area if he has already inspected and checked other workplaces).
- **Complete overview of the workforce.** Provides an accurate real-time overview of where employees are within the plant, allowing previous movement data to be analysed for security audits, compliance, and continuous improvement. Real-time movement data can be used to automatically generate zone access logs and provide a complete and accurate picture for identifying bottlenecks, simplifying layouts, and making smarter decisions, which in turn improves both safety and productivity.
- RTLS can be used to quickly locate an employee in a complex building (e.g. a hospital) in an **emergency** when the employee cannot be reached by other means (e.g., telecommunications).
- **In an emergency/evacuation,** RTLS can provide the information needed to ensure that all employees are outside the building.
- **Prevention of accidents in hazardous areas.** RTLS can measure the time spent in a given area (e.g., a frozen space) and alert the employee/control room if the employee exceeds the maximum time allowed in that space.
- **Accident prevention during maintenance.** With the help of RTLS, electrical or mechanical maintenance, etc., danger zones can be created in the production/logistics physical area, which can be used to prevent other employees (or logistics machines) from entering the restricted zone.
- If the moving logistics equipment is also equipped with RTLS tags, a set of rules can be created that warns/intervenes in the event that a person and a machine/ possibly goods come within a specified safety distance. (e.g. moving goods with bridge cranes in the plant)
- **Optimization of shift changes,** monitoring of **Covid rules** (minimum safety zone between two workers), compliance tracking, logging, contact tracing.

6.3. Tracking materials, inventory, equipment, and tools

A critical condition for production is optimized material flow and, in most cases, its continuity and long-term maintenance. During production, moving products (main products in production), moving tools and service equipment, raw materials and components belonging to each area of operation are involved in the process alongside human resources. In the case of optimized material flow, the finished product is manufactured in the quantity and quality specified in the plans, with minimized production-related inventories and costs. The success of a production process depends on many parameters, which can be dynamically measured and optimized, i.e., influenced, using RTLS. Perhaps the most typical, intense, and complex manufacturing environment is the operation of a conveyor belt assembly plant. With this in mind, we will briefly review the benefits that an RTLS can provide in this type of manufacturing and related logistics tasks.

- The most important thing is **to track the entire assembly line route of the finished product** (e.g. a car) throughout the manufacturing process, with decimetre precision. In practice, for example, after the first body parts are assembled, the product to be manufactured (car) receives its unique RTLS tag identification. All customer-side options for the finished product associated with a given order are matched with the RTLS tag moving in production in the background. This way, at any point in logistics or production, the RTLS tag can be detected and background information on all options related to the order can be retrieved immediately.
- Based on the movement (operational) information of the finished product equipped with the RTLS tag, so-called **KANBAN requests** can be initiated in relation to the built-in component. By tracking KANBAN shipments with RTLS, the stocking of components to be installed during production can be optimally coordinated with the appropriate and precise production position. For example, the manufacturing system sets the required tightening torques for a given size or type, or sets the required tightening torques for tools with a revolver tool head. For example, the manufacturing system sets the required tightening torques for a given size or type, or tools with a revolver tool head can automatically select from the tool heads located in the revolver. The manufacturing system can also notify the operator if a product is arriving at the operating location that requires equipment to be moved from another location.
- The number of devices, parts, and production tools equipped with RTLS tags can be as high as several thousand in a single production run. In this case, the RTLS Server services provide complex data that can be fully measured and monitored in terms of the scheduled operating times and conditions required for predictive maintenance specific to the manufacturing system.
- In the case of a well-designed and thoroughly digitized manufacturing system, customer audits can also be performed on the virtual twin of the manufacturing system, and even online audits can be performed or the production history of a given time slot can be retrieved at any time.
- With the help of RTLS, **specific exclusions** can also be made for production. For example, a production tool can be automatically shut down if a physically undesirable and excluded tool/product combination appears at a production site.

