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Manufacturing in Romania

Research Report on the International Manufacturing Strategy Survey VI in Romania (2013-2014)

Presa Universitară Clujeană

SZÁSZ LEVENTE GYÖRFY LEHEL-ZOLTÁN

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1. Executive summary

The ***International Manufacturing Strategy Survey (IMSS)*** is an international research project carried out every 3-4 years in several countries of the world. The project was launched in 1992 by the London Business School (UK) and the Chalmers University of Technology (SWE). The sixth round of the project was carried out in ***2013-2014*** and included ***40 manufacturing companies from Romania***. Besides Romania, the current version of the IMSS database (June 2014) contains data collected from altogether 970 manufacturing companies from 21 countries. Some more countries and manufacturing plants are still expected to contribute to the database during 2014.

The IMSS research is oriented toward single manufacturing plants within companies. Companies are selected from the ***ISIC Rev. 4 Div. 25-30 industries*** which cover: manufacture of fabricated metal products, except machinery and equipment (25), manufacture of computer, electronic and optical products (26), manufacture of electrical equipment (27), manufacture of machinery and equipment not elsewhere classified (28), manufacture of motor vehicles, trailers and semi-trailers (29), manufacture of other transport equipment (30). The targeted sectors ***contribute with 23.1% to the total industrial production in Romania***.

Questions of the IMSS survey were targeted to the last three full years of company operations, covering the ***evolution of respondents in the 2010-2012 period*** and ***their current state in 2013***. In this period ***the industrial production of Romania has witnessed a strong "comeback"*** after the financial crisis. It contributed with around 30% to the total GDP of the country, and has been an important component of yearly GDP growth.

The IMSS VI data collection in Romania has been carried out between Oct 21, 2013 and Dec 23, 2013 coordinated by the two authors of the research report at hand from the ***Babeş-Bolyai University in Cluj-Napoca***, Faculty of Economics and Business Administration. The targeted population of manufacturing companies included mostly medium-sized companies operating generally in the urban environments of all eight development regions of Romania. 764 manufacturing companies were included in the targeted population, 498 of them could be contacted, out of which 186 companies agreed to participate (37.3% agreement rate). At the end of the data collection process 40 valid questionnaires have been collected, resulting in a ***response rate of 21.5%***.

Companies from the Romanian sample use ***mainly one-of-a-kind or batch production process*** types which allow for a higher degree of customization, while mass production is used up to 20% of the cases. Accordingly, ***more than half of the companies use make-to-order policies***, and only 10% produces to stock, the others using design-to-order or assemble-to-order policies. ***More than half of the sourcing and selling operations are executed within the country***, while around 40% of them is executed with partners from foreign countries from the same continent. A higher degree of internationalization (outside the continent) is rather uncommon. In respect of ***business performance*** indicators (sales and profitability), ***only few companies reported a substantial improvement*** in the last three years, most of them still reaching similar performance levels.

On average, respondent companies perceive a ***high degree of competitive rivalry*** within the industry, and a rather ***strong bargaining power of customers***. The most important strategic goals pursued are centered around offering ***high quality products***, and a

greater order size flexibility. Fast and reliable deliveries also score high, together with offering lower selling prices. On the other hand, ***environmental and social responsibility, and product customization are the least preferred strategic objectives***.

Romanian manufacturing companies from our sample also offer ***services*** alongside their products. The most frequent services offered include ***maintenance and repair services*** and ***spare parts provision***. On average, services account for 15.28% of the total sales figure of companies.

In terms of ***manufacturing practices*** the research report at hand presents detailed results concerning the implementation of action programs in altogether nine important manufacturing areas: servitization, workforce organization, technology management, production planning and control, quality management, environmental and social responsibility, product development, risk management and supply chain management (internal and external supply chain integration). The ***highest efforts*** undertaken in the last three years were in the domain of ***internal integration***, i.e., integrating the processes of the manufacturing department with those of the purchasing and sales department. These improvement efforts were mainly targeted at developing the joint decision making between the manufacturing and purchasing department. On the other hand, only ***low efforts*** were undertaken in the last three years ***to implement technology improvement practices***, including the implementation of advanced production processes, smart technologies and process automation.

In terms of the perceived risks respondent companies indicated only a low probability of occurrence of various ***risk factors***, the highest average value being reached in case of ***supply disruption***.

Respondents also indicated that the possible impact on the company would be the highest in terms of the same supply disruption factor, while manufacturing and distribution disruption scored somewhat lower. The highest efforts were undertaken by respondents to respond to these risk factors, while prevention, detection, or recovering after the occurrence of a risk factor scored lower.

