PRACE NAUKOWE UNIWERSYTETU EKONOMICZNEGO WE WROCŁAWIU
RESEARCH PAPERS OF WROCŁAW UNIVERSITY OF ECONOMICS 2019, vol. 63, nr 6

ISSN 1899-3192
e-ISSN 2392-0041

Karolina Werner-Lewandowska

Poznan University of Technology
e-mail: karolina.werner@put.poznan.pl

ORCID: 0000-0002-9549-4511

Monika Kosacka-Olejnik

Poznan University of Technology
e-mail: monika.kosacka@put.poznan.pl

ORCID: 0000-0001-6950-2728

LOGISTICS MATURITY OF THE SERVICE INDUSTRY – RESEARCH RESULTS

DOJRZAŁOŚĆ LOGISTYCZNA PRZEDSIĘBIORSTW USŁUGOWYCH – WYNIKI BADAŃ

DOI: 10.15611/pn.2019.6.19
JEL Classification: 1400

Summary: The paper presents the results of research on the logistics maturity of the Polish service industry. The research goal of the article is to demonstrate the logistics maturity level of service enterprises. In the research, 2 000 Polish service enterprises were included, which represent various service sections according to the Polish code list of classification of business activities (hereafter: PKD). The companies under study were differentiated according to the company's size, depending on the employment level. The subject of the research was the logistics tools used by the surveyed enterprises in areas of logistics activity such as warehouse management, transport management, supply chain management, supply and inventory management, and IT tools. To determine the logistics maturity level, the Logistic Maturity Model for Service Industry (hereafter: LMM4SI) was used, based on the assumption that the logistics maturity level of a service enterprise depends on the logistics engineering tools that were used.

Keywords: logistics maturity, service enterprise, company logistics, logistics tools.

Streszczenie: W artykule zaprezentowano wyniki badań nad sektorem usługowym w Polsce w kontekście dojrzałości logistycznej. Celem badawczym artykułu było wykazanie poziomu dojrzałości logistycznej przedsiębiorstw usługowych. Obiektem badań było 2000 polskich przedsiębiorstw usługowych należących do różnych sekcji usług według PKD, o różnej wielkości zależnej od poziomu zatrudnienia. Przedmiotem badań były narzędzia logistyczne wykorzystywane przez badane przedsiębiorstwa w obszarach aktywności logistycznej takich jak: zarządzanie magazynem, zarządzanie transportem, zarządzanie zapasami i zaopatrzeniem, zarządzanie łańcuchem dostaw oraz narzędzia IT. Do określenia poziomu dojrzałości

wykorzystano opracowany model LMM4SI (Logistic Matrurity Model for Service Industry), który opiera się na założeniu, że poziom dojrzałości logistycznej przedsiębiorstwa usługowego zależy od narzędzi instrumentarium logistycznego, które są w nim stosowane.

Słowa kluczowe: dojrzałość logistyczna, przedsiębiorstwo usługowe, logistyka przedsiębiorstwa, narzędzia logistyczne.

1. Introduction

An increase in the number of service enterprises has been observed in Poland, which brings the Polish economy closer to the market's model typical for Western European countries. According to data from the Central Statistical Office in Poland, in 2018 service enterprises constituted 54% of all enterprises, among which dominated enterprises treated as micro, small and medium enterprises (hereafter: SMEs) (CSO, 2019). In 2017, SMEs represented 99.8% all Polish enterprises, whereas the largest group (96%; 2 million) were micro-enterprises (Zakrzewski and Skowrońska, 2019). Polish SMEs run their business mainly in the service sector (52.3%), where 13.5% provide services in the field of professional, scientific and technical activities, 8.8% of companies deal with health care and social assistance, and 7.5% provide services in the field of transport and warehouse management.

Considering the role played by Polish enterprises in the Gross Domestic Product (hereafter: GDP), in terms of the economic sector it was noted that for SMEs, the service sector has the greatest impact (e.g. in 2016 the total share of GDP by SMEs was 43.1%, while for large companies 29,2% (Zakrzewski and Skowrońska, 2019).

In terms of the number of employees in Polish enterprises, in 2017 companies representing the service sector dominated, too.

Regarding the average monthly gross salary (in PLN) per one employee according to the code of business activities in Poland (hereafter: PKD), it was stated that employees receive the highest salary in the section assigned to the service sector, namely: *Information and communication*. It is noteworthy, that the lowest remuneration is in the section *Other business activity*.

Taking the above statistics into consideration, it was stated that the Polish service sector represents high research potential, which justifies research on this topic. In 2018, the Polish service sector was dominated by enterprises providing the following services: professional, scientific and technical activities (19%), transportation and storage (12%), and other service activities – 12% [1](CSO, 2019).

[1] According to the Code list of business activities in Poland there are the following sections in service sector: H – transportation and storage, I – accommodation and food service activities, J – information and communication, K – financial and insurance activities, L – real estate activities, M – professional, scientific and technical activities, N – administrative and support service activities, O – public administration and defense; compulsory social security, P – education, Q – human health and social work activities, R – arts, entertainment and recreation, SiT – other service activities.

It should be noted, that there is a high degree of competitiveness in the services sector. As a result, service companies as well as production companies and trade companies, regardless of their size, aim to improve their performance in order to increase their competitiveness and profits. Considering the above objective, maturity models have been created that allow to assess the current situation of the organization and determine the direction of further development (Kosieradzka and Smagowicz, 2016).

