MONITORING ON-TME AND REAL-TIME PERFORMANCE OF SUPPLY CHAIN NETWORKS FROM AN SME PERSPECTIVE

KEYWORDS

Supply Chain Monitoring, Visibility, SME

INTRODUCTION

Data availability has improved the last decades, enabling companies to make use of large data amounts. While big enterprises have the resources to build up or hire knowledge and invest in a professional data infrastructure, this is not always the case in small and medium-sized enterprises (SMEs). However, to increase the visibility of the OEMs networks they rely on fast and quality data of their subcontractors. This may put pressure on SMEs in these networks as they may lack technology and resources. By conducting case studies, we analyze SMEs aiming to identify opportunities and limits of real-time performance monitoring in their supply chains. As a reference point, we compare and contrast SMEs supply chain performance monitoring maturity to an OEM's best practices.

Purpose of this research is to define states of entities (state, identity, time and location) moving through the supply chain (SC) network (e.g. orders, shipments) and therefore the granularity of process description that is possible and suitable from the SME perspective. This can help SMEs keep up with OEMs by meeting their requirements. To this end, we extend the State-Identity-Time (SIT) framework (Shu and Barton 2012) by a fourth component, which is location. It associates the tracked entity to a position (Francis 2008) in space (e.g. by coordinates) and hence allows to add geographic context to extend analysis and visualization capabilities. For the considered companies, we evaluate, what data is available to track entities via the State-Identity-Time-Location (SITL) framework through the network from the suppliers to the customers. Next, we create an ontology for the SITL framework, which relies on the existing EAGLET ontology (Geerts and O'Leary 2014) to encourage the transfer of research from big to small businesses, commit to a common understanding of the introduced domain concepts and to leverage data and knowledge re-use for further exploration and analysis. Moreover, we classify whether the data is available historically or in (near) real time. Based on that, we develop guidance on how to apply SITL and demonstrate how this data can be used to monitor performance (e.g. timeliness) in the network of the respective SME.

LITERATURE REVIEW

The concepts of SC visibility and monitoring are gaining importance over the last decade – especially in times of a pandemic. Nevertheless, various concepts and ideas are discussed under this term and no commonly agreed definition exists in the SCM literature. For example Francis (2008) addresses *"timely messages"* (alerts) in case of deviation from the target state in his definition of SC visibility, whereas Merle (2003) refers to such kind of permanent checking and feedback as the definition of SC monitoring. Within our research, we understand SC visibility as the broader concept that provides the theoretical framework and defines requirements for SC monitoring, by taking over the definition of Francis (2008): *"Supply chain visibility is the identity, location and status of entities transiting the supply chain, captured in timely messages about events, along with the planned and actual dates/times for these events."* Consequently, we understand SC monitoring as a downstream task of SC visibility that includes the data collection, processing and analysis for the tracked entities along the network to produce added value for a company (McKinney et al. 2015).

The SIT framework (Shu and Barton 2012) was developed to use data-rich environments that are present in many supply chains to accelerate the data-driven supply chain allowing supply chain monitoring in real time. In the SC visibility literature, another important part of tracking entities are events. An event triggers the change of status and/or location (Francis 2008). In the EAGLET ontology for a highly visible *"supply chain of things"* (Geerts and O'Leary 2014) there is a strong emphasis on events too. Parallels in the explanations of central features can be found between SIT of Shu and Barton (2012), the definitions by Francis (2008) and the model of Geerts and O'Leary (2014).

METHODOLOGY

We conduct multiple cases in the branch of automotive industry. We compare the preconditions for supply chain monitoring of the OEM and the SMEs. Additionally, it will be evaluated whether the use cases of the OEM are also relevant and applicable in the SME context.

We consider the State-Identity-Time-Location (SITL) Framework (Shu and Barton 2012; Francis 2008), which includes the state of an entity, its ID as identity, and a time stamp including date plus daytime and extend it by the concept of location by adding geographic geometries (e.g. points denoted by coordinates in a geographic coordinate system). The state of an entity depends on the type of product, monitoring purpose, level of entity hierarchy. An example is given below in the preliminary findings.

PRELIMINARY FINDINGS

For the considered car manufacturer, we chose to present the delivery network as an example. Therefore, the processes of supply and production are not included, resulting in the absence of the status' *in production* and *on stock*, as shown in Table 1.

Table 1: The SITL framework at the considered OEM

Dimension	Description	Remark
State	Possible values: initialized, *in production, on stock,* in transit, delivered, issued	The state 'issued' is used for exceptions (e.g. waiting for decision because of damage)
Identity	A combination of ID, product-type, sink (i.e. customer)	At companies, this can be split in three variables: ID, product-type, sink
Time	Date and time	It can be distinguished between actual, planned and predicted time
Location	Possible values: the production plant, the customer, an intermediate point during the delivery	Address data can be translated in GPS data

Supply chain visibility and monitoring encompass various challenges that need to be addressed in order to provide meaningful information. Those include (1) how to identify wrong data that is passed to a monitoring system, (2) how to handle data change (e.g. target change, rerouting), (3) how to define target times that are a crucial part of the alerting system, (4) how to incorporate external data (e.g. weather data from an API impacting shipments), and finally (5), defining a complete ruleset that addresses the company's needs for alerts (e.g. thresholds for stock levels, waiting time). Point (2) is party addressed by the EAGLET ontology, which provides grammar to "stereotypical patterns" of item flows.

CONCLUSION

Although the work and best practice recommendations of Merle (2003) and the Odette SCM group – that includes prominent OEMs of the automotive industry – has been published back in 2003, SC monitoring is still a topical issue as information and communication technologies ever evolve, hence, pave the way for new approaches. By developing an ontology-based framework for SC monitoring from an SME perspective, we contribute to the SC visibility and monitoring literature. We anticipate that the mastering of the balancing act between meeting OEMs requirements and managing the own company profitable is essential for SME. We aim to support SMEs in drawing benefits from SC visibility and monitoring equally by giving them a coherent methodology. Our research is limited because we look at only a few cases. Further

research may extend this work by applying our approach to more companies coming from various industries in order to further refine the process and enhance applicability and generalizability of the suggested method.

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