In respect of ***manufacturing performance***, respondent plants indicated the ***highest improvements*** in the last three years ***in terms of delivery speed and reliability, new product introduction ability***, but also in terms of product quality and reliability. The ***lowest improvement*** has been reported in terms of ***increasing workers' motivation and satisfaction***. Interestingly, although environmental protection was among the least important strategic priorities, respondents have undertaken considerable efforts to reduce pollution emissions and reduce waste production.

In respect of current manufacturing performance measured in comparison with main competitors, respondents reported the highest values in terms of the same factors on which they were able to reach high performance improvements, namely delivery speed and reliability, new product introduction ability, and product quality and reliability. A special attention has been devoted to ***manufacturing and ordering costs*** as well, where companies reported ***worsening performances*** in the last three years, and perceived a somewhat ***lower current performance relative to main competitors*** in terms of these factors.

2. The IMSS research project

2.1. About IMSS

The International Manufacturing Strategy Survey (IMSS) is an international research project in which several business schools and research institutions participate from all around the world. The main objective of the IMSS project is to periodically explore manufacturing and supply chain strategies, practices and performances of industrial companies belonging to the ISIC Rev. 4 Div. 25-30 sectors. The project aims to contribute to academic and industrial knowledge not just by assessing the role of these companies on a global or national level, but also by exploring firm-internal operations, i.e., the "black-box" of these companies. With the help of the participating companies the IMSS project designs a common database by collecting data on manufacturing strategies, practices and performance on the manufacturing plant level.

As manufacturing companies face numerous and serious challenges, it is of foremost importance for both researchers and practitioners to understand the nature and quality of manufacturing's responses to these challenges under different national and industrial contexts. The continuously increasing global competition puts an increased pressure on national industries and individual companies, forcing them to change and adapt their strategies and practices to the conditions of a dynamically evolving environment. Moreover, fierce competition and the sophistication of customer demands cause some traditional technological and organizational practices to become quickly outdated. Adopting the right strategies and practices under such circumstances is a vital issue for competitiveness and business success.

Aiming to offer responses to the challenges presented above, the IMSS applies a questionnaire based survey to manufacturing plants with the help of local (national) coordinators. Collected data are used for scientific purposes and to deliver reports and bench-marking to the participating companies. More detailed information about the IMSS project can be found on the following website: www.manufacturingstrategy.net.

2.2. History of the project

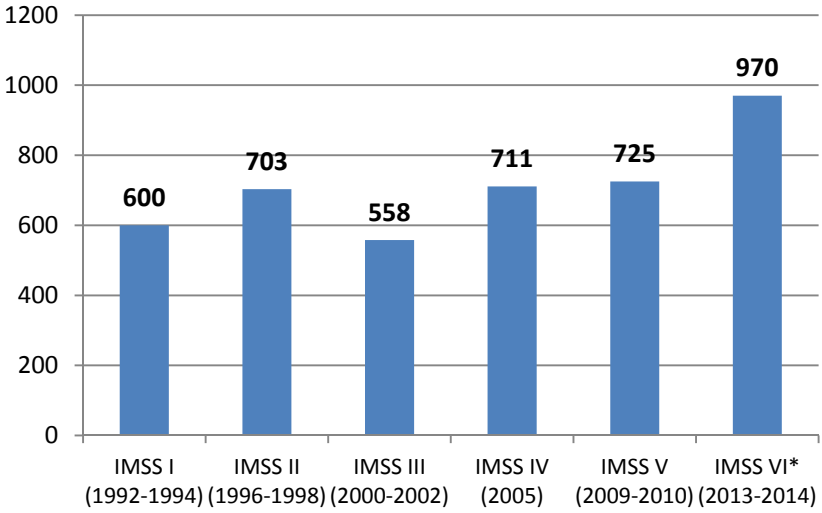
The IMSS project has been previously carried out five times, in 1992, 1996, 2001, 2005 and 2009. The current IMSS was launched in the second half of 2013 and represents already the sixth round of the project. The IMSS was originally initiated in 1992 by the London Business School (UK) and the Chalmers University of Technology (SWE) and involved a group of 20 world-class business schools. Today the project is coordinated by the Politecnico di Milano (Italy), and involves a network of more than 40 prestigious universities and research institutions from all over the world, including the Vlerick Management School (Belgium), HEC Montreal (Canada), City University of Hong Kong (China), Aalborg University (Denmark), Aalto University (Finland), Corvinus University of Budapest (Hungary), Indian Institute of Management (India), Universita degli studi di Bergamo (Italy), Monash University (Malaysia), University of Groningen (Netherlands), Catholic University of Portugal (Portugal), University of Maribor (Slovenia), ESADE Business School (Spain), Stockholm School of Economics (Sweden), University of St. Gallen (Switzerland) etc., and the Babeş-Bolyai University (Romania). The timing of the IMSS rounds is summarized in Table 1.

