LOGISTICS MATURITY MODELS - STATE OF THE ART AND CRITICAL EVALUATION

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Abstract

The paper presents the literature review of maturity models used for improvement of logistics performance in industrial companies. The aim of the paper is an analysis of the state of the art and critical evaluation of strengths and weaknesses of the existing models. The paper outputs are principal requirements for a comprehensive logistics maturity model building and issues for a future research.

Keywords: Logistics maturity model, logistics performance, critical evaluation

1. INTRODUCTION

The ever-increasing importance of logistics and the increasing demands on logistics management in the environment of supply chain globalization leads to the need to create tools for the analysis, knowledge and evaluation of the current level of performed logistics processes, which form the foundation for their continuous improvement. Maturity models are such an approach in this area. The concept of maturity can then be understood as "the state in which the system under investigation is complete, perfect and ready" [1]. The subject of the evaluation of the maturity of logistics processes is therefore the analysis and evaluation of logistics processes in order to determine the degree of their maturity, helping to determine progress from early stages to stages of excellence, full readiness and completeness in terms of individual sub-processes and their skills. The aim of the paper is the deep analysis of the state of art and a critical evaluation of strengths and weaknesses of the existing logistics models to define requirements for a comprehensive logistics maturity model building.

2. BUSINESS PROCESS MATURITY MODELS

The idea of the maturity model originally stemmed from software engineering. In 1993, the Software Engineering Institute (SEI) of Carnegie Mellon University in Pittsburgh (USA) developed the Capability Maturity Model (CMM), which became the first standardized process designed to assess the level of IT organization quality by analyzing the performance level of the software development process [2].

The purpose of maturity models is to assess the level of examined processes on an imaginary maturity scale from the lowest level to the highest level. According to [3], maturity is considered to be a "state where the process is complete, perfect and ready". The maturity model can be defined according to [4] as "a construction-based model that consists of an anticipated, limited development path, separated into stages with defined characteristics and dimensions" or as "a sequence of levels (or stages) that together form an anticipated, desired, or logical path from the initial state to maturity" [5].

To this date, the development of maturity models for a wide range of processes has seen an unprecedented increase in popularity. For example, Tarhan et al. [2] analyzed 61 scientific articles focusing on the maturity models of business processes published between 1990 and 2014. The authors state that the current state of research in the area of maturity models is in the early stages and that academic literature lacks the methodological application component for many of the common maturity models that have been designed so far. They propose aligning existing models with a strong emphasis on normative properties and conducting empirical studies to demonstrate the validity and usefulness of these models.

3. STATE OF THE ART OF LOGISTICS MATURITY MODELS

One of the basic ideas of logistics process maturity models is that increased maturity will improve business performance, which will improve the financial performance of the business. The fact that there is a correlation between process maturity and business process performance indicators has already been mentioned in publications [6] and [7]. The results of the Söderberg and Bengtsson study [8] also show that there is a strong relationship between the maturity of logistics processes and their financial performance. One conclusion of the study is that when companies use maturity indicators to improve their logistics processes, it is very likely to have a positive impact on the company's performance and probably on its financial performance. Confirmation of the above assumption clearly supports the creation and use of maturity models and their use in managing and improving logistics processes. In some studies, maturity models themselves are considered to be performance measurement methods, and therefore logistics process performance indicators [9].

The following section will briefly introduce the published logistics maturity model. The study [10] provides industry enterprises with operational guidelines for evaluating distribution processes that, according to the author, are practical, verifiable, repeatable and extensible to other areas of logistics processes. However, the publication does not allow the model to be used by the professional public, as it does not contain details of the model or instructions for its application.

In its work, Werner-Lewandowska [11] focuses on the maturity of the logistics processes of a company operating in the service sector and presents a series of 81 basic skills and methods, the implementation of which is considered to be an indicator of the maturity of in-house logistics processes, distinguishing 5 basic logistics areas - planning, resources, stock, distribution and reverse processes.

Lahti [12] presented an analysis of the 6 maturity models of logistics processes in his study. He compares the basic characteristics of some maturity models with a focus on determining the number of levels, their nomenclature and definitions. They also introduced their own maturity model, which, like other models, is not very detailed and includes only 4 levels. What is interesting, however, is the definition of individual levels through the level of integration of in-house logistics processes - from a functional/operational focus, through internal and external process integration to integration throughout the enterprise. A total of 16 logistics process skills in 5 areas (planning, resources, manufacturing, delivery and overall) are rated on a proposed scale based on questionnaires. The disadvantages of this model is its considerable abstraction of reality and the impossibility to identify specific opportunities for improvement in detail.