When designing an RTLS, it is necessary to consider the combination of operations, human resources, materials, equipment, and tools that need to be tracked. The most complex RTLS tagging task occurs in warehousing and production support, as all three conceptual areas need to be tracked in these processes. Of course, the simplest solution would be to tag as many people and objects as possible with RTLS tags in order to solve a specific task or achieve the necessary optimization and then examine the entire system. It may also be suggested that the best solution would be to tag every piece of merchandise in a warehouse with an RTLS tag. These seem like valid suggestions, but so far we have not discussed the costs associated with implementing RTLS and tagging. We will examine this issue in the next section.

7. Costs and cost reduction opportunities associated with the introduction of RTLS

When considering the development of a real-time location system (RTLS) using UWB, for example, to examine the logistics processes of an intralogistics facility, it is important to understand the costs involved in developing the system and how these costs are distributed during implementation. The data presented in this chapter is based on our own experience and the relevant reference literature: [11-12].

The basic element of RTLS is the RTLS tag. In 2025, the cost of a standard UWB, TDoA, and TWR radio communication tag with basic casing (i. e., not robust mechanical/heat/water resistant) will be EUR 80-100. This is not a high cost in itself, but tags are usually required in large quantities for the real-time monitoring of a logistics object (goods, material handling equipment, human resources, operating times, etc.), so it is quite possible that we would need several hundred or even several thousand such tags. However, large quantities mean significant costs, and such a purchase must always be carefully considered.

Most projects "fall through" at this point. Therefore, it is very important to think carefully about what we want to achieve by using RTLS. Is it really necessary to track all materials? Are there any solutions that can reduce the number of RTLS tags? There are already several practices in the industry, such as indirect tracking or tracking unit load carriers instead of goods.

Indirect tracking: For materials that can be tracked using a large number of RTLS tags, it is recommended to track the material handling equipment (forklift) instead of the material itself. The forklift truck has position data when loading or unloading, and if the transaction can be recorded in an information system independent of RTLS (e.g., WMS), the two data sets (forklift truck position and transaction receipt) can be paired to track the material (goods). This can result in significant cost savings and prevent the suspension of a potential project implementation.

How can we resolve the anomaly that even with significant initial investment allocation, an RTLS implementation project can still come to a standstill? The industry responded quickly to this challenge.

Pilot project opportunity to support high-volume decision-making

A distinctive feature of UWB-RTLS is that it is highly scalable across a wide range, meaning that it can be expanded relatively easily. UWB-RTLS can handle anywhere from a few RTLS tags to thousands of RTLS tags, just as it can cover the necessary areas with anywhere from four antennas to thousands of antennas.

In order to eliminate the high initial costs, it has become standard practice for UWB-RTLS providers to offer pilot projects as a first step towards a large-scale implementation. This usually includes a mobile and quickly assembled pilot system; 4-5 anchors that are easy to install with batteries and mobile stands, as well as a WiFi-based time synchronization protocol, containing 10-12 RTLS tags and a simplified server system (3-4 anchors do not require serious hardware for trilateration). These components can be integrated in a matter of hours and implemented with millimetre accuracy using a floor plan of the site, providing a fast, efficient, and suitable tool for measurement purposes. These tools are usually owned by the UWB-RTLS service provider and are only leased to the customer for the testing period. This means that the customer has access to a small, low-budget prototype system in which they can perform basic functional tests and measurements that are characteristic of the entire intralogistics facility (and can be expanded later) [13].