Table 1. Timing of the International Manufacturing Strategy Surveys (IMSS)

Project round	Timeframe of data collection
IMSS I	1992-1994
IMSS II	1996-1998
IMSS III	2000-2002
IMSS IV	2005
IMSS V	2009-2010
IMSS VI	2013-2014 *(still ongoing as of June 2014)*

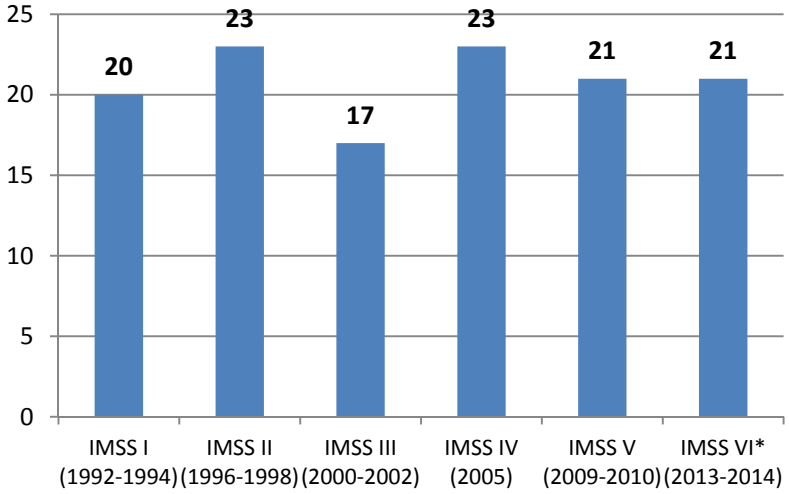
The first iteration of the project (IMSS I) was carried out during the 1992-1994 period with the participation of 600 manufacturing plants from 20 different countries. The second round (IMSS II) was carried out in the 1996-1998 period and involved 703 manufacturing plants in 23 countries. The third iteration (IMSS III) of the project was carried out in the 2000-2002 period, with the participation of 585 manufacturing plants in 17 different countries. The fourth round (IMSS IV) took place in 2005 involving 711 plants and 23 countries. The fifth round (IMSS V) of the project started in 2009 and ended early 2010 with the participation of 725 manufacturing plants in 21 different countries. The sixth round (IMSS VI) has been initiated in 2013 and is still under development in the first half of 2014 (the data reported reflect the database version available in June 2014). While still several countries are expected to contribute with their survey data, the current version of the IMSS database contains already 970 manufacturing plants from 21 countries. For the first time in the history of the project the final figures are expected to exceed 1000 companies. The evolution of these figures is illustrated on Figure 1 and Figure 2.

Figure 1. Evolution of the number of manufacturing plants involved in the IMSS project



** Preliminary figures for the IMSS VI (as of June 2014) – more participating plants are expected*

Figure 2. Evolution of participating countries in the IMSS project



** Preliminary figures for the IMSS VI (as of June 2014) – more participating plants are expected*

Being a global research project both developed and developing countries are involved in the IMSS from almost each continent, except Africa.

Table 2 (IMSS I-III) and Table 3 (IMSS IV-VI) illustrate the composition of IMSS samples by country for each round of the survey.

Table 2. IMSS I-III samples composition by country

IMSS I		IMSS II		IMSS III	
Country	**No. of plants**	**Country**	**No. of plants**	**Country**	**No. of plants**
Argentina	41	Argentina	31	Argentina	14
Australia	29	Australia	55	Australia	40
Austria	27	Brazil	27	Belgium	19
Belgium	3	Canada	40	Brazil	35
Brazil	28	Chile	10	China	30
Canada	23	China	30	Croatia	35
Chile	6	Denmark	27	Denmark	38
Denmark	17	Finland	14	Germany	32
Finland	17	Germany	28	Hungary	58
Germany	24	Hong Kong	14	Ireland	32
Italy	41	Hungary	38	Italy	60
Japan	27	Italy	74	Netherlands	14
Mexico	62	Japan	29	Norway	51
Netherlands	27	Korea	50	Spain	20
Norway	20	Mexico	29	Sweden	19
Portugal	41	Netherlands	29	UK	47
Spain	29	New Zealand	32	USA	14
Sweden	61	Norway	13		
UK	36	Peru	8		
USA	41	Spain	33		
		Sweden	27		
		UK	24		
		USA	41		
TOTAL (IMSS I)	**600**	**TOTAL (IMSS II)**	**703**	**TOTAL (IMSS III)**	**558**

