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Gross value added in services – a case study of the sea port in Szczecin

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Keywords: Gross Value Added, port services, econometric modelling of GVA

Abstract: The aim of the paper is to determine the size and structure of the Gross Value Added (GVA) generated by the supply of services in Szczecin seaport. Correlations, multipliers, and elasticities between different port services are indicated in the paper. The GVA is an economic measure of the size of generated production. In seaports, it expresses the value of the generated and delivered flow of services of warehousing and cargo handling, securing the safe movement and mooring of ships in port and their technical and commercial support, of accessibility to port infrastructure for in port manufacturers and port users, of organization, planning and coordination of processes of cargo and transportation units handling inside the port and at other nodes of the transportation chain. The scope of the research at Szczecin seaport included four groups of activities, namely:

– cargo handling companies;
– sea transportation support companies, including the ones supplying port shipping services (navigation, pilotage, and towage), dredging and underwater works (carried within the inner port basins), sea rescue, and other maritime services;
– sea transportation agencies supplying services of port and maritime forwarding, shipbuilding brokerage, ship agencies, customs, maritime consulting and expertize, cargo stowage and securing aboard the ship, cargo expertise and inspection, and other services (logistics); and
– sea port authorities.

GVA has been calculated by subtracting the value of the intermediate consumption from the gross output of the port sector companies. The intermediate consumption consists of the value of consumed materials and energy, external services, and the rest of the by nature costs of business entities. The GVA calculation has been based on the statistical data obtained from the Centre of Maritime Statistics at the Statistical Office in Szczecin.

Introduction

The Gross Value Added (GVA) is the value of goods and services generated by subjects of the national economy in certain fixed periods of time. In economics, the level of consumption of goods and services is often identified with the prosperity or, as Smith (1776) named it, with the nation's wealth. The "value added" term derives from the process of production where the value of raw materials, materials, semi-products or final products constantly increases at each stage of the production. The higher the level of processing products, the higher value of products is observed in comparison to the value of raw materials used. This additional value created at each stage of the process of production is called "value added." That means that the relatively high value added, which is usually calculated per capita, for comparison purposes is being reached in economies with a higher level of processing of raw materials and materials, oriented at production and export of high technologies. And inversely, the low level of GVA will accompany the economies oriented at mining and export of raw materials, such as oil, coal, timber, metal ores, etc.

Furthermore, the GVA constitutes the sum of goods and services generated in an economy at each level of production in a given period of time. It may be established as a total sum of values of production of every unit of a national economy, and thus it is referred to as the production in total. The production in total is always higher than the value of goods and services because in the process of the aggregation of the value of generated production at each level of a production process there are accumulated values of the production generated at lower levels. In order to avoid double calculation of incomes from sales realized at different levels of a production process, it is needed to decrease the production in total by money flows between co-operators, contractors, or service suppliers herein named the indirect consumption.

In the public statistics systems the GVA constitutes an essential element of the calculation of the gross domestic product (GDP) generated within the economy. The aggregation of GVA per individual categories, branches, and sections of a national economy up to the level of a whole economy results in the GDP expressed in prices of production factors or, in other words, in basic prices. Subsequently, the GVA generated in all sections of a national economy and increased by taxes on products, and, in turn, decreased by grants to products forms the GDP expressed in market prices. Usually, the GVA constitutes about 90% of the national gross product.

The GVA can also be used to measure the influence of individual sectors of a national economy in the direct creation of a national gross product, for example in transport, tourism, construction, or maritime economy. In practice, however, there appear problems in determining the GVA for those sectors of a national economy which have not been explicitly presented in the Polish Classification of Activities (PKD 2007). It happens so also in the case of the maritime economy. Entities of the maritime economy have been

"spread" over various sections and departments of the PKD 2007. Therefore the calculation of the GVA for the maritime economy is not easy. So far, not even the Central Statistical Office has run any calculations of the GVA for the maritime economy, for example within the frame of the so called "satellite calculations."