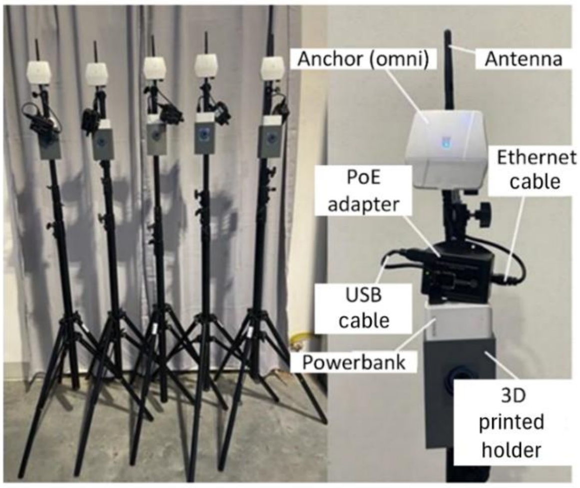

Figure 2. Components of the Pilot UWB-RTLS hardware [13]

The efficiency indicators measured in the RTLS pilot system can be easily adapted to the entire warehouse or intralogistics unit. If the efficiency indicators meet expectations and the return on investment is 1 year or less, the entire RTLS project can be launched.

8. The process of introducing RTLS, steps in process development

The article examined in advance all activities, steps, preliminary analyses, and circumstances that presented the steps involved in introducing and using RTLS and the necessary questions to be examined when taking those steps. During the examination, a proposed process was compiled that briefly and concisely represents the interrelated and recurring questions and steps described in more detail in the chapter.

The steps were embodied in a compiled flowchart; it presents the issues and steps involved in the introduction of RTLS in a defined logistics system model, as well as the chronological stages of its integration and use in a logistics environment (Fig. 3).