Maturity models are defined as a set of various tools and practices used for the company's assessment in the scope of management skills, in order to improve some key factors that lead to the achievement of established objectives (Looy, 2014). The Object Management Group treats the maturity model as an evolutionary process of implementing key practices in one or several areas of the company. The assessment is realized by maturity levels which allow to improve the practices used by a company. Hence maturity models are methods of measuring the progress of an organization in the continuous improvement achievement in various areas of management. Therefore, the maturity model's task is to determine the current state of the enterprise and to set goals for the company's development, by setting priorities for activities, as well as identifying the resources and methods of their implementation (Kosieradzka and Smagowicz, 2016).

However, many diverse maturity models have been created and the existing ones have been adapted into various fields of human activity, some common elements of maturity models can be identified. Firstly, there is a limited number of assessment levels, the most often from 4 to 6 levels. Secondly, each maturity level is described by some maturity status indicators, which should be obtained at a particular maturity level. Moreover, maturity levels are ordered according to their state of maturity: from immature (initial state) to desirable (mature). Often to achieve a given maturity level, the requirements of previous states must be met (Steenberger, Bos, Brinkkemper, Weerd, and Bekkers, 2010). In order to assess maturity, various methods of gathering information are used such as self-assessment, survey, direct observation, and interview. Self-assessment is carried out by employees who know the business, and interviews are often carried out by external experts who assess the current state and determine the reasons for this state (Kosieradzka and Smagowicz, 2016).

Maturity models are used in the company's assessment in the following areas: process management, production management, quality management, project management, risk management and business continuity (Kosieradzka and Smagowicz, 2016).

However, process and organizational maturity assessment is a popular tool used by companies, and the assessment of logistics maturity is a new concept that has been an original concept, which has been rarely used in the theoretical and practical context (Werner-Lewandowska and Kosacka-Olejnik, 2019a).

The remainder of the article is organized as follows: Section 2 presents the background to the logistics maturity model used in the research considering existing logistics maturity models in the literature, and components of the model used in the research and the assessment procedure. Section 3 shows the results of research on

the logistics maturity of companies providing transportation and storage services. Finally, Section 4 summarizes the study and presents an outlook for further research.

2. Logistics maturity model – research framework

2.1. Logistics maturity model in the literature

In order to determine the logistics maturity for the service industry, a literature review on logistics maturity model was conducted. The subject of research was a set of scientific papers on logistics maturity. Research was carried out in the first quarter of 2017, with the use of scientific databases including: Web of Science, SCOPUS, and Emerald Insight. In total, 11 publications were analysed in detail including: (Janse, Schuur, and de Brito, 2010; Eadie, Perera, and Heaney, 2011; Battista, Fumi, and Schiraldi, 2012; Bemelmans, Voordijk, and Vos, 2013; Cao and Jiang, 2013; Battista and Schiraldi, 2013; Jellouli and Abdelkadhi, 2013; Mazur and Stachowiak, 2014; van Lith, Voordijk, Matos Castano, and Vos, 2015; Benmoussa Abdelkabir, Abd, and Hassou, 2015; Tontini, de Carvalho, Schlindwein, and Tomarevski, 2016). As a result of the conducted literature research the following conclusions were drawn (Werner-Lewandowska and Kosacka-Olejnik, 2019b):

- C1: Despite the growing the research interest in logistics maturity and the increasing number of papers, there exists a research gap in the definition of the *logistics maturity* term.
- C2: There are logistics maturity models dedicated for the whole company's logistics system (systematic approach) which constitute 45% of all models, while the remaining 55% are related to a single logistics subsystem, e.g. the procurement or distribution subsystem.
- C3: The most often used approach is to create a model consisting of 4-6 maturity levels. The limitation of the number of used maturity levels results from the fact that each level requires the identification of the factors determining a given level. Therefore, in the authors' opinion, the more levels there are, the more difficult the model's description.
- C4: The vast majority of examined maturity models allow to assess maturity in a particular dimension through the use of purpose-built questionnaires. The assessment of the achieved level is strictly carried out, thus only if all the requirements indicated at particular level are met, this particular level is achieved. Consequently, the information about the level of compliance with the requirements at a given level is gathered.
- C5: A particular maturity level should be identified by the requirements indicated at an adequate level, excluding descriptions of levels.

The list of conclusions presented above (C1-C5) has become the guidelines for the authors used in the development of the Logistics Maturity Model for Service Industry (hereafter: LMM4SI).

2.2. Logistics maturity model components

The research described in the paper, used LMM4SI consisting of the following components presented in Figure 1:

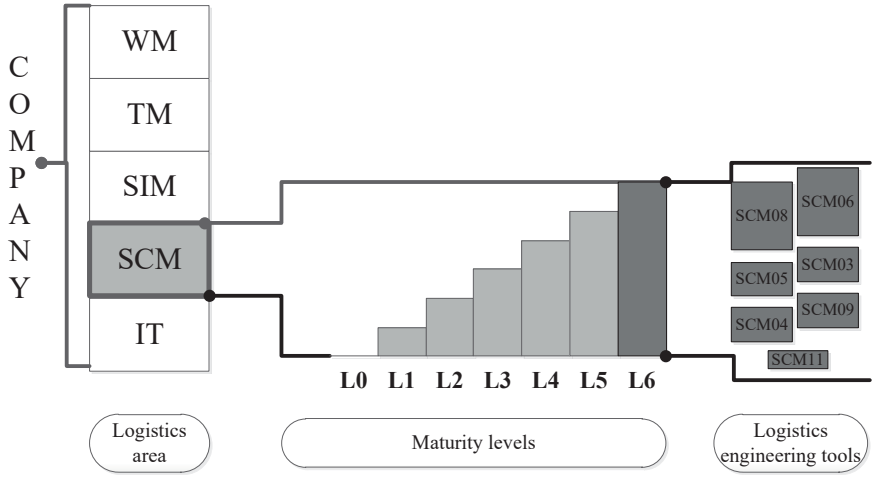


Fig. 1. LMM4SI-concept of the model

Source: own elaboration based on (Werner-Lewandowska and Kosacka- Olejnik, 2018).

With reference to Figure 1, in the LMM4SI were evaluated five logistics areas, which may be identified in the logistics system of a service enterprise including: warehouse (WM), transport (TM), supply and inventory (SIM), supply chain management (SCM) and IT suport (IT). It was assumed that in each service enterprise the SCM and IT area may be identified, however the rest of them are optional as a company may not use a means of transport (lack of TM area), does not need a warehouse to provide a service (lack of WM area) and/or does not collect materials needed to provide services (lack of SIM area). It was assumed that each logistics area is assessed separately with the use of maturity levels (L0-L6), as shown in Figure1 for the SCM area. Level L0 means that the examined area is immature, while level L6 means full maturity (perfection). These maturity levels correspond to the particular industrial logistics development stages, described in detail in (Werner-Lewandowska and Kosacka-Olejnik, 2019a).

The last component of LMM4SI is a set of logistics engineering tools. In the research there was included a list of 65 logistics engineering tools ascribed to particular logistics areas assessed within the logistics maturity model (the full list of tools is available in (Werner-Lewandowska and Kosacka-Olejnik, 2019b)). Table 1 there is an example of logistics tools dedicated for the SCM area.

It is noteworthy that in the presented research, SCM is treated as a logistics maturity level, therefore it was assumed that a company is a participant of a supply chain.

Table 1. Logistics engineering tools in the SCM area

ID LD*	Name of the tool	ID LD*	Name of the tool
SCM01	Demand forecasting	SCM07	Time-based process mapping
SCM02	Supplier relationship	SCM08	Omni-channel distribution
SCM03	Calculating order's cost	SCM9	Strategic procurement
SCM04	Calculation of stockholding cost	SCM10	SCM audit
SCM05	S&OP	SCM11	CPFR
SCM06	Supply chain risk assessment		

* ID LD is an identification number of a particular logistics engineering tool used into the research.

Source: (Werner-Lewandowska and Kosacka-Olejnik, 2019b).

It was shown that a particular maturity level is evaluated using logistics engineering tools which determine the logistics maturity level of the company under study. However, in a given logistics tools set ascribed to the particular area there is a varied number of tools, but each of them has a specific influence on a particular maturity level. Owing to that, it was assumed that a given tool determines to a certain extent a particular maturity level. The results of expert research showed the influence of a particular tool on a given maturity level in the assessed logistics area as was presented for each tool in Figure 2.

Regarding Table 1 and Figure 2, e.g. in the SCM area, there are identified 11 logistics engineering tools but the maturity state (Level L6) is determined only by six tools which have some influence on the highest maturity level in this area, including: SCM03, SCM04, SCM05, SCM06, SCM08, SCM09, SCM11 (Figure 2). Moreover, among all the tools ascribed to the SCM area which determine the L6 maturity level, there may be observed a diversification of the impact of a particular tool in the case of an analyzed maturity level. Considering that the highest impact is for SCM06 and SCM08 with the value 0.2, thus they will determine this level with the greatest impact (the rest of tools have an impact of 0.1 or 0.05). It is noteworthy that tool SCM06 has an impact on the level L4 and L5, but it also has the greater impact in the L4 maturity level. As a consequence, it determines with a higher impact L4 but it is also a determinant of the maturity levels for L5 and L6.

With reference to Figure 2 it was assumed that the impact of all the tools ascribed as relevant (no matter how strong the impact was), for each particular maturity level there is a reference value (an aggregated value) calculated as the sum of all the values of the particular tools. In order to determine the logistics maturity level during the assessment, this reference value will be used to define the actual state of a company in a given logistics area.

In the presented research, it was assumed that a higher level of logistics maturity is related to the achievement of a higher level of perfection in a particular activity. This means that the latest solutions in the field of logistics engineering are used in a company.