Table 3. IMSS IV-VI samples composition by country

IMSS IV		IMSS V		IMSS VI*	
Country	**No. of plants**	**Country**	**No. of plants**	**Country**	**No. of plants**
Argentina	44	Belgium	36	Belgium	30
Australia	14	Brazil	37	Canada	30
Belgium	32	Canada	19	China	130
Brazil	16	China	59	Denmark	39
Canada	25	Denmark	18	Finland	34
China	38	Estonia	27	Germany	24
Denmark	36	Germany	38	Hungary	57
Estonia	21	Hungary	71	India	136
Germany	18	Ireland	6	Italy	53
Greece	13	Italy	56	Japan	83
Hungary	54	Japan	28	Malaysia	17
Ireland	15	Korea	41	Netherlands	49
Israel	20	Mexico	17	Norway	29
Italy	45	Netherlands	51	Portugal	34
New Zealand	30	Portugal	10	**Romania**	**40**
Norway	17	**Romania**	**31**	Slovenia	17
Portugal	10	Spain	40	Spain	30
Sweden	82	Switzer	31	Sweden	32
Netherlands	63	Taiwan	31	Switzerland	30
Turkey	35	UK	30	Taiwan	28
United Kingdom	17	USA	48	USA	48
USA	36				
Venezuela	30				
TOTAL (IMSS IV)	**711**	**TOTAL (IMSS V)**	**725**	**TOTAL (IMSS VI)**	**843**

** Preliminary figures for the IMSS VI (as of June 2014) – more contributing countries are expected*

The most constantly present countries in the IMSS samples are the developed countries of Western and Northern Europe (Belgium, Denmark, Germany, Italy, Netherlands, Norway, Spain, Sweden, UK), and North America (Canada, USA). Eastern Europe has relatively few participating countries in the project, with Hungary being the most constant member. Romania has joined the IMSS project in 2009 and has participated in the last two rounds of the survey. The breakdown of the IMSS sample based on the continent where the participating countries come from is summarized in Table 4, where the Eastern European region is presented in more detail.

Table 4. IMSS samples composition by continent

	IMSS I	IMSS II	IMSS III	IMSS IV	IMSS V	IMSS VI*
North America	**64**	**81**	**14**	**61**	**67**	**78**
Central/South America	**137**	**105**	**49**	**90**	**54**	**0**
Northern/Western Europe	**343**	**269**	**332**	**335**	**316**	**384**
Eastern Europe	**0**	**38**	**93**	**88**	**129**	**114**
Hungary	*0*	*38*	*58*	*54*	*71*	*57*
Croatia	*0*	*0*	*35*	*0*	*0*	*0*
Estonia	*0*	*0*	*0*	*21*	*27*	*0*
Greece	*0*	*0*	*0*	*13*	*0*	*0*
Romania	*0*	*0*	*0*	*0*	*31*	*40*
Slovenia	*0*	*0*	*0*	*0*	*0*	*17*
Asia	**27**	**123**	**30**	**93**	**159**	**394**
Australia/Oceania	**29**	**87**	**40**	**44**	**0**	**0**
TOTAL	**600**	**703**	**558**	**711**	**725**	**970**

** Preliminary figures for the IMSS VI (as of June 2014) – more contributing countries are expected*

2.3. Research methodology

2.3.1. The IMSS questionnaire

The questionnaire is designed by an international team of researchers. Related to previous editions, new questions are always added to the questionnaire, reflecting the changing areas of interest in the field of manufacturing and supply chain management, both from the perspective of academia and businesses. Core questions, however, remain the same between subsequent editions to ensure the possibility of longitudinal analyses.

The IMSS questionnaire focuses on understanding the market strategies and priorities of the business units to which participant manufacturing plants belong to, how these strategies can be applied to manufacturing objectives, manufacturing and supply chain practices, and areas for improvement which can positively contribute to plant performance. IMSS questionnaires, including the last edition, are generally divided into three sections:

- Section A: Description, strategy, organization and performance of the business unit
- Section B: Description, strategy, organization and performance of the dominant activity of the plant (since often even a single plant may perform a variety of very different manufacturing activities, respondents are requested to consider the "dominant activity of the plant", i.e. the activity, which is considered to best represent the plant)
- Section C: Current manufacturing and supply chain practices, and past action programs (including: production planning and control, technology management, quality management, supply chain management, environmental and social sustainability, risk management, network operations, globalization)

Finalized questionnaires are pilot tested before application in each round of the survey. Afterwards, questionnaires are handled by the national coordinators. The language of the questionnaire is English, but, where needed, it is translated into local language using a reliable method (double parallel translation and/or back-translation). The usual time frame for survey administration is between 2 and 3 months in each country. The methodology for survey administration is the self-administered survey. Questionnaires are generally sent out by e-mail or on paper. Starting from the 2013 edition (IMSS VI) the questionnaire can also be accessed in the form of a web-survey, which has been designed by the central coordinators and made available for all partners.