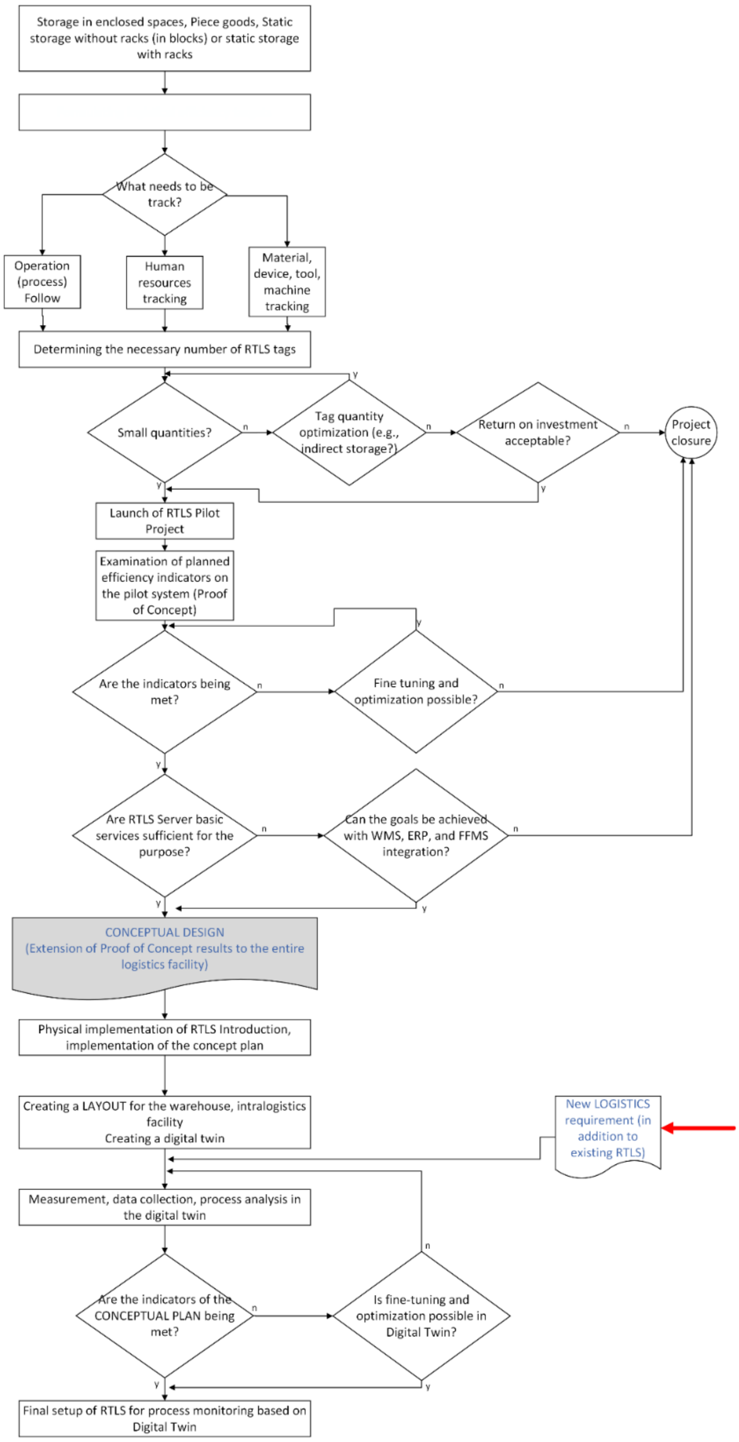

Figure 3. Steps for introducing and using RTLS

REFERENCES

[1] Bátori, T. & Tamás, P. (2021). Application Possibilities of RTLS System in Production Logistics. *Journal of Production Engineering*, **24**(1), 22-28, http://doi.org/10.24867/JPE-2021-01-022

[2] Bátori, T., Tamás, P. & Melis, Z. (2021). Investigation of Technological Possibilities of Warehouse Location. *Academic Journal of Manufacturing Engineering*, **19**(3), 41-49.

[3] POZYX.IO Inc. *How ultra-wideband works - POZYX.io.* Retrieved from https://www.pozyx.io/pozyx-academy/how-does-ultra-wideband-work

[4] SEWIO Inc. *HID - SEWIO Inc. RTLS homepage*. Retrieved from https://www.sewio.net/

[5] Siemens UWB. *Identification and locating systems: Simatic ident.* Retrieved from https://www.siemens.com/en-us/products/simatic-ident/

[6] Ubisense Inc. *Ubisense Location technology*. Retrieved from https://ubisense.com/location-technology/

[7] Zebra Technolgies Inc. *Ultra Wideband (UWB) Technology*. Retrieved from https://www.zebra.com/us/en/products/location-technologies/ultra-wideband.html.

[8] Molnár-Major, P. & Bóna, K. (2025). Using Indoor Positioning Systems (IPS), for Supporting the Digital Mapping and Evaluation of Material Handling Processes, in Intralogistics Systems. *Acta Polytechnica Hungarica*, **22**(5), 279-298 , https://doi.org/10.12700/APH.22.5.2025.5.15

[9] Berkhan, P., Kärcher, S. & Bauernhansl, T. (2024). Framework for the Classification of Real-time Locating System (RTLS) Use Cases in Matrix Production Systems. *Procedia CIRP*, **130**, 1346-1351, https://doi.org/10.1016/j.procir.2024.10.250

[10] Halawa, F., Dauod, H., Lee, I. G., Li, Y., Yoon, S. W. & Chung, S. H. (2020). Introduction of a real time location system to enhance the warehouse safety and operational efficiency, *International Journal of Production Economics*, **224**, 107541, https://doi.org/10.1016/j.ijpe.2019.107541

[11] Thiedea, S., Sullivana, B., Damgravea, R. & Luttersa, E. (2021). Real-time locating systems (RTLS) in future factories: technology review, morphology and application potentials. *Procedia CIRP* **104**, 671–676, https://doi.org/10.1016/j.procir.2021.11.113

[12] Sullivan, B. P., Yazdi, P. G. & Thiede, S. (2023). Total Cost of Ownership of Real-Time Locating System (RTLS) Technologies in Factories. *Procedia CIRP*, **120**, 822-827, https://doi.org/10.1016/j.procir.2023.09.082

[13] Pekarcikova, M, Mizerak, M., Trojan, J., Hovana, A. & Lachvajderova, L. (2024) Use of SEWIO Real-Time Location System in practice: technical preparation of hardware, data collection and analysis. *MM Science Journal,* **2024**(March) 7274-7279, https://doi.org/10.17973/MMSJ.2024_03_2024005