LA	ID LT	L1	L2	L3	L4	L5	L6
WM	WM01	0.35	0.25	0.2	0.1	0.05	0.05
	WM02	0.35	0.2	0.25	0.05	0	0.15
	WM03	0.35	0.3	0.2	0.05	0	0.1
	WM04	0.25	0.2	0.15	0.15	0.15	0.1
	WM05	0.4	0.35	0.15	0.1	0	0
	WM06	0.4	0.15	0.3	0.1	0	0.05
	WM07	0.3	0.15	0.45	0.05	0.05	0
	WM08	0.55	0.1	0.2	0.1	0.05	0
	WM09	0.15	0.2	0.35	0.05	0.2	0.05
	WM10	0.25	0.25	0.35	0.15	0	0
	WM11	0	0.1	0.55	0.15	0.2	0
	WM12	0	0	0	0.2	0.3	0.5
	WM13	0.2	0.25	0.2	0.15	0.1	0.1
	WM14	0	0	0.2	0.45	0.2	0.15
	WM15	0	0	0	0.5	0.3	0.2
	PM02	0.3	0.15	0.25	0.15	0.1	0.05
Reference value /aggregated (total) impact		3.85	2.65	3.8	2.5	1.7	1.5
TM	TM01	0.1	0.1	0.15	0.35	0.25	0.05
	TM02	0	0	0	0.5	0.3	0.2
	TM03	0	0.4	0.35	0.2	0.05	0
	TM04	0.3	0.35	0.3	0.05	0	0
	TM05	0	0	0	0.4	0.35	0.25
	TM06	0	0	0.05	0.5	0.25	0.2
	PM01	0.25	0.05	0.1	0.2	0.3	0.1
Reference value /aggregated (total) impact		0.65	0.9	0.95	2.2	1.5	0.8
SCM	SCM01	0	0.15	0.15	0.5	0.2	0
	SCM02	0.05	0.05	0.05	0.6	0.25	0
	SCM03	0.3	0.2	0.25	0.15	0	0.1
	SCM04	0.15	0.15	0.15	0.25	0.2	0.1
	SCM05	0.05	0.15	0.45	0.2	0.05	0.1
	SCM06	0	0	0	0.55	0.25	0.2
	SCM07	0	0	0.25	0.5	0.25	0
	SCM08	0	0.1	0.3	0.15	0.25	0.2
	SCM09	0.1	0.1	0.35	0.2	0.15	0.1
	SCM10	0	0	0	0.8	0.2	0
	SCM11	0	0	0	0.75	0.2	0.05
Reference value /aggregated (total) impact		0.65	0.9	1.95	4.65	2	0.85

LA	ID LT	L1	L2	L3	L4	L5	L6
SIM	SIM01	0.4	0.25	0.25	0.1	0	0
	SIM02	0.55	0.15	0.25	0	0.05	0
	SIM03	0.45	0.15	0.3	0.1	0	0
	SIM04	0.45	0.25	0.1	0.2	0	0
	SIM05	0.15	0.25	0.4	0.15	0	0.05
	SIM06	0.15	0.15	0.55	0.1	0	0.05
	SIM07	0.1	0.2	0.2	0.3	0.1	0.1
	SIM08	0	0.25	0.4	0.3	0.05	0
	SIM09	0.2	0.2	0.2	0.25	0.15	0
	SIM10	0.5	0.1	0.05	0.25	0.05	0.05
	SIM11	0.25	0.25	0.2	0.1	0.2	0
	SIM12	0.2	0.2	0.35	0.1	0.1	0.05
	SIM13	0.3	0.25	0.35	0	0	0.1
	SIM14	0.15	0.15	0.35	0.15	0.15	0.05
	SIM15	0.35	0.15	0.25	0.1	0.1	0.05
	SIM16	0.35	0.2	0.15	0.1	0.1	0.1
	SIM17	0.05	0.15	0.4	0.1	0.3	0
	SIM18	0.25	0.2	0.2	0.15	0.15	0.05
Reference value /aggregated (total) impact		4.85	3.5	4.95	2.55	1.5	0.65
IT	IT01	0	0.1	0.3	0.2	0.25	0.15
	IT02	0	0.1	0.25	0.2	0.3	0.15
	IT03	0	0	0	0.15	0.55	0.3
	IT04	0	0	0	0.1	0.55	0.35
	IT05	0	0	0.1	0.2	0.5	0.2
	IT06	0	0	0	0	0.4	0.6
	IT07	0	0	0	0	0.4	0.6
	IT08	0	0	0	0	0.3	0.7
	IT09	0	0	0	0	0.1	0.9
	IT10	0	0	0	0	0.5	0.5
	IT11	0	0	0	0.05	0.4	0.55
	IT12	0	0	0	0	0.45	0.55
	M01	0	0	0.25	0.5	0.15	0.1
Reference value /aggregated (total) impact		0	0.2	0.9	1.4	4.85	5.65

Fig. 2. LMM4SI – maturity level determinants

Source: (Werner-Lewandowska and Kosacka-Olejnik 2019b).

2.3. LMM4SI – maturity assessement

The assessment of logistics maturity regarding the LMM4SI is performed according to the procedure presented in Figure 3:

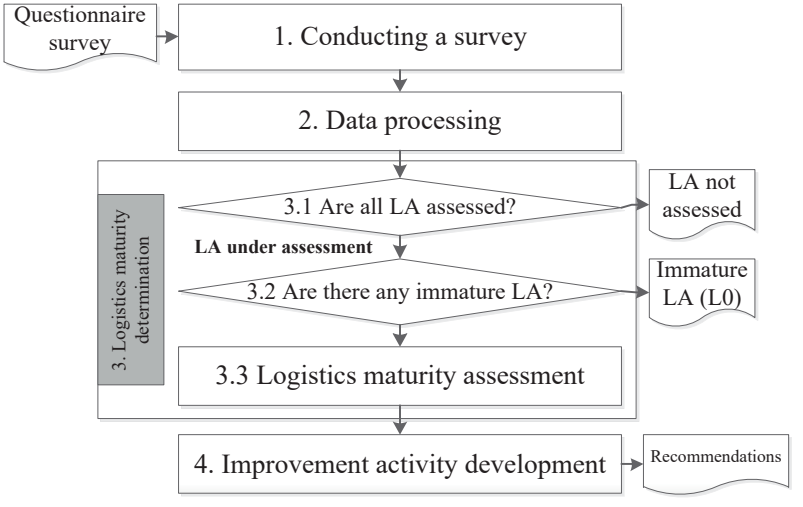


Fig. 3. Stages in logistics maturity assessment with the use of LMM4SI

Source: (Werner-Lewandowska and Kosacka-Olejnik, 2019b).

