

## 1. Purpose of this document set

**Objective.** Our objective by providing this data is to gain knowledge on how to further optimize our processes and our handling of requirements based on research know how. We are most interested in:

- Insides on how to handle the single cases of not fully complying requirement data that appear in our processes.
- How to extract domain requirements for a subsystem in case of multiple distributed documents and multiple systems.

**Data.** This data set shall provide a set of requirements and use cases from an industry context for research in software engineering (SE) and requirements engineering (RE). The data provided are based on real projects and product development data. All provided data run through a selection, and anonymization process that includes:

- Small adjustments mainly for anonymization and pseudonymization.
- Selection of isolated requirements from different sources within the industry setup.
- Recombination of these requirements to provide a meaningful data set similar to real data.
- The data sets include only requirements that address domain specific state-of-the art basic features (see [1]).

The data set shall be extended stepwise.

**Data limitations.** The data do not provide a full overview of a real project or the real product development. The represented business domain process and the RE work process are simplified based on the real process elements. Any kind of extended feature or unique-selling-point is not represented in this data set; therefore, the data are not sufficient to build a domain software product. We focus on requirement information that are used for the Warehouse Management System (WMS) software, including those influencing the WMS requirements but coming from other sub-systems.

## 2. Data selection

We used domain standards and domain market reports [1] to select the most common feature aspects of domain products. We setup a simplified domain business process and a simplified RE work process based on projects and different stages of intralogistics projects and product development data reflecting the most common feature aspects. We tried to keep as far as possible a reasonable product scope. We want to address in the future more example of different RE artifacts along the RE work process to share an overview on complexity and dependencies influencing the domain product. We reviewed artifact example within the domain and from different groups, projects, and years, and extracted those linking to the most common feature aspects. This includes fully complying requirements and more informal documented requirements. We rearranged them in this data set. Based on the background selection process the provided data set might not be representative related to how many requirements fully compliant with requirement quality criteria.

## 3. Domain

These data are used in intralogistics to develop and configure intraLogistics Automation Systems (LAS). Intralogistics is a sub-domain of the logistics domain with focus on work processes and material handling within the boundaries of a warehouse. LAS include mechatronic products and different level of software products, like conveyor belts, item handling robots, transport robots, storage, and retrieval systems mechatronic controls software, programmable logic controller (PLC), and Warehouse Management System (WMS). We only provide requirements from a strategic, mechatronic, mechatronic control, or host system level if they are relevant for the WMS or in case of dependency with WMS requirements. In any cases we focus on WMS requirements.

RE processes in this context are multistage RE processes. Including product development RE process and a customer project RE process, each with multiple roles involved.

Product RE: Starts with a general vision, transferred into a system-of-system concept with related requirements, broken down into system and sub-system requirements one of them a WMS.

Project RE: Start with a customer request that might include self-written first requirements or a requirements specification created by a consultant company, overall system sales activities and elicitation of overall project requirements, followed by sub-system requirement refinement by experts.

#### 4. Glossary

**AMR** – Autonomous mobile robots

**ASN** – Advanced shipping note

**ASRS** – Automated Storage and Retrieval System - A mechatronic storage system

**FEFO** – First Expired – First Out – A strategy based on the expiration of best before dates.

**HU** – Handling unit – Load carrier like pallets, tablets, boxes as used to handle items in (intra-)logistics.

**LAS** – intraLogistics Automation System – An orchestration of mechatronic storage, retrieval, and task processing systems together with software systems like machine controls, PLS, and WMS.

**PLC** – programmable logic controller – Industry computer system used for mechatronic component control and regulation based on connections to sensors and actuators.

**Process** – The term process can relate to any on the following process variants and different meanings of the term might be used. Specific variants are:

**Business process** – Mostly used for the business process in a warehouse owning company. On different level of detail. They can include aspects like: company administrative work flows, human resource management, ordering processes, purchasing, replenishment, supplier agreements, invoicing, and intralogistics work processes.

**Intralogistics business process** – A process that focuses on activities in a warehouse that are needed to enable work and material flow processes in a warehouse.

**Material flow process** – A process in a warehouse that focuses on material movement and handling from inbound to outbound including all in-between steps.

**Work process** – Either a work process in the warehouse or in the providing company.

**Software development process** – Processes related to the development of software (here mainly the WMS).

**Software process** - Processes within the software like system-user interaction flow, or code related processes.

**WMS** – Warehouse Management System – A software system used in warehouses to control storage inventory, organize warehouse processes, and to manage and optimize storage capacity, intralogistics material flow, and operator workflows. [2]

#### 5. Domain specific state-of-the art basic features

Based on the WMS Market Report Compact 2022 [1] the functional aspects with the highest coverage on the WMS market are (83% to 68%):

- Warehouse structure
- Advanced shipping note, Advanced shipping note completion / feedback on stock
- Dispatch
- Relocation / replenishment / rebooking
- Receipt
- Packing
- Storage
- Transport management
- Inventory management

- Order picking

Within the category of additional functions domain specific state-of the art basic features are (81% to 71%) based on the WMS Market Report Compact 2022 [1]:

- Handling-Units-Management
- Batches / production lot ID
- Multi-client capability
- Serial number
- Cross-docking
- Best before dates

## References

- [1] L. M. Wings; K. Schmeltzpfenning, et al.; WMS MARKET REPORT COMPACT 2022; Fraunhofer-Institut für Materialfluss und Logistik IML; 2022; Online: [https://www.warehouse-logistics.com/152/3/publications-\(incl-wms-market-report\).html#Marktreport2022](https://www.warehouse-logistics.com/152/3/publications-(incl-wms-market-report).html#Marktreport2022), last checked: 17.12.2024
- [2] Verein Deutscher Ingenieure; VDI 3601 – Warehouse Management Systems; Beuth Verlag; Berlin; 2015