Reyes and Giachetti introduced another logistics process maturity model [13]. The disadvantage of the model is they still only use the basic general scale of maturity of processes in the structure: undefined, defined, managed, cooperating, and leading processes. The advantage of the model is, however, that it considers two other dimensions of evaluation: abstraction level - operational, tactical and strategic level of process management and different views on logistics processes - performance, information systems and technologies, customers, supplies, manufacturing and suppliers. The evaluation is in the form of a questionnaire, which was compiled by the Delphi method among the professional public, which for each level of the given subprocess or skill contains a general description of the respective level.

Battista et al. [14] present a sophisticated logistics maturity model that attempts to overcome some important limitations of known models: an insufficient framework to incorporate a methodology for identifying qualitative and quantitative relationships between key performance indicators (KPIs), strategic objectives and improvement measures to be implemented in a specific area of logistics processes [15]; difficulties in using existing frameworks in industrial processes due to the low flexibility of the logistics process modeling architecture; difficulties for professionals to understand the criteria in process modeling and maturity assessment [16]; a lack of a holistic framework capable of incorporating a global vision of logistics processes [17].

The presented maturity model consists of 5 relatively standard maturity levels from a level at which processes are uncontrolled, or ad hoc driven, to level-optimized processes and 13 major logistics sub-processes. In designing the model, however, the creators took the real situation and skills of logistics processes into account by including different indicators for different levels of maturity. For example, at level one, key performance indicators are not used at all, because the processes are basically uncontrolled, success indicators are used in specific areas, at level 2 indicators are used to determine the company's ability to obtain data and process information and process efficiency indicators, and level 5 works with key process performance indicators. However, as these indicators are relatively complex, there are many relationships between KPIs. In addition, it is clear that improving the process in a selected KPI can easily affect other indicators that can be mathematically linked or correlated. These interconnections, which create a certain KPI network, are further taken into account in the process of designing measures to increase the level of maturity during the process of choosing a target indicator. The presented maturity model works with three types of bonds - very strong direct/indirect, strong direct/indirect and weak direct/indirect. This network is modeled in the study as a weighted graph: each indicator represents a node and the bonds are represented by edges. Edges are weighted according to the three levels described with respect to the type of relationship (direct/indirect) with other nodes. Thus, for each node, it is possible to calculate its degree, which describes whether the KPI is more or less positively linked to the other KPIs. Thus, by reading values in a network of indicators, management may choose to focus on those indicators of a higher degree, those whose improvement would have a positive impact on most other indicators or those which would have a profound effect on the maturity of the entire logistics system.

Although the authors report considerable benefits of implementing the said logistics process maturity in a particular company, it is necessary to mention the main disadvantage of this model, which is mainly its non-transferability, the impossibility to modify or use it in another company.

One of the most recent publications in the field of logistics maturity models belongs to Oleskow-Szlapka [18], who presented a methodological maturity model framework with a focus on industrial logistics 4.0. The designed logistics maturity model 4.0 is based on three dimensions of the model; the evaluation itself is carried out in areas pertaining to each dimension: management - investment, innovation management, value chain integration; material flow - degree of automation and robotization in warehousing and transport, IoT, 3D printing, 3D scanning, advanced materials, augmented reality, smart products; information flow - data-driven services, Big Data, RFID, real-time localization systems, IT systems.

In the evaluation, there are 5 levels determining the level of maturity - ignoring, defining, adopting, managing, integrating, including a definition in the basic description of the levels. The main advantage of the presented methodological framework is, besides taking into account the 3 basic dimensions of the maturity model, its focus on modern technologies. The disadvantage of the proposed model is, above all, its lack of development into a form that would allow users to set their own maturity level evaluation criteria.

4. CRITICAL EVALUATION OF STATE OF THE ART

Available literature includes studies on the development of individual models of logistics process or business process maturity in general, as well as publications seeking to compare individual models, their structures, proposed scales and metrics. However, the common denominator of many models is the fact that their practical implementation and use in managing and improving logistics processes is very complicated or they make searching for missing methodologies with publicly available information an almost impossible task.