For the first time in Poland, the calculations of the GVA for Polish maritime ports and for Polish maritime economy in the years 1996–1999 were presented in the year 2001 (Bernacki 2001), and then the scope of the analysis was expanded for the period of 2000–2003 (Lis 2005) and 2004–2005 (Lis 2010). In this article, there are presented the most recent results of the GVA analysis in the port sector in Szczecin.

The aim of the paper is to establish the volume and the structure of the GVA generated in connection with the production of services at the maritime port in Szczecin. The calculations of the GVA have been made for the port sector entities in Szczecin, and then the correlation, multiplier, and (point) elasticity dependences of the GVA of the port services against the volume of cargo transhipment have been determined. The GVA as the measure of the volume of the generated production, expresses in maritime ports the value of services in several main port activities. These activities are as follows:

- the generated and delivered by the producers flow of services connected to the operations of warehousing and cargo handling;
- securing the safe movement and mooring of ships in port and their technical and commercial support;
- accessibility to port infrastructure for port manufacturers and port users; and
- organization, planning, and coordination of processes of cargo and transportation units handling inside the port and at other nodes of the transportation chain.

1. Methodology

The scope of the research at Szczecin seaport included four groups of activities, namely:

- cargo handling companies;
- sea transportation support companies, including the ones supplying shipping services (navigation, pilotage, and towage), dredging and underwater works (carried within the inner port basins), sea rescue and other maritime services;
- sea transportation agencies supplying services of port and maritime forwarding, shipbuilding brokerage, ship agencies, customs, maritime consulting and expertize, cargo stowage and securing aboard the ship, expertise and cargo inspection, and other services (logistics); and
- sea port authorities.

For the research, the statistical data derived from the finance reports of the maritime business entities (GUS F-02 forms) was used. The research covered all the entities obliged by the Law on the Public Statistics and respective *lex specialis* to submit reports. The research covered the years 2010–2013. The research process consisted of the following four stages:

1. Estimation of the GVA according to ESA 2010 methodology.
2. Defining the GVA structure for the main port activities in Szczecin.
3. Defining the multiplying relations between the individual types of activities conducted in the port of Szczecin.
4. Determination of the Pearson product-moment correlation coefficients between the GVA generated by the particular types of activities and the volume of cargo transhipment in the port of Szczecin.
5. Determination of GVA (point) elasticities with regard to the volume of cargo transhipment in the port of Szczecin.

2. Research results

The first step in the analysis of the GVA in port sector services in Szczecin is the estimation of the value added on the basis of the ESA 2010 (European System of Accounts) methodology. For the needs of this exercise, the creation perspective has been used, i.e., the production in total and the indirect consumption have been determined for the groups of entities supplying services within the port sector in Szczecin. The ultimate GVA of the port services sector constitutes the result of the subtraction of the indirect consumption from the production in total. The analysis results have been compiled in Table 1.

The obtained results indicate the forming of an increasing tendency of development of the GVA generated by port service companies in the port of Szczecin since 2006. In 2013, the value added of the port sector in Szczecin amounted to 275.3 million PLN, and it increased in comparison to 2006 by 55.2 million PLN. This means that during the period of 2006–2013, the value added generated in the port of Szczecin increased on average by 3.2% from year to year. It is worth noting that in that period the cargo turnover in the port of Szczecin decreased at the average rate of 1.2% a year, which shows the increasing earning capacity of port production in Szczecin measured in the GVA per one ton of transhipped cargo. For comparison, in 2006 the GVA per 1 ton amounted 22.06 PLN, whereas in 2013, 1 ton transhipped in the port of Szczecin "generated" 31.59 PLN of GVA.