It is advised that the questionnaire is filled in by operations, manufacturing or technical managers of the company or the person in an equivalent position. In some cases (mostly medium-sized companies), the general manager can also answer most of the questions. Some parts of the questionnaire can be filled in by other functional area managers.

2.3.2. Targeted population and sample selection

The IMSS research is oriented toward single manufacturing plants within companies. The following criteria are used to select the population of potential companies to be involved in the survey:

- To ensure the comparability of individual plant-level data, extremely small companies are filtered out from the targeted population. The lower limit of company size is 50 employees.
- Companies are selected from the ISIC Rev. 4 Div. 25-30 industries which covers:

Table 5. Industry sectors involved in the IMSS

ISIC code (Rev. 4)	Description
25	Manufacture of fabricated metal products, except machinery and equipment
26	Manufacture of computer, electronic and optical products
27	Manufacture of electrical equipment
28	Manufacture of machinery and equipment not elsewhere classified
29	Manufacture of motor vehicles, trailers and semi-trailers
30	Manufacture of other transport equipment

- Companies included in previous samples are all targeted to maximize the overlap between samples.
- Local coordinators have to combine two different methods of sampling: convenience and random. At least 10% of the cases has to come from random sampling. Convenience sampling is primarily used in case of companies that have participated in previous IMSS editions.

Based on the four criteria presented above, each local research team defines the targeted population using an official database of companies. Then, each company is contacted prior to receiving the questionnaire, in order to identify the correct respondent, present the project, clarify purposes and benefits, as well as receive approval for sending the questionnaire. Questionnaires are sent to those companies that agreed to participate in the project. IMSS requires a minimum response rate of 20%, which is calculated as the ratio between valid questionnaires received and the total number of questionnaires sent.

2.3.3. Data quality control

Several centrally predefined criteria are applied to ensure the quality and comparability of the data collected:

- Prior to sending the data to the central database, it has to be ensured that the ratio between valid answers and the number of questionnaires sent (response rate) is higher than 20%.
- Prior to sending the data to the central database, each questionnaire is checked individually to conform to the selection criteria of companies (industry codes, number of employees, traceable sampling method, type of instrument used – paper version, electronic file, online survey)
- Handling incomplete questionnaires and missing data: missing answers have to be limited as much as possible. Local coordinators should contact again companies to ask them to complete missing responses. Questionnaires having more than 30% of the answers missing are returned to the companies
- Quality control procedures: the web-based survey has a built-in quality control for data introduction. For e-mailed or paper-based questionnaires data quality (e.g. unreliable answers, values out of range, percentages not totaling 100%) is checked using a centrally designed electronic data validation procedure.
- Country coordinators also check the collected data for late-respondent bias and non-respondent bias.

3. The Romanian industrial context

Before presenting the details and results of the Romanian IMSS VI research project, it is important to assess the economic and industrial context in which the targeted manufacturing plants operate. As the research was carried out in 2013, and the majority of IMSS VI questionnaire items referred to the last three full years (2010-2012), economic indicators presented in this section refer to the same period.

Following the first years of the economic crisis, the past 4 years in Romania brought a positive growth of the Romanian GDP in almost all quarters and years compared to the same period of the previous year. Exact figures are presented in Table 6. The estimated GDP in 2013, the year of questionnaire administration in Romania, was 631 billion lei, the equivalent of 140 billion euro.

Table 6. GDP growth in Romania between 2010-2013 (% of the same period, previous year)

	1st quarter of year	2nd quarter of year	3rd quarter of year	4th quarter of year	Year
2010	97.8	99.5	98.3	99.5	98.5
2011	101.8	101.5	103.9	101.9	102.3
2012	100.1	102	99.4	100.8	100.6
2013	102.1	101.4	104.2	105.5	103.5

Source: National Institute of Statistics, Press Release, 53/5th of March, 2014, National Institute of Statistics, Press Release, 13th of March, 2013

The share of the industrial sector in the GDP has reached 30% in 2013 (see Table 7).

