

# Material Handling Systems for Physical Internet Hubs – Evaluation and readiness of present Material Handling Systems for the Physical Internet

Dipl.-Ing. Herbert Gabernig and Dipl.-Ing. Florian Ehrentraut

## Introduction

Upon the numerous research fields arising from the Physical Internet (PI) concept, PI Hubs are one of the key elements to realize a future PI. PI Hubs, synonymous to nodes in the Digital Internet, represent the transition points of a future PI network and can be described as a node where PI-containers switch from one logistics service to another. They represent a gateway between two logistics networks, change of mode of transport, change of vehicle, coupling/decoupling, etc. [1].

## Problem statement and objectives

In order to enable seamless open asset sharing and flow consolidation on a massive scale the PI will transform the way physical objects are moved, deployed, realized, supplied, designed and used all around the world. To fulfil those high requirements, PI Hubs need special, advanced machines and handling processes. The aim of the presented research work is to evaluate the readiness of material handling processes of current hubs in a future PI. For achieving this aim, the following research questions are observed:

- What are material handling processes for goods and their corresponding material handling systems within present hubs throughout the supply chain network?
- What are PI-hub key elements and their characteristics in terms of material handling processes?
- What are the technological gaps between the present situation of used material handling systems and the desired systems for realizing the Physical Internet?

## Methods

In order to identify processes and their corresponding material handling systems within hubs, knowledge about fundamental processes within a hub was needed. For addressing these fundamental processes, the Distribution Centre Reference Model (DCRM) was selected (see Fig 1). Base on the DCRM different research steps described in Tab.1 are performed.

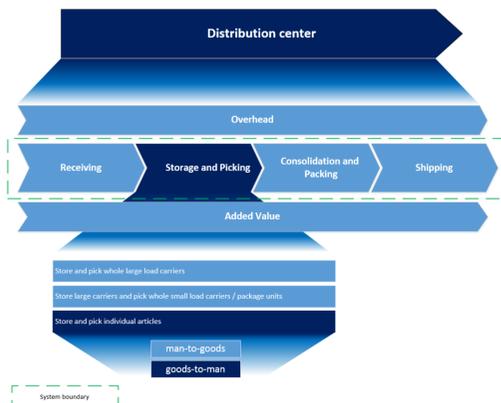
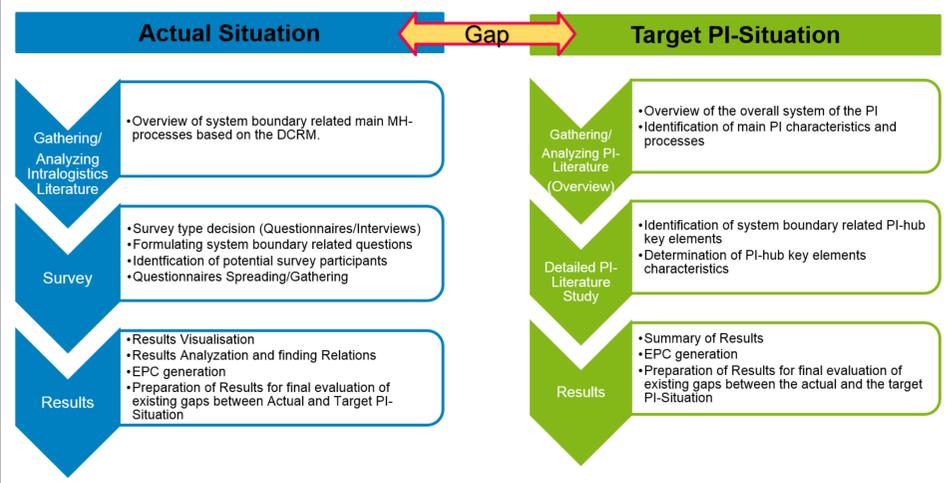


Fig. 1: General processes of the DCRM and system boundary of the research [2]

Tab. 1: Different research steps



## Results

The main output of the presented research work is illustrated in Tab. 2: The gaps between the processes, equipment or system executed or existing in current hubs and future PI-hubs by comparing the questionnaire results from with the corresponding PI-hub key element characteristics. For this purpose a “level of accordance” (between present hub and future PI-hub key element characteristics) has been set up, to rate the degree of overlap between the present hub system characteristics and PI-hub key element characteristics.

Tab. 2: Results of the Variance Comparison Rating corresponding to overlaps between present hub system characteristics and PI-key element characteristics → Poor: No or only marginal overlaps; Medium: Several overlaps; Strong: Overlaps in many or even all areas.

Process, Equipment or System	Level of accordance between present hubs and PI-hubs	Context
Handling equipment for loading and unloading	Poor	ULFE
Unit load composing and decomposing	Poor	Lvl. of automation
Conveyor/Sorting techniques	Strong	Hub complexity
Identification system	Poor	MHS-Design
Stores and buffers	Strong	Frequency of use
Warehouse management system/Planning software	Poor	Technological means for identification
Use of different external means of transport (powered with alternative fuels)	Poor	Type of execution
	Strong	Frequency of use; Type of execution
		Last mile

## Conclusion and outlook

Even though some system requirements of the PI already exist to some extent in present hubs there is one major concern strongly connected with many of the necessary developments which have to be fulfilled for successfully realizing a future PI: The modular PI-container. As most of the material handling systems nowadays are designed for pallet handling operations, there was no need for adapting the used conventional systems for a palletless handling system like the PI so far. This automatically leads to the low levels of accordance presented in Tab. 2. The mutual influence between the PI-container development and the development of matching material handling systems for the PI is inevitable, not least because of the amount of handling systems which the PI-container will be eventually handled with. As illustrated in Fig. 2, the PI-requirements are also influencing the development of PI-containers and corresponding material handling systems.

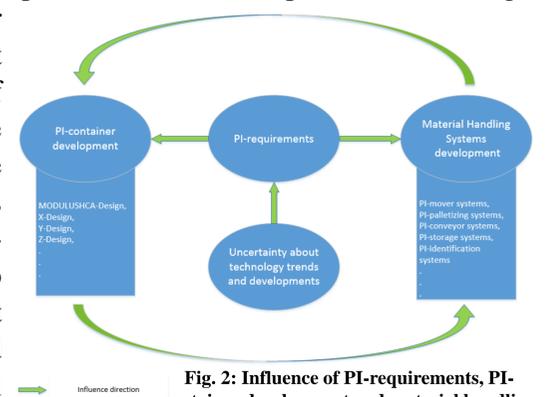


Fig. 2: Influence of PI-requirements, PI-container development and material handling systems development

## Bibliography

- [1] Ballot, Eric; Montreuil, Benoit; D. Meller, Russell: The Physical Internet - The Network of Logistics Networks. Paris, 2014.
- [2] Warehouse-excellence: warehouse-excellence. URL <http://en.warehouse-excellence.de/homepage/components/> - Accessed: 30.05.2018

## Acknowledgments

The research presented was conducted at Graz University of Technology by Dipl.-Ing. Herbert Gabernig in the course of his Master Thesis and by Dipl.-Ing. Florian Ehrentraut in the course of his PhD-Thesis.