Table 1. Production in total, indirect consumption, and GVA of the port sector in Szczecin in years 2004–2013

Specification	Year	Production in total	Indirect consumption	**GVA**
		in million PLN		
Port sector in Szczecin	2004	831.6	585.2	**246.4**
	2005	726.3	502.5	**223.8**
	2006	724.5	504.4	**220.1**
	2007	727.3	506.2	**221.2**
	2008	801.4	551.6	**249.8**
	2009	605.8	359.2	**246.6**
	2010	666.5	425.1	**241.4**
	2011	742.6	485.9	**256.6**
	2012	735.0	481.3	**253.7**
	2013	768.9	493.6	**275.3**
Transhipment, warehousing, and storage of goods in sea ports	2004	214.7	122.4	**92.2**
	2005	166.5	80.2	**86.4**
	2006	156.2	75.9	**80.4**
	2007	145.0	70.4	**74.7**
	2008	153.8	75.1	**78.8**
	2009	161.6	71.8	**89.8**
	2010	179.1	87.6	**91.5**
	2011	191.1	91.3	**99.8**
	2012	200.9	93.7	**107.2**
	2013	219.6	105.9	**113.7**
Other activity supporting maritime transport	2004	60.0	21.6	**38.3**
	2005	60.3	26.9	**33.3**
	2006	63.6	27.5	**36.1**
	2007	62.6	25.9	**36.7**
	2008	71.8	30.5	**41.4**
	2009	89.3	48.7	**40.6**
	2010	76.3	50.5	**25.8**
	2011	86.5	69.8	**16.7**
	2012	80.4	71.0	**9.4**
	2013	68.5	47.6	**20.9**

Activity of maritime transportation agencies	2004	440.7	396.3	**44.4**
	2005	391.3	349.5	**41.8**
	2006	398.8	354.4	**44.4**
	2007	416.9	365.9	**51.1**
	2008	469.4	407.8	**61.5**
	2009	248.4	201.8	**46.6**
	2010	295.8	248.8	**47.0**
	2011	347.2	286.2	**61.0**
	2012	335.5	278.1	**57.4**
	2013	357.3	299.1	**58.2**
Sea port managing authority	2004	116.3	44.9	**71.4**
	2005	108.2	45.9	**62.3**
	2006	105.9	46.6	**59.3**
	2007	102.7	44.0	**58.7**
	2008	106.4	38.2	**68.1**
	2009	106.5	37.0	**69.6**
	2010	115.3	38.2	**77.1**
	2011	117.8	38.6	**79.1**
	2012	118.2	38.5	**79.7**
	2013	123.5	41.0	**82.5**

Source: own elaboration on the basis of the data of the Centre of Maritime Statistics at the Statistical Office in Szczecin and of Szczecin and Świnoujście Seaports Authority S.A.

Within the scope of the structure of GVA creation in the port of Szczecin in 2013, the highest participation had the companies supplying services of cargo transhipment, warehousing, and storage of goods (41.3%) and the Szczecin and Świnoujście Seaports Authority S.A. (30%). Then, in the creation of the GVA participated the entities in the port of Szczecin supplying the services of port-maritime forwarding, shipbroking, ship agencies, custom clearance, consultation and maritime expertise, cargo stowing and securing, survey and cargo control, and others (logistics). Their combined participation in the creation of the GVA amounted to 21.2%. The last group of the entities creating the GVA were the entities providing the activities supporting the maritime transport, including the ones supplying port navigation services (navigation, pilotage, and towing), dredging and underwater works (performed within the inner port basins), sea rescue, and other maritime services. Their participation in the creation of the GVA amounted to 7.6% in 2013 (Fig. 1).