Table 7. GDP structure in Romania by sectors (%)

	Contribution to GDP structure (2012)	Contribution to GDP structure (2013)
Agriculture	5.3%	5.6%
Industry	28.4%	30.0%
Services	53.5%	52.2%
Gross Value Added	87.2%	87.8%
Taxes on product	12.8%	12.2%
Total	**100.0%**	**100.0%**

Source: National Institute of Statistics, Press Release, 53/5th of March, 2014, National Institute of Statistics, Press Release, 13th of March, 2013

The industrial sector has largely contributed to GDP growth in three of the last four years (2010, 2011 and 2013), as illustrated in Table 8. Overall, in the period between 2010-2013 the contribution of the industrial sector to the Romanian GDP growth proved to be the highest relative to the other sectors. In the most recent year (2013) two third of the Romanian economic growth is attributable to the industrial sector (2.3% point of 3.5%), and one third to the agriculture sector (1.1% point of 3.5%).

Table 8. Contribution of sectors to GDP growth (%)

	2010	2011	2012	2013
Agriculture	-0.1	0.7	-1.4	1.1
Industry	1.2	1.3	-0.6	2.3
Construction	-1	0.3	0	(included in industry)
Services	-1.1	-0.1	1.8	0.1

Source: National Institute of Statistics, Monthly Statistical Bulletin no. 1/2011, 1/2012, 1/2013, Press Release, 13th of March, 2013

The industrial sector has shown a strong "comeback" after the economic crisis. Monthly industrial production indices had several decreases in 2010, but in the following years the industrial production has shown an almost continuous growth. In 2011 only two months, January and July, have shown a drop in industrial production. Between 2012 and 2013 the industrial sector has grown dynamically in every month compared with the same period of the previous year. Detailed figures are illustrated in Table 9.

Table 9. Monthly industrial production indices of the industry sector (compared to the same period of the previous year)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	85.7	90.1	103.9	95.9	99.1	105.1	103.3	85.8	108.3	110.5	111.6	100.6
2011	97.50	102.2	115.8	102.1	110.8	108.0	107.2	99.0	114.8	114.7	117.8	99.60
2012	101.4	103.8	116.1	102.9	116.8	110.0	111.6	100.7	114.1	121.9	120.5	100.9
2013	107.5	111.3	117.7	123.4	114.8	116.0	124.5	105.0	125.8	135.6	131.6	111.2

Source: National Institute of Statistics, TEMPO database

The most important subsector of the Romanian industry is the manufacturing sector, having the highest share of industrial production: 76% in 2011. The ISIC Rev. 4. Div. 25-30 industrial sectors involved in the IMSS research project contribute with 23.1% to the total industrial production in Romania. The most important sectors in this group are the manufacture of motor vehicles, trailers and semi-trailers (ISIC 29), with 9.6% of the total industrial production.

Table 10. Structure of the Romanian industrial sector, 2011 (%)

INDUSTRY	**100%**
MINING AND QUARRYING	3.5%
MANUFACTURING	76.0%
Manufacture of fabricated metal products, except machinery and equipment (25)	*3.7%*
Manufacture of computer, electronic and optical products (26)	*2.7%*
Manufacture of electrical equipment (27)	*2.7%*
Manufacture of machinery and equipment n.e.c. (28)	*3.0%*
Manufacture of motor vehicles, trailers and semi-trailers (29)	*9.6%*
Manufacture of other transport equipment (30)	*1.4%*
TOTAL ISIC 25-30	***23.1%***
Other manufacturing	*52.9%*
ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	17.1%
WATER SUPPLY, SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	3.4%

Source: National Institute of Statistics, TEMPO database

The monthly industrial production indices of the manufacturing sector show a similar trend to that of the total industrial sector. Beginning from September 2011 the production of the manufacturing sector has increased in each month compared to the same period of the previous year. Exact figures are provided in Table 11.

Table 11. Monthly industrial production indices of the manufacturing sector

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2010	81.40	87.70	103.4	96.30	100.7	107.6	104.6	84.2	110.9	111.9	113.0	98.2
2011	94.60	101.1	116.4	102.2	113.0	110.5	109.3	99.1	117.7	116.6	118.8	96.6
2012	99.10	101.7	116.3	103.0	118.9	111.9	113.1	100.2	116.3	124.6	121.9	97.6
2013	105.6	112.2	118.5	126.8	117.9	119.2	128.3	105.4	129.8	139.3	134.3	109.1

Source: National Institute of Statistics, TEMPO database

4. The IMSS VI research project in Romania

4.1. IMSS VI Romania

The IMSS VI data collection in Romania has been carried out between Oct 21, 2013 and Dec 23, 2013. At the end of this 2 months process 40 valid questionnaires have been collected from Romanian manufacturing companies. The data collection procedure has been coordinated by two researchers of the Babeş-Bolyai University from Cluj-Napoca, Faculty of Economics and Business Administration, and has been carried out in cooperation with the Metro Media Transilvania, a private company specialized in market study and social research, being one of the leaders in this field on the Romanian market. Members of the research project are presented in Table 12.