Scientific literature has revealed that although many models of process maturity in general as well as models focusing on logistics processes have been developed, it cannot be said that the issue of assessing the maturity of logistics processes has been satisfactorily explored. Despite the relatively high number of models, their practical utilization happens rather as an exception and is mostly problematic, mainly due to the lack of methodology covering model implementation, their excessive vagueness, lack of accessibility or lack of

verification in practice. The main identified shortcomings of existing models of logistics process maturity, approaches to their creation, practical implementation in business practice or other implications for the creation of the maturity model include:

- The maturity levels of current models are usually very broad and vague, and in most studies their definition is not based on empirical research on real logistics processes, but rather on their general classification. In most models, maturity levels are discreetly separated, which allows for a relatively easy interpretation of the assessment, but only remotely reflects the real situation where maturity levels are definitely not clearly defined.
- The evaluation of process maturity is done by assessing basic general skills of logistics processes, or by a rough comparison with theoretical levels of business process maturity in general. Most models completely lack a more detailed elaboration of investigated processes.
- These skills are often assessed only in terms of level of achieved/not achieved or on a general scale of maturity (non-standardized to optimized), however, there is no sophisticated system defining skill level, which classifies them according to technology level, staff, support system, level progress in a certain skill with respect to the way it is being used and at what quality.
- In most models, the links between skills and indicators are not systematically taken into account, which is one of the barriers to their wider practical application.
- The published studies do not allow the use of the model in practice, mainly because the complete model is not part of the study, most of the study is not published or the methodology for using the model is missing.
- Most models with a few exceptions do not take into account more views; dimensions of logistics processes, which may include, for example: processes, technology, human capital, level of abstraction, etc.
- The models do not work with varying degrees of abstraction of logistics processes and do not allow the evaluation of the maturity of the process at all basic levels of process abstraction - operative, tactical or strategic.
- The models are closed; there is no model providing an update reflecting the development of new technologies and developments in the logistics process management or business sectors. Thus, after the model is published, it is virtually impossible to update the model by adding up-to-date new skills that have emerged or become standard in the industry.
- Models lack a detailed multiple level evaluation - very simple overview input evaluation, advanced evaluation working with a wide set of indicators, including determining their links or a fully-integrated evaluation that can be implemented within an enterprise information system or linked to a key indicator system,
- Available models do not include lists of specific recommendations - or a methodology for their compilation - that would allow for systematic work to achieve higher levels in individual areas; establish a plan for this area of management. Despite the evaluation, further recommended steps can only be inferred from the questions used to assess the level of maturity of logistics processes, so it is necessary to work with specialists who, based on the evaluation and analysis of logistics processes in a particular company, determine the improvement plan and its specific steps.
- There is no model which would work across various industries and logistics processes.

5. COMPREHENSIVE LOGISTICS MATURITY REQUIREMENTS

A critical evaluation of the available scientific literature clearly reveals a research gap in the maturity model of logistics processes, which should be filled by further research. The following characteristics explain what the

"ideal" maturity model should contain for the successful advancement of scientific research in the research area:

- The maturity levels must be determined on the basis of research into real logistics processes; their skills in the enterprise, and must allow the use of the model across sectors while maintaining the informative value of the results.
- The defined maturity levels should account for the reality of the smoothness of transition between them, rather than define them as discreetly separated maturity levels.
- The assessment of the maturity levels should be based on the assessment of logistics process skills identified by intensive research in real processes.
- The skills in question must be evaluated with a sophisticated system in which the skills will be classified both in terms of their components and security through technology as well as security through personnel and support systems. The system will allow the assessment of the level of the given skill, taking into account the methods and the way it is implemented and the quality of implementation.
- The maturity model must take into account the links between skills across all dimensions of the proposed model.
- The model must include a methodology for using the model in practice and the entire model, including the methodology and other parts, must be available to the professional public.
- The model must account for a wide range of views of logistics processes identified on the basis of research in practice; dimensions of logistics processes, which may include, for example: processes, technology, human capital, level of abstraction, etc.
- The maturity model must enable the level of maturity to be assessed at all basic levels of process abstraction - the operational, tactical and strategic levels of process management.
- The maturity model must allow for updates reflecting the development of new technologies and developments in the logistics process management or business sectors, for example by adding updated skills, best practices or technologies that have emerged or become standard in the industry. All this while maintaining the informative value.
- The maturity model should allow evaluation at several levels of detail, overview input assessment, advanced assessment including determining skill links and indicators. It should also be possible to integrate the model within the enterprise's information system, including the link to the key indicator system.
- The model should include lists of specific recommendations and a methodology for their compilation that will allow for systematic work to increase the maturity level, establishing a plan for this area of management.

6. CONCLUSION

The study shows that there are many weaknesses of existing logistics maturity models, approaches to their building, practical implementation in business practice or other implications for the maturity model building. Only their elimination can help to make these models more objective and comprehensive tool for improving logistics performance of industrial companies. The development of such a tool is the aim of future research work of the authors of the article.

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