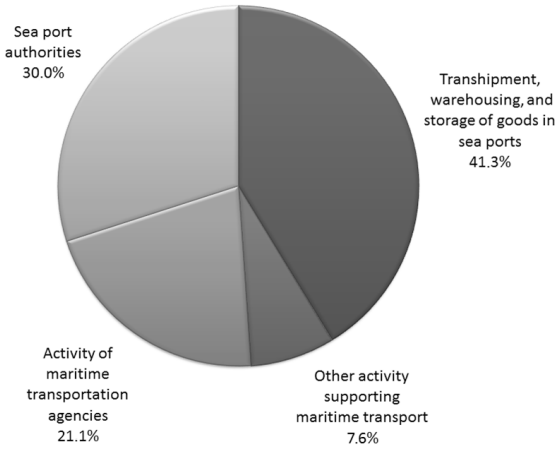

Fig. 1. The structure of the GVA in the port of Szczecin by types of the supplied port services in 2013

Source: own elaboration.

The analysis of the structure of GVA creation in the port services sector can also be conducted in the form of a business relations algorithm (Bernacki 2012), taking the GVA generated by transhipment services as the basis of comparison. The algorithm of business relations in the port of Szczecin is presented in Fig. 2.

	Added value			
Year	Warehousing and storage	Other activity supporting maritime transport	Maritime transport agencies	Sea port managing authorities
2004	1.00	0.42	0.48	0.77
2005	1.00	0.39	0.48	0.72
2006	1.00	0.45	0.55	0.74
2007	1.00	0.49	0.68	0.79
2008	1.00	0.53	0.78	0.87
2009	1.00	0.45	0.52	0.77
2010	1.00	0.28	0.51	0.84
2011	1.00	0.17	0.61	0.79
2012	1.00	0.09	0.54	0.74
2013	1.00	0.18	0.51	0.73

Fig. 2. The dependency algorithm in creation of the GVA per types of port activity in the port of Szczecin

Source: own elaboration.

The dependencies which arise during the development of port services, as measured by the newly generated value, indicate that in the port of Szczecin in 2013 the cargo transhipments induced the production of the rest of the types of port services in the proportion of 1.0 (transhipments) to 0.18 (port navigation services, pilotage, rescue, dredging and underwater works, towage, mooring, and other port services), to 0.73 (port administration and business management) and to 0.51 (customs agencies, ship agencies, brokerage, maritime forwarding, maritime consultancy, maritime expertize, clearing and stowage services, and cargo control).

Studies on the dependencies between the GVA and the port cargo turnover in Szczecin have led to unsuspected results. The Pearson product-moment correlation coefficient between the volume of cargo turnover and the GVA (expressed in basic prices in 2013) generated in the port of Szczecin during the years 2004–2013 assumed the value of –0.71 (Table 2). This indicates the strong negative linear correlation of the studied variables. The lower the cargo turnover in the port of Szczecin, the higher GVA. This means that the quantitative increase of cargo transhipment volumes does not constitute a necessary condition for the increase of the GVA. The increase of the value added at the diminishing turnover volumes may be caused by the change in the cargo structure in the port, the increase in the turnover of break cargo (conventional, containerized). During the years 2004–2014 in the port of Szczecin, the share of containerized break cargo in the total turnover doubled and rose from the level of 3.4% up to 7.4%.

Table 2. The Pearson product-moment correlation coefficients between the volume of cargo transhipment at the port of Szczecin and the GVA of the port sector in Szczecin in the years 2004–2013

Variables	GVA				
	Port sector in Szczecin in total	Transhipment, warehousing, and storage of goods in sea ports	Other activity supporting maritime transport	Activity of maritime transport agencies	Sea port managing authority
Cargo turnover at Szczecin port	–0.71	–0.59	0.17	–0.59	–0.68

Source: own elaboration.

The negative correlations between the added value and the volume of cargo transhipment appeared for the majority of types of port services with the exception of the activity supporting maritime transport.