With reference to Figure 3, an interview should be carried out with the use of a survey to verify which logistics engineering tools are used/known by the company under study. The survey questionnaire consists of two sections: section I includes 65 questions about the use/knowledge of logistics engineering tools, and section II the questions about the company's size and type of provided service.

Regarding Figure 3, in the second stage of logistics maturity assessment all the data obtained from the survey are processed so the parameterization of the logistics tools impact on the level of logistics maturity is made. As a result of this stage, the answers obtained in the survey are converted into numerical values according to the rule:

- tool is used – the value is "1";
- tool is not used – the value is "0";
- tool is not known in the company – the value is "–1".

The objective of the third stage of research presented in Figure 3 is to determine the logistics maturity level of a particular logistics area in the company under study. This stage requires three steps.

Owing to the fact that WM, TM and SIM are optional logistics areas (hereafter: LA), they are firstly verified with the use of filtering questions in terms of their occurrence in the company. Secondly, each logistics area is examined in terms of

immaturity. It was assumed that lack of knowledge of 50% of all logistics tools assigned to a given logistics area complies with the immature state (level L0) of logistics maturity. In this case, further research is not conducted. In the last step, logistics maturity levels for the evaluated logistics areas are determined. In order to define logistics maturity level, we used data on reference value/total aggregated impact of tools assigned to a particular maturity level for the analyzed logistics area (Figure 2, e.g. in the case of WM, for level L1 the reference value is 3.85) and answers from surveyed company obtained as a result of the interview. The value assigned to a particular response in a survey (0,1,–1) is multiplied by the impact force of a given tool, and then the total impact of the tools within the maturity level is calculated (Table 2, cell: Result). Consequently, there is obtained the numerical value expressing the degree to which the reference value for the maturity level in a given logistics area is achieved (range from 0% – 100%), i.e. the Maturity Index (hereafter: MI). The highest result of the Maturity Index (the best match) indicates the achieved maturity level. A numerical example of the maturity level calculation in the SCM area is presented in Table 2:

Table 2. Maturity level determination in the SCM area – numerical example

ID LD	Answer	Processing	Impact of a tool for a given maturity level					
			L1	L2	L3	L4	L5	L6
SCM01	YES	1	1*0	1*0.15	1*0.15	1*0.5	1*0.2	1*0
SCM02	YES	1	0.05	0.05	0.05	0.6	0.25	0
SCM03	Don‘t know	–1	0	0	0	0	0	0
SCM04	YES	1	0.15	0.15	0.15	0.25	0.2	0.1
SCM05	NO	0	0	0	0	0	0	0
SCM06	NO	1	0	0	0	0.55	0.25	0.2
SCM07	NO	0	0	0	0	0	0	0
SCM08	YES	1	0	0.1	0.3	0.15	0.25	0.2
SCM9	YES	1	0.1	0.1	0.35	0.2	0.15	0.1
SCM10	YES	1	0	0	0	0.8	0.2	0
SCM11	YES	1	0	0	0	0.75	0.2	0.05
Result*			0,3	0,55	1	3.8	1.7	0.65
Maturity index (MI)**			46.15%	61.11%	51.28%	81.72%	85.00%	76.47%

* Result stands for the total value of the real influence of all the tools in a given maturity level.

** MI stands for the degree to which the reference value for the maturity level in a given logistics area is achieved.

Source: own elaboration.

With reference to Table 2, considering the results of the MI, in this case the company under study in the SCM area represents the L5 logistics maturity level.

Finally, according to Figure 3, after logistics maturity determination there are prepared recommendations regarding improvement actions, beginning with the immature logistics area.

3. Logistics maturity of the Polish service industry – research results

This paper presents the results of research on the logistics maturity of companies providing transport and storage services. According to CSO reports, logistics services providers generate the largest GDP impact among all service enterprises (CSO, 2019).

3.1. Research object

Among all service companies included into research on the logistics maturity of the Polish service industry (2000 took part), 190 enterprises providing services in the field of transport and storage were examined. The structure of the studied population by company size (measured by the employment rate – E) is presented in Figure 4.