Table 12. People responsible for the IMSS VI research project in Romania

Name	Institution/ position	Role in the project	Contact
Levente SZÁSZ	Babeş-Bolyai University, Cluj-Napoca Faculty of Economics and Business Administration (assistant professor)	Project team leader	levente.szasz@ econ.ubbcluj.ro
Lehel-Zoltán GYÖRFY	Babeş-Bolyai University, Cluj-Napoca Faculty of Economics and Business Administration (assistant professor)	Project team member	lehel.gyorfy@ econ.ubbcluj.ro
Calin MOLDOVAN-TESELIOS	Metro Media Transilvania	Data collection manager	mmt@mmt.ro

Funding for the research project has been assured by the “Domus Hungarica” research grant (DSZ/64/2013) offered by the Hungarian Academy of Sciences.

The survey procedure has been carried out following the guidelines and criteria of the IMSS VI research. Consequently, the research consisted of the following steps:

1. Definition of the target population based on IMSS VI criteria.
2. Companies with valid contact information have been contacted via e-mail or telephone call.
3. An electronic questionnaire or the web address of the online survey has been sent to companies that agreed to participate in the project.
4. Companies were contacted again after several weeks if the completed questionnaires have not been received or if they contained missing or unreliable data.
5. Step 4 was repeated until valid questionnaires have been received, or until, in some cases where data quality was insufficient, questionnaires have been discarded.
6. Romanian database has been finalized and sent to the central coordinators of IMSS VI.

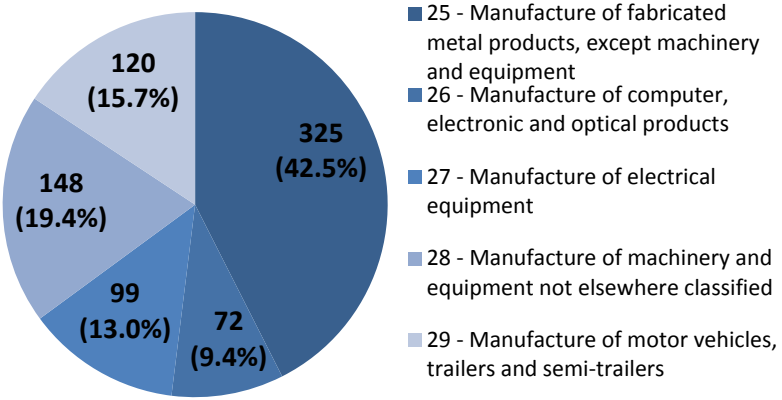
4.2. Description of target population

As the first step of the data collection procedure, the target population has been carefully defined using the official database of Metro Media Transilvania. Companies have been selected based on the following two criteria:

- Companies that belong to the ISIC Rev. 4. Div. 25-29 industrial sectors (ISIC Div. 30 – "Manufacture of other transport equipment" has been dropped due to insufficient data);
- Companies that had at least 50 employees at the end of 2012.

Based on these criteria the target population has been defined containing altogether 764 companies. The distribution of the population based on industry sector is presented on Figure 3.

Figure 3. The distribution of the target population by industry sector (total 764 companies)



Based on employee number and sales figures the size of each company in target population has also been determined. As 50 employees is the minimum criterion, the population contains only medium and large companies. The distribution of the population by size is presented in Table 13.

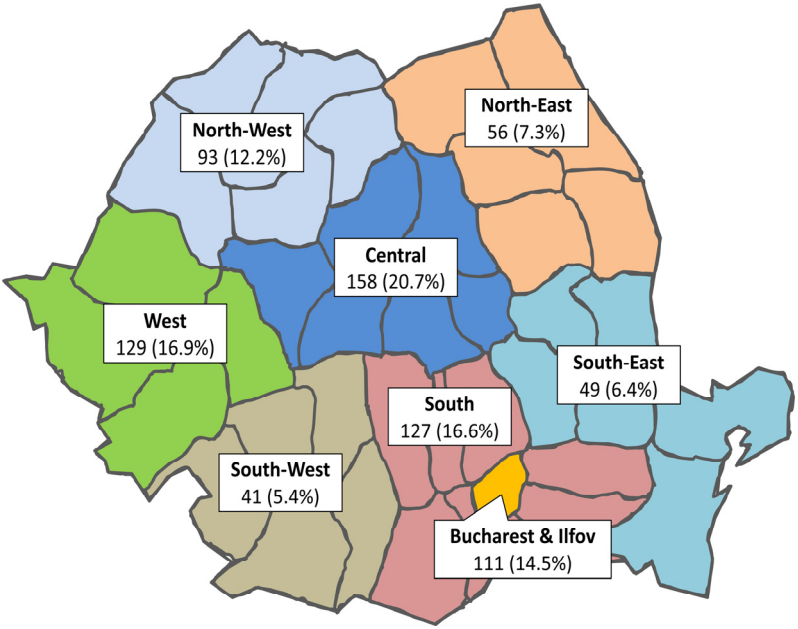
Table 13. The distribution of the target population by size