In order to determine the elasticities of the GVA of port services in Szczecin against the cargo turnover, the classic attitude in production modelling as proposed by Cobb

and Douglas (Cobb, Douglas 1928) has been used. The GVA in the port of Szczecin has been assumed as the endogenic variable constituting the equivalent to the production expressed in its value. In the classic model, there has been considered non-constant elasticity of substitution between factors of production and the measure of technical-organizational progress as proposed by Solow (Solow 1956). The base function has taken the following form:

$$Y_t = \alpha_0 K_t^{\alpha_1} L_t^{\alpha_2} e^{\gamma t} e^{U_t} \tag{1}$$

where:
Y_t – GVA of the port sector in t time;
K_t – gross value of fixed assets in the port sector in Szczecin in t time;
L_t – average employment in the port sector in Szczecin in t time;
U_t – model random component (the Solow balance);
α_1, α_2 – punctual elasticities of the GVA respectively for fixed assets and for employment;
γ – measure of the technical and organizational development at the port sector in Szczecin (includes also the effects of structural changes in cargo transhipments).

In order to estimate the model structural parameters and to find the point elasticities against the production factors, the ordinary least squares estimator (OLS) method has been used. Prior to that, the GVA model has been brought to a linear form by means of taking the natural logarithms. The estimation results and the final form of the model have been described as:

$$\hat{Y}_t = 67768{,}6 K_t^{-0{,}353} L_t^{-0{,}361} e^{0{,}065t}, \quad R^2 = 0{,}907 \tag{2}$$

The model in 90.7% explains the variability of the GVA in the port of Szczecin during the years 2004–2013. The estimates of production elasticity (GVA) were, in both cases, negative, which means that the increase in outlays on fixed assets and increase of employment by 1% would induce a decrease of the GVA respectively by 0.35% and 0.36% (*ceteris paribus*). Due to the fact that at the assumed significance level ($\alpha = 0.05$), both model parameters were statistically insignificant, i.e., too high standard estimation errors were obtained – respectively 0.35 and 0.33, the authors have attempted a non-linear model estimation with the use of the Levenberg-Marquardt iteration algorithm. The final form of the model is described as:

$$\hat{Y}_t = 27522{,}1 K_t^{-0{,}338} L_t^{-0{,}277} e^{0{,}066t}, \quad R^2 = 0{,}923 \tag{3}$$

The change in the procedure of estimation of model parameters of the GVA for the port of Szczecin had impact on the improvement of the estimation results. The fitting of the model (R^2) has increased up to 92.3%, whereas the estimates of port production elasticity (GVA) amounted to –0.338 against the outlays on fixed assets, and to –0.277 against the employment in the port sector with the standard estimation errors at the level of 0.3 for both parameters. In the case of the technical-organizational progress criterion in the port of Szczecin, the models (2) and (3) have given similar plus value and statistically essential estimations of that parameter. In the first instance, the advance criterion

for the port of Szczecin amounted to $\gamma = 0.065$, whereas in the second one to $\gamma = 0.066$. This means that the port production measured with the GVA would increase in the port of Szczecin as the result of the technical-organizational progress at the average year-on-year rate of 6.8% and 6.9% respectively.[1] This progress manifests itself, most of all, by the change of the cargo turnover structure and by the increase of the total factor productivity.

The next step in the analysis of economic correlations in the port of Szczecin has been the modelling of the GVA in relations to the level of cargo turnover. The following model of the GVA has been assumed:

$$Y_t = \beta_0 C_t^{\beta_1} e^{\gamma t} e^{U_t} \tag{4}$$

where:
C_t – cargo transhipment in the port of Szczecin;
the remaining definitions as per the above.

The use of the ordinary least squares estimator (OLS) method to estimate the model parameters (4) brought the following results:

$$\hat{Y}_t = 12879{,}2 C_t^{-0{,}271} e^{0{,}043t}, \qquad R^2 = 0{,}892 \tag{5}$$

The GVA model (5) in 89.3% explains the variability of the value added and indicates the negative correlation which appeared between the port cargo turnover and the GVA of the port services during the years 2004–2013. Same as in the case of models (2) and (3), the negative correlation between the turnover and the GVA is connected to the increase of total factor productivity and to the changes in the transhipment structure in the port of Szczecin. In this instance, in terms of value the model indicates also the increase in the port sector production at the rate of 4.4% per annum as the result of the technical-organizational progress.