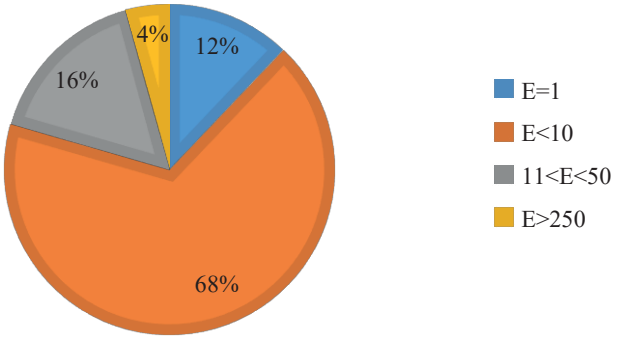


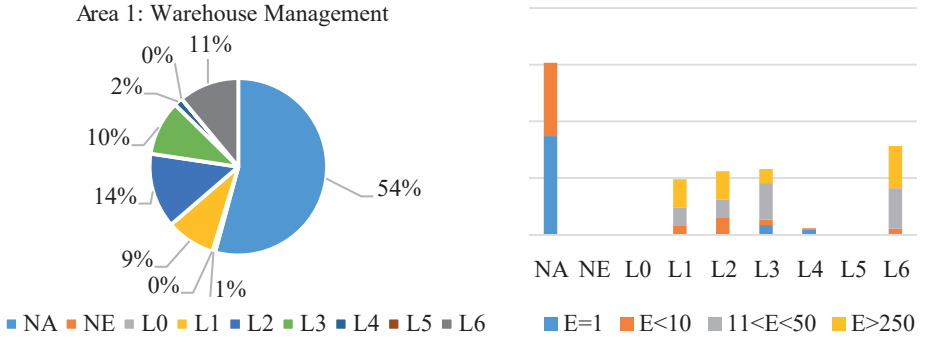
Fig. 4. The structure of the studied population of enterprises by company size

Source: own elaboration.

With reference to Figure 4, micro-enterprises employing fewer than 10 people dominate in the studied population, however one-man businesses were excluded from this group, treating them as a separate category. In the research there were no medium-sized enterprises with 50 to 250 employees as none of them agreed to participate in the survey.

3.2. Logistics maturity in the warehouse management area – research results

The results of research carried out on the logistics maturity of logistics services providers in the area of the warehouse management are presented in Figure 5.



where: NA – area is not assessed because of lack of particular logistics activity in a company's logistics, NE – lack of evaluation as more than 50% of tools are not known, L0 – lack of knowledge as more than 50% of tools are not known, L1-L6 maturity levels

Fig. 5. The logistics maturity level in the Warehouse Management area – distribution of responses

Source: own elaboration.

According to the respondents' answers (Figure 5), 54% of the surveyed enterprises were not assessed in this logistics activity area because they do not have any storage place (this applies only to micro-enterprises). Only one enterprise was not evaluated in terms of logistics maturity due to the fact that it did not use more than 50% of the logistics engineering tools used in the research.

As a consequence, the following conclusions can be drawn:

- C1 (WM): Micro-enterprises do not have a warehouse for storing materials needed for providing services in the future.
- C2 (WM): Companies know and use logistics tools related to warehouse management, regardless of the company's size.
- C3 (WM): SMEs and large enterprises reach the level of maturity from L1 to L3 in the Warehouse Management area, and due to the use of modern IT solutions, they achieve level L6 in the IT solutions area.

3.3. Logistics maturity in the Transport Management area – research results

The results of the research conducted on the logistics maturity of logistics services providers in the area of the transport management are presented in Figure 6.

With reference to Figure 6, only 11% of companies under study were excluded from the assessment of transport management area due to the fact that they do not use vehicles to provide a service. For 3% of enterprises it was found that they do not use more than half of all logistics engineering tools assigned to a particular logistics area, so they were not evaluated. This refers to three micro-enterprises, which have their own vehicle fleet.

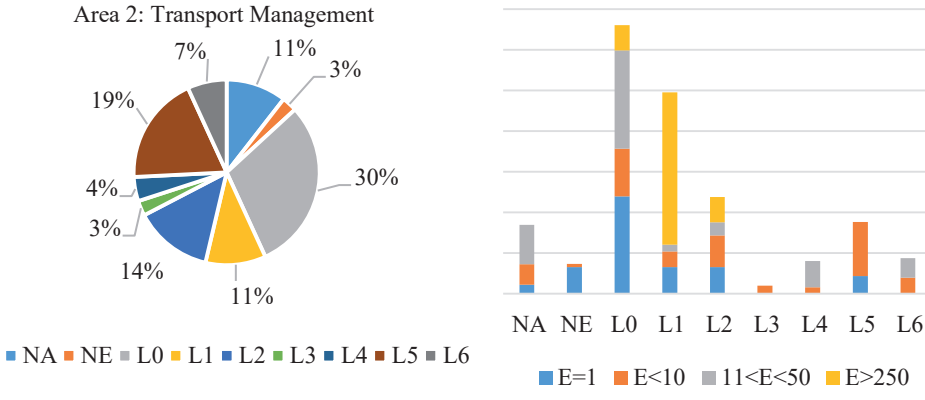


Fig. 6. The logistics maturity level in the Transport Management area – distribution of responses

Source: own elaboration.

As a consequence of the conducted research, the following conclusions can be drawn:

- C1 (TM): Most service companies have their own vehicle fleet, however 30% of them achieve the lowest level of logistics maturity – L0. This results from the lack of the knowledge of logistics tools related to transport management, primarily among micro and small enterprises.
- C2 (TM): In the transport management area, large companies reach mainly level L1 (75%) and they do not achieve a level higher than L2.
- C3 (TM): The highest maturity levels (L5, L6) in the transport management area are achieved by micro and SMEs.

