## A TOOL-BASED APPROACH TO ASSESS SIMULATION WORTHINESS AND SPECIFY SPONSOR NEEDS FOR SMEs

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INTRODUCTIONMETHODOLOGYTOOLREFLECTION ANDAND MOTIVATIONAND FINDINGSDEVELOPMENTOUTLOOK





## Introduction and Motivation



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### Some German "Mittelstand" (Small and Medium sized enterprises (SMEs)) facts:

• SMEs account for 35 % of total corporate turnover [1]

• Host more than 80% of training places and employ 58.5 % of the German workforce [1]

• Face systemic disadvantages compared to their corporate counterparts with regards to digitalization



## Introduction and Motivation



### Status quo for many SMEs

- Lack of operational support for (potential) users of Discrete Event Simulation (DES) in SMEs
- Existing user support does not appear to be sufficiently SME-specific
- o Limited simulation knowledge in SMEs
  - DES awareness and understanding
  - Identification of DES-worthiness / -worthy problems
  - Collection & understanding of necessary data
  - Lack of personnel and financial resources or expertise

### Identified needs for action

- Support for SMEs in the
  - Determination of the DES-worthiness
  - Formulation of the goal description
  - Development of a list that contains application problems worthy of simulation
  - Establishment of criteria for assessing simulation worthiness
  - Development of a tool to support SMEs in the initial phases of a simulation study





Addressed aspects	Banks et al. (2010) [2]	Rossetti (2015) [3]	Rabe et al. (2008) & Wenzel et al. (2008) [4-5]	Law (2019) [6]
DES-worthiness				
Problem description				
Goal description				
Gathering data				
Verification and validation				
Additional tools (e.g., checklists)				
Focus on SMEs				

present partially present not present





## Methodology and Findings



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## Research Methodology







## Research Methodology







## Research Methodology – Literature Review



Start Identify DES fields of application in scientific literature

Review case studies with a focus on SMEs **Research question:** Which problems of SMEs in production and logistics systems can be solved using DES?

Search strings: (discrete event\* AND simulation) AND (small and medium enterprise\*) AND (logistic\*OR manufacturing\* OR production\*)

Language: English and German

Databases: Web of Science Core Collection, ACM Digital Library, IEEE Xplore, Business Source Premier, WISO, Google Scholar, ScienceDirect and Emerald Insight

Categories: **planning**, **implementation**, and **operation** of a system

Sampling (first 50 publications)

Case studies from 1999 to 2019

29 relevant (i.e., SME-related) DES case studies (see backup)



## Research Methodology – Delphi Study





## Research Methodology – Delphi Study Design



### o Benefits

- Asynchronous response possible
- Anonymous feedback
- More time for reflection
- o Goal
  - Ensure completeness and validity of the list
  - Capture expert opinions on the relevance of the application problems



### • Assessment of given application problems (29 in total)

- Frequency  $\rightarrow$  7 categories: From Rarely to 1 time per day
- **Importance**  $\rightarrow$  4 categories : From unimportant to important
- Termination criteria
  - Expert consensus: 75% of respondents have the same opinion
  - **Stability of opinion:** Stability of expert opinions based on categorical data
- Expert selection
  - Digitization experts and process owners in the industry who participate in the WisLab project

Addition of four new problems; valid and complete problem checklist; problem evaluation



## Research Methodology









### • Criteria definition from pertinent literature

- Banks (1998) [7]
- Law (2015) [8]
- März et al. (2011) [9]
- Robinson (2004) [10]
- Rossetti (2015) [3]
- VDI (2014) [11]
- Wenzel et al. (2008) [5]

Compile ehanced problem checklist Identify criteria to assess DESworthiness of potential problems

- Criteria weight: Pairwise comparison based on frequency
  - Case 1: one criterion is cited less often than the other , thus it is less important
  - Case 2: both criteria are cited equally often
  - Case 3: one criterion is cited more often than the other, it is considered more important

#### Weighted criteria for the definition of DES-worthiness





## Life-cycle related distribution of DES utilization [year]

# Industry related distribution of DES utilization [%]







### Number of participants per round

## "Does your SME use DES in production or logistics?"





Round 1: Jul. 28, 2021 - Aug. 13, 2021 Round 2: Aug. 23, 2021 - Sep. 10, 2021 Round 3: Oct. 04, 2021 - Oct. 15, 2021

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## Weighted criteria for DES-worthiness



### Weight [%] based on pairwise criteria comparison

Stochastic influences (dynamic systems) Experimental scenario analysis Long time system analysis Highly interconnected system elements Large number of system elements Non-existence of the real system Performance analysis of dynamic systems Short time system analysis Relaxed assumptions for uncertain data Special requirements for visualization





## Research Methodology







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## Tool development



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## **Tool Requirements**



Functional requirements	Additional requirements			
The tool must have a list of problems	The tool must be cost-effective			
The tool must allow the selection of a problem and a further description	The tool must have a manual			
The tool must contain a list of DES-worthy criteria	The tool should explain the procedure of a simulation study			
The tool must link the task to the DES-worthiness criteria	The tool must provide data security			
The tool must link the task with the support section of the target description				
The tool must guide the user to the creation of the target description document	The tool must be user friendly			
The tool must allow filling in the document of the target description	The tool must require little staff training			
The tool should allow printing the document from the target description				
The changeability of criteria for determining the DES-worthiness must be restricted	The tool should be flexible to adapt to different industries			
The tool should allow database updates				
The tool must demonstrate the DES-worthiness of a task	The tool will communicate with other software (interface capabilities)			



## Tool Prototype (1/4)





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Start



## Tool Prototype (3/4)







## Tool Prototype (4/4)

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### $\circ$ Methodology

- User survey
- Expert opinion with a checklist
- $\circ$  Results
  - Survey
    - Suggestions for improvement
      - $\checkmark$  Improved connection between given problem and DES-worthiness
      - $\checkmark$  More detailed explanation about the simulation study process
      - $\checkmark$  Provision of comparable reference problems
  - Checklist
    - 82% of the desirable tool aspects were fully fulfilled









## Reflection and Outlook



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### Lessons learned

- Pre-test the Delphi study
- User case study based on a reference example would be useful
- Tool evaluation in a more comprehensive user group from the SME sector is necessary
- More detailed explanation of simulation study aspects desirable



## Summary and Outlook



### Recap

- DES is rarely used in SMEs
  - Lack of resources and Know-How
  - DES application during system realization is very rare
  - SMEs need tools that meet their needs
- $\circ$  Tool development
  - Goal: Enabling SMEs to independently identify problems worthy of DES and specify their sponsor needs
  - Checklist for the identification of DES-worthy problems
    - Based on scientific literature and case studies
    - Evaluation and enhancement via a Delphi study

### **Future directions**

- Expert evaluation on the relevance of the weighted criteria for DES-worthiness
- Evaluate the developed tool in a more comprehensive user group from the SME sector
- Further development of the demonstrator into a standalone software or integration into existing software
- Holistic solution for SMEs (i.e., more operational support for the later stages of a simulation study)



## Thank you for your attention!



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