Fig. 3 presents the actual and model values of the GVA of the port sector in the port of Szczecin. All models properly reflected the dynamics of the "production" of port services. In practice, the presented models, aside from the analytical and diagnostic function in the scope of business dependencies in the port sector in Szczecin, could also – with the adoption of proper assumptions of changes in exogenous variables, i.e., the value of fixed assets of the port sector, employment in the sector, and the size and structure of cargo turnover – perform a predictive function as the tools for formulating prognosis of GVA generated in result of the supplied port services.

[1] Results of the technical and organizational development are measured by the production index in the form: $e^{\gamma t}$ or by the rates of dynamics expressed in percentage: $(e^{\gamma t}-1)\cdot 100\%$.

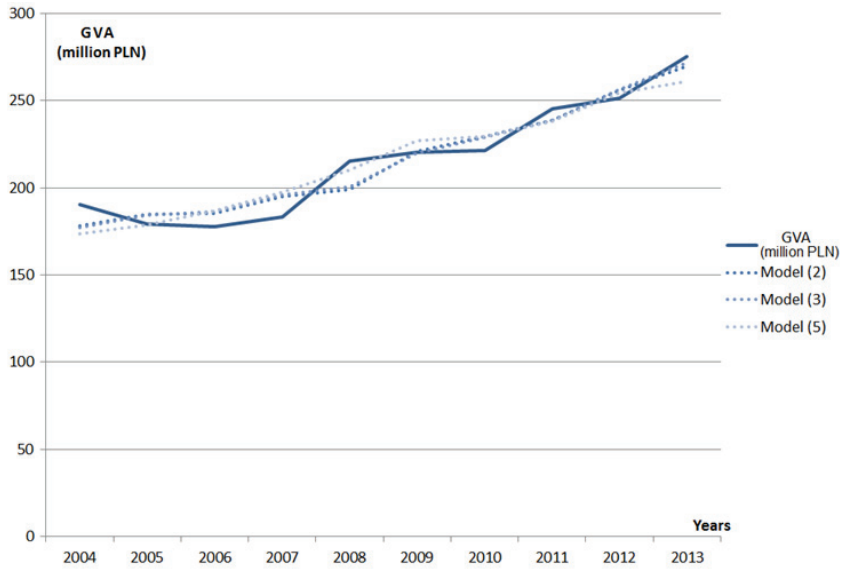

Fig. 3. GVA of port services in Szczecin in the years 2004–2013 (the actual and the model values)

Source: own elaboration.

Conclusions

On the basis of the conducted analysis the following conclusions may be derived:

1. The GVA of the port sector constitutes the measure of the production of that sector expressed in terms of value, because it expresses the total value of port services or, in other words, the total production of the port sector calculated with the consideration of mutual inter-branch money flows (indirect consumption).
2. In 2013, the GVA of the port sector in Szczecin amounted to 275.3 million PLN, and it increased in comparison to the year 2006 by 55.2 million PLN.
3. In 2013, the highest share in the creation of the GVA of the port sector services in the port of Szczecin had the companies supplying transhipment-warehousing services (41.3%) and Szczecin and Świnoujście Seaports Authority S.A. (30%). The least share in creation of the GVA (7.6%) was demonstrated by the companies supplying port shipping services (navigation, pilotage, and towage), dredging and underwater works (carried within the inner port basins), sea rescue, and other maritime services. The entities supplying in the port of Szczecin services of port-maritime forwarding, shipbroking, ship agency, customs clearance, maritime consulting and expertize, cargo stowing and securing, cargo expertize and inspection, and other services (logistics) in total generated 21.1% of the GVA in the port of Szczecin.