3.4. Logistics maturity in the Supply and Inventory Management area – research results

According to the research, none of the enterprises gather supplies of materials for future services. Consequently, this logistics area was not analyzed as 100% of the companies stated in the survey that they do not have stock. This seems to contradict the results of research in the area of warehouse management because 46% of the surveyed enterprises declared that they maintain storage space in the enterprise. In the authors' opinion, warehouses exist in service enterprises, but they are used for short-term storage of materials needed to perform ongoing services. To sum up, service providers in the field of transport and warehouse management do not create high inventory levels for future services.

3.5. Logistics maturity in the Supply Chain Management area – research results

The results of research conducted on the logistics maturity of logistics services providers in the area of the supply chain management are presented in Figure 7.

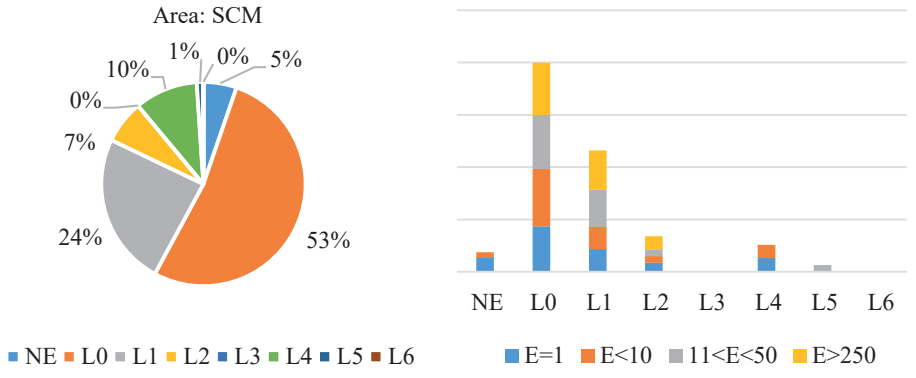


Fig. 7. The logistics maturity level in the Supply Chain Management area – distribution of responses

Source: own elaboration.

With reference to Figure 7, only 5% of companies under study were excluded from assessment of the SCM area due to the fact that they do not use more than half of the logistics engineering tools assigned to this logistics area. This fact applies to micro companies.

As a consequence of the conducted research, the following conclusions can be drawn:

- C1 (SCM): Regardless of company size, more than half of companies under study (53%) achieve immaturity – L0, resulting from lack of knowledge of more than 50% of all logistics engineering tools assigned to SCM area.
- C2 (SCM): As a consequence of the lack of using particular tools for the supply chain risk assessment or multi-channel distribution, none of the surveyed enterprises reached the L6 logistics maturity level.
- C3 (SCM): The maximum logistics maturity level in the SCM area achieved by large companies is L2, for small enterprises is level L5, and for micro companies level L4.

3.6. Logistics maturity in the IT solutions area – research results

The results of research conducted on the logistics maturity of logistics services providers in the area of the IT solutions are presented in Figure 8.

According to Figure 8, only for one surveyed enterprise the logistics maturity assessment in the IT solutions area was not possible due to the fact that over 50% of the logistics engineering tools assigned to this logistics area were not used. This was a micro-company. Moreover, only 4% of the surveyed enterprises represent the lowest logistics maturity level – L0 in the area of IT solutions, used to support logistics activity, which applies to micro-companies.

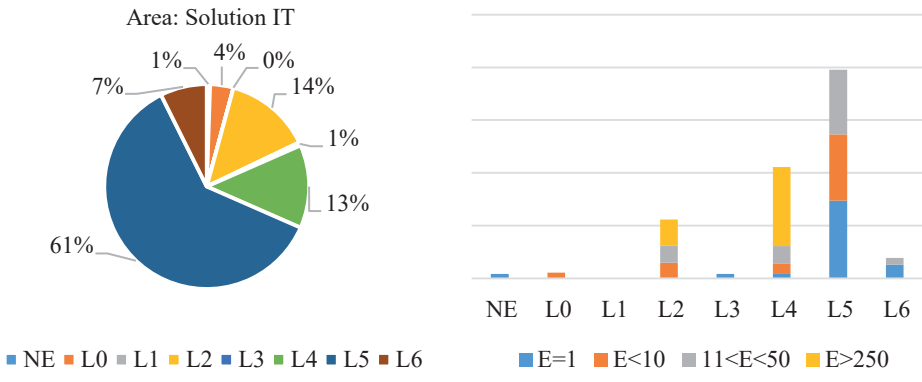


Fig. 8. The logistics maturity level in the IT Solutions area – distribution of responses

Source: own elaboration.

As a result of the conducted research, the following conclusions can be drawn:

- C1 (IT): The size of the enterprise does not affect the knowledge and use of IT solutions that support the logistic activity of enterprises providing services in the field of transport and warehouse management.
- C2 (IT): More than half (61%) of the enterprises under study achieved level L5 of the logistics maturity in the area of the IT Solutions. This proves the use of such solutions as online shopping, RFID, and Truck & Tracing. It is noteworthy that the L5 logistics maturity level was not achieved by any of the large enterprises, but one-person businesses represent it in 74% of the cases. The same relationship may be noticed for the highest logistics maturity level – L6.
- C3 (IT): Large enterprises employing over 251 employees, achieve logistics maturity levels L2 and L4 in the scope of the applied IT solutions.

4. Conclusions

To sum up, it should be noted that company size determined by the number of employees does not determine the logistics maturity level of service companies which provide transport and warehouse management services.

