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Service flow networks for functional design of distribution centers

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The work deals with the determination of an approach for concept planning of distribution centers. For this purpose, the "Distribution Center Design Process" is defined. Solution concepts for distribution centers are developed and evaluated in an eight-step process. In particular, the formalization of the functional area, which has not yet been considered scientifically, will be focused on. This results, among other things, in the definition of services and basic transformation properties of handling units. These can be used to create and semantically test service flow networks, which describe the functional sequence and transformations in distribution centers.

INTRODUCTION

Distribution Centers
- Distribution centers are complex systems and indispensable components of modern supply chains
- They contribute significantly to the quality of the entire network
- More than 3 million sqm of new logistics space in Germany in 2016
- Flexibility as a success factor

Conceptual Design
- Complex, ill-structured decision problem
- Carried out by interdisciplinary collectives
- Design approach is heuristic: mathematically optimal solution does not exist
- Goal: the best possible solution

Conclusions and Questions
- It follows from the fact of the structural deficiencies that the legitimation of the planning result results from the intersubjectivity of the heuristic used.
- This also means that the derivation of heuristics – as far as possible – meets the requirements of formal rationality, i.e. the process of decision-making should be rational, while the goals guiding the process may be subjective.
- Thus, the scientifically founded derivation of the partial problems, their arrangement in a planning process as well as a suitable documentation of these contents are tasks of outstanding importance for the quality of the planning results.

Using Service Flow Networks within DCDP for Functional Design of Distribution Centers

DCDP
- Functional design, incl.
  Top-down problem analysis
  Task definition & objective setting
  Development of the initial Service Flow Network
  Design of the Service Flow Network
- Physical design, incl.
  Bottom-up solution synthesis
  Evaluation and decision making
  Performance design and (overall) layout
  Allocation of resources
  System boundaries and organization
  Definition of subsystems
  Iterations within and across phases

Service flow definition
- Handling units and services with each
  Function flows within the DCDP.
  Service Flows
  Describes the function of a distribution center at different hierarchy levels

Handling Unit Properties
- Predecessor-successor relations (example)

Formalization
- \( I = (A, \Theta, K, \Pi) \)
- Functional system \( I_f \) consisting of attributes \( X \) and functions \( \Theta \)
- \( \Theta = S \)
- Function = Service
- \( S = \Gamma_1 \times \Gamma_2 \)
- Services are defined as relations \( h \) between attributes \( \alpha_1, \alpha_2 \) of a function system
- The attributes of the function system are interpreted as function-flows within the DCDP
- The services \( s \) determined within the scope of service decomposition are linked to an SFN.
- An SFN \( G_{S\!F\!N} \) is a directed graph with the node set \( A \) and the edge set \( \Theta = (\alpha_1, \alpha_2) \)
- In which each node \( k \in A \) represents a functional flow (Handing lists with specific (flow) properties), and each edge \((\alpha_1, \alpha_2) \in \Theta \) a transition between flows.
- The SFN defined in this way thus becomes a reflection of the functional system:
  \( I_f \leftrightarrow G_{S\!F\!N}(A, S) \)

SUMMARY & OUTLOOK
- Distribution Center Design Process (DCDP): 8-step process for conceptual design of distribution centers as a blueprint for model- and system-engineering-based concept planning of distribution centers: Symmetrical process, with each 4 phases of functional design and physical design
- Development of the Service Flow Network concept (SFN) to describe the functional structure and the logical linking of functions respectively services with each other within a distribution center
- Integration of DCDP and SFN concepts into digital design environments (see Poster 20 - Digital design of intralog. systems)

REFERENCES

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