4. During the analyzed period, the profitability of port activities measured in the GVA per 1 ton of transshipped cargo was increasing. In 2006, the GVA per 1 ton amounted to 22.06 PLN, and, in 2013, 1 transshipped ton "produced" 31.59 PLN of GVA.
5. The transhipments realised in the port of Szczecin in 2013 induced the production of the rest of the types of port services as per the following multiplier dependences: 0.18 of the GVA of transhipment companies was generated by the so called shipping services companies, pilotage, and other port services, 0.73 of the GVA of transhipment companies was generated by the port administration and business management, whereas 0.51 by customs agencies, ship agencies, forwarding services, and the rest of the logistics services.
6. During the years 2004–2013, the negative correlation between the cargo transshipments and the GVA was noted in the port of Szczecin. Pearson product-moment correlation coefficient amounted to –0.71. This is, most of all, the effect of changes in the structure of cargo turnover and increase of collective work productivity in the port of Szczecin.
7. In the port of Szczecin, there was observed the technical-organizational progress expressing itself in the increase of the total factor productivity and the change of the cargo turnover structure in favor of containerized break cargo which brought the increase of the GVA per 1 transshipped ton. The econometric models indicated that the technical-organizational progress in the port could, *ceteris paribus*, influence the increase of the production of that sector during the years 2004–2013 on an average year-on-year rate from 4.4% to 6.9%.

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WARTOŚĆ DODANA W USŁUGACH NA PRZYKŁADZIE PORTU MORSKIEGO W SZCZECINIE

Słowa kluczowe: wartość dodana brutto, usługi portowe, modelowanie ekonometryczne wartości dodanej brutto

Streszczenie: Celem artykułu jest ustalenie wielkości i struktury dodanej wartości powstającej w związku z produkcją usług w porcie Szczecin. Wskazano na zależności korelacyjne, mnożnikowe i elastyczności, jakie pojawiają się na tle rozwoju poszczególnych rodzajów usług portowych. Wartość dodana brutto, to ekonomiczna miara wielkości wytworzonej produkcji. W portach morskich wyraża ona wartość wytworzonego i dostarczonego przez producentów na rynek strumienia usług związanych z operacjami przeładunkowo-składowymi ładunków, zapewnieniem bezpiecznego ruchu i postoju w porcie statków morskich oraz ich obsługi technicznej i handlowej, dostępnością do infrastruktury portowej dla producentów portowych i użytkowników portu, organizacją, planowaniem i koordynacją procesów obsługi ładunków i środków transportu w porcie i w pozostałych ogniwach łańcucha transportowego. Zakresem badań objęto w porcie Szczecin cztery grupy podmiotów, a mianowicie:

- przedsiębiorstwa przeładunkowe,
- przedsiębiorstwa prowadzące działalność wspomagającą transport morski, w tym świadczące portowe usługi żeglugowe (nawigacja, pilotaż, holowanie), roboty czerpalne i podwodne (wykonywane w obrębie wewnętrznych akwenów portowych), ratownictwo morskie i inne usługi morskie,
- morskie agencje transportowe, świadczące w porcie usługi spedycji portowo-morskiej, maklerstwa okrętowego, agencji żeglugowych, prowadzące obsługę celną, doradztwo i ekspertyzy morskie, usługi dotyczące rozmieszczania i zabezpieczania ładunku na statku, usługi rzeczoznawstwa i kontroli ładunków i inne usługi (logistyczne),
- zarząd portów morskich w Szczecinie i Świnoujściu

Wartość dodaną brutto obliczono odejmując od produkcji globalnej przedsiębiorstw sektora portowego wartość zużycia pośredniego. Na zużycie pośrednie składa się z kolei wartość zużytych materiałów i energii, usługi obce oraz pozostałe koszty rodzajowe podmiotów gospodarczych. Obliczeń wartości dodanej w porcie Szczecin dokonano w oparciu o dane źródłowe pozyskane z Ośrodka Statystyki Morskiej Urzędu Statystycznego w Szczecinie.

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