Firstly, regardless of the company's size, enterprises use logistics engineering tools in the area of warehouse management, transport management, supply chain management, supply and inventory management and IT solutions, which support logistics activity. As a consequence, it was stated that the developed LMM4SI (Werner-Lewandowska and Kosacka-Olejnik, 2019b) is a useful methodology for logistics maturity assessment.

Moreover, the knowledge of the logistics engineering tools in the area of transport management (30%) and SCM (53%) is very poor, in these authors' opinion. In particular, the ignorance of tools related to SCM may by a cause for

concern as the companies under study are logistics companies, called logistics services providers, which in modern supply chains become 3PL or 4PL, and they play a significant role.

What is more, the number of companies which achieve high logistics maturity levels (L5, L6) in the examined logistics areas, is very small, and micro or small enterprises prevail.

As directions for future research, one can include (i) identification of the logistics engineering tools used in logistics maturity assessment which are unknown, (ii) clarification on the lack of inventory for providing services in the future in terms of maintaining storage space by service companies providing transport and warehouse services.

Acknowledgements

This paper refers to the research financed by the National Science Center, Poland, project "Research on logistics maturity in service enterprises", grant no. 2016/21/D/HS4/02116.

Bibliography

Battista, C., and Schiraldi, M. M. (2013). The logistic maturity model: Application to a fashion company. *International Journal of Engineering Business Management*, (5), 1-11.

Battista, C., Fumi, A., and Schiraldi, M. (2012). The logistic maturity model: Guidelines for logistic processes continuous improvement. *POMS 23rd Annual Conference*. Chicago, Illinois, USA.

Bemelmans, J., Voordijk, H., and Vos, B. (2013). Designing a tool for an effective assessment of purchasing maturity in construction. *Benchmarking: An International Journal*, (20), 342-361.

Benmoussa, R., Abdelkabir, C., Abd, A., and Hassou, M. (2015). Capability/maturity based model for logistics processes assessment: application to distribution processes. *International Journal of Productivity and Performance Management*, (64), 28-51.

Cao, W., and Jiang, P. (2013). Modelling on service capability maturity and resource configuration for public warehouse product service systems. *International Journal of Production Research*, (51), 1898-1921.

Central Statistics Office (CSO). (2019). *Rachunki kwartalne PKB 2014-2018.* Retrieved from: http://stat.gov.pl

Eadie, R., Perera, S., and Heaney, G. (2011). Key process area mapping in the production of an e-capability maturity model for UK construction organisations. *Journal of Financial Management of Property and Construction*, (16), 197-210.

Janse, B., Schuur, P., and de Brito, M. P. (2010). A reverse logistics diagnostic tool: The case of the consumer electronics industry. *The International Journal of Advanced Manufacturing Technology*, (47), 495-513.

Jellouli, O., & Abdelkadhi, M. (2013). Test Logistics Maturity of the industrial zone in the Region of Gabes. *International Journal of Supply Chain Management, 2*(4), 123-150.

Kosieradzka, A., and Smagowicz, J. (2016). Analiza porównawcza modeli dojrzałości organizacji. In M. Ćwiklicki, S. Jabłoński, and S. Mazur (Eds.), *Współczesne koncepcje zarządzania publicznego. Wyzwania modernizacyjne sektora publicznego*. Kraków: Fundacja Gospodarki i Administracji Publicznej, 280-293.

Looy, A. (2014). *Business Process Maturity: A Comperative Study on a Sample of Business Process Maturity Model*. Berlin: Springer-Verlag, 5-10.

Mazur, A., and Stachowiak, A. (2014). The framework of methodology for identification of organizational maturity with assessment of excellence level of logistics systems. In I. Abrudan (ed.), *The Management between profit and social responsibility*, Proceedings of the 4th Review of Management and Economic Engineering International Management Conference, 18-20.

Steenbergen, M., Bos, R., Brinkkemper S., Weerd I., and Bekkers W. (2010). The Design of Focus Area Maturity Models, *Global Perspectives on Design Science Research*, (6105), 317-332.

Tontini, G., de Carvalho, L. C., Schlindwein, N. F. D. C., and Tomarevski, V. (2016). Maturity model of procurement and supply management in small and medium-size enterprises: Benchmarking of hospitals and metal-mechanic companies, *International Journal of Quality and Service Sciences*, (8), 315-333.

van Lith, J., Voordijk, H., Matos Castano, J., and Vos, B. (2015). Assessing maturity development of purchasing management in construction, Benchmarking: An International Journal, (22), 1033-1057.

Werner-Lewandowska, K., and Kosacka-Olejnik, M. (2018). Logistics maturity model for service company – theoretical background, *Procedia Manufacturing,* (17), 791-802.

Werner-Lewandowska, K., and Kosacka-Olejnik, M. (2019a). Logistics Maturity Model for Engineering Management – Method Proposal, *Management system in Production Engineering, 27*(1), 33-39.

Werner-Lewandowska, K., and Kosacka-Olejnik, M. (2019b). Logistics engineering application in the logistic maturity model for the service enterprises. Proceedings of The 14th International Conference of Logistics and SCM System, Chinese Martime Institute, 229-236.

Zakrzewski, R., and Skowrońska, A. (Eds.) (2019). *Raport o stanie sektora małych i średnich przedsiębiorstw w Polsce*. Warszawa: Polska Agencja Rozwoju Przedsiębiorczości.