Tackling Non-transparency - Identification of Hidden Problems in Component-Based Supply Chains

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Introduction

Non-transparency in component-based supply chains beyond tier 1 [1] [2]

- Hidden Problems remain undetected, propagate and reinforce before popping up as crisis event at tier 1 [3][4]
- Traditional supply chain management: reactive measures at tier 1 or 2. [5]

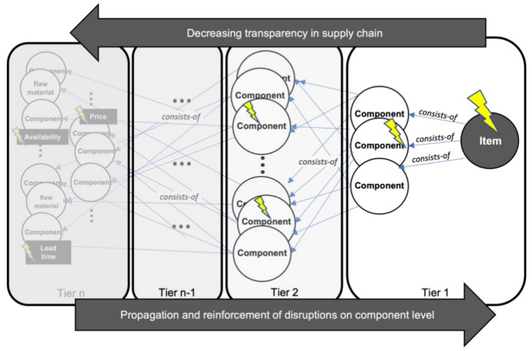

Fig 1. Hidden problems in component-based supply chains.

Hidden Problem Detector identifies critical supply chain components, whose shortage interfere timely and cost-effective production → enables proactive measures for end users to manage shortages

Methods

Hidden Problem Detector uses graph-theoretic centrality measures (in-degree, out-degree, out-strength, and betweenness-centrality of nodes) to identify critical supply chain components, whose shortage interfere timely and cost-effective production

1. Bill of materials (BoM) are mapped onto a knowledge graph
2. Enrichment of graph with component data (e.g., seller, manufacturer, category etc.)
3. Graph-theoretical determination of component criticality
4. Integration of historical data regarding market availability, prices and lead times
5. Generating decision support for end users

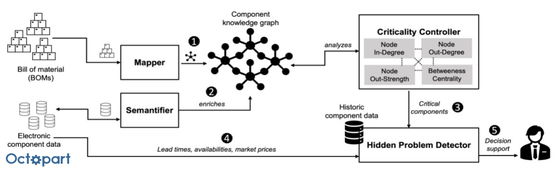

Fig 2: Model for graph-theoretic analysis of component criticality in supply chains

Results

Service prototype **Hidden Problem Detector** detects and localizes hidden problems in component-based supply chains in sensor manufacturing

➢ Client-server architecture:

Octopart · python · Flask · neo4j

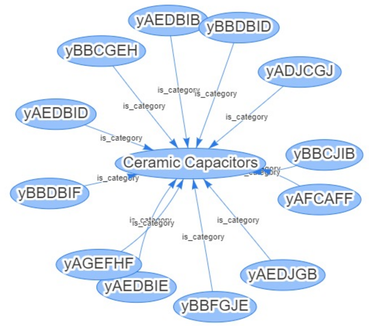

Fig 3. Knowledge Graph of Ceramic Capacitor

➢ Shortage alerts for critical components

	Component	Manufacturer	Supplier	Type	Reason
1	H131700	3M	['Electro Sonic', 'Heilind Europe', 'NAC Semi', 'Onlinecomponents.com', 'Master Electronics', 'Heilind Electronics']	No results	For the current time horizon the component H131700 shows shortage behaviour by incrase in lead-time (50.0 %) and increase in price (1710.61 %)

Tab 1. Example of alert about Components

➢ Actual and historic market data for critical components

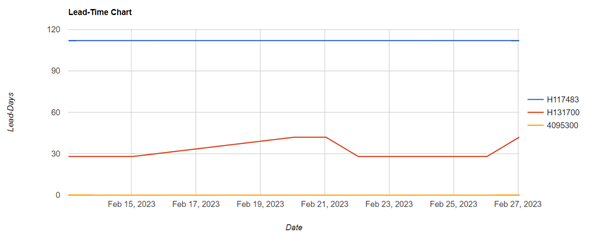

Fig 4. Factory lead time for the selected period

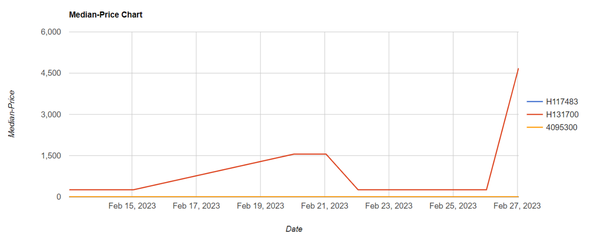

Fig 5. Median price trend

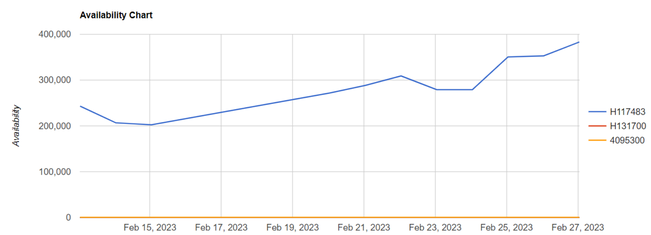

Fig 6. Availability trend

Indicator Changes

Component ID	Change	13.02.2023	27.02.2023
H117483	-1.61 %	0.435545	0.428545
H131700	1710.61 %	258.499165	4680.41015
4095300	0.0 %	6.51	6.51

Component ID	Change	13.02.2023	27.02.2023
H117483	57.52 %	243.197,00	383.078,00
H131700	0.0%	0,00	0,00
4095300	0.0 %	450,00	450,00

Component ID	Change	13.02.2023	27.02.2023
H117483	0.0 %	112.0	112.0
H131700	50.0 %	28.0	42.0
4095300	No results	No results	No results

Tab 2. Indicator changes

Conclusion and Future Work

- Graph-theoretic analysis with respect to in-degree, out-degree, out-strength, and betweenness-centrality of nodes enables answering of various questions, e.g., **"Which are critical components / manufacturers / suppliers?", "Are there changes in lead times / availabilities / prices, that could be critical for the entire product range?"**
- Components with high criticality are characterized by a high out-strength, AND/OR high out-degree, AND/OR high in-degree with respect to upstream components, AND/OR low in-degree with respect to alternatives, AND/OR high betweenness-centrality
- Future work: empirical user study with prototype (qualitative or quantitative)

References & Acknowledgements

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