Size	Number of companies	Percentage of total
Medium-sized companies	589	77.1%
Large companies	175	22.9%
TOTAL	**764**	**100.0%**

The IMSS VI study in Romania has been designed to cover all the major regions of the country.

Figure 4 illustrates the number of companies in each region, while the percentages in brackets indicate the ratio between companies in a specific region and the total population.

Figure 4. The distribution of the target population by regions



Additionally, it was also assessed whether the company is headquartered from a rural or an urban area. The distribution of the target population in this respect is presented in Table 14.

Table 14. The distribution of the target population by headquarter environment

Headquarter environment	Number of companies	Percentage of total
Rural	121	15.8%
Urban	643	84.2%
TOTAL	**764**	**100.0%**

During the data collection process the following number of companies were involved in the different stages of the survey:

- Target population: 764 companies
- Number of companies contacted: 498 companies
- Number of companies agreed to participate: 186 companies
- Number of valid responses: 40 companies

Based on the figures above the following success rate was achieved:

- Agreement rate: 37.3% (no. of companies agreed to participate / no. of companies contacted)
- Response rate: 21.5% (no. of valid answers / no. of questionnaires sent)

4.3. Sample description and representativeness

As a result of the data collection procedure 40 valid answers have been collected in Romania. 4 questionnaires have been collected through the online survey, while the remaining 36 questionnaires have been collected on paper. For this latter category double input was used as a fault-proof method to ensure data consistency.

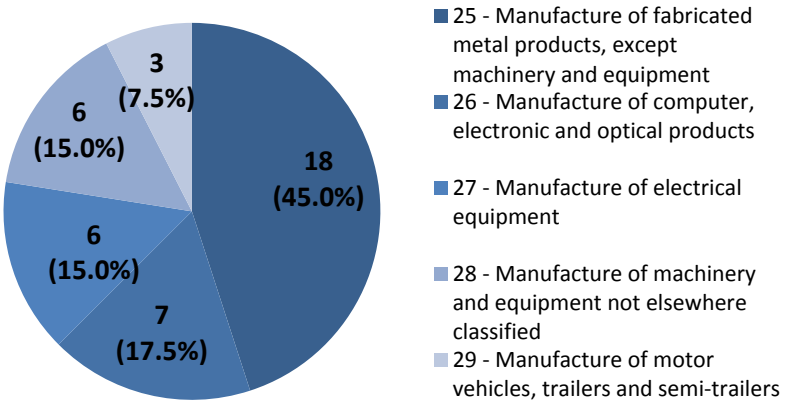
In respect of company ownership 77.5% of the plants in the Romanian sample belong to a company with domestic majority ownership, while the remaining 22.5% were manufacturing plants established or operated by foreign companies. Countries that are present as foreign owners in the sample are Germany (10.0% of the plants), Italy (7.5% of the plants), France and Austria (2.5-2.5%).

The following tables and figures present the distribution of the Romanian sample in respect of industry, size, region and rural/urban environment. It has also been investigated whether the Romanian sample is statistically representative of the targeted population. Chi-square tests indicated that the IMSS VI sample is

statistically representative in respect of all four sample characteristics.

As illustrated on Figure 5, almost half of the IMSS VI sample belongs to the "ISIC 25 – Manufacture of fabricated metal products, except machinery and equipment" industry, while the other sectors show a fairly evenly distributed pattern.

Figure 5. Sample composition by industry sector



Results of the Chi-square test, shown in Table 15, indicate that the sample is representative of the total population in respect of industry sectors.

Table 15. Representativeness of the sample in respect of industry

Industry	No. of companies	Expected no. of companies
25	18	17.0
26	7	3.8
27	6	5.2
28	6	7.8
29	3	6.3
Chi-square (4, N=40) = 5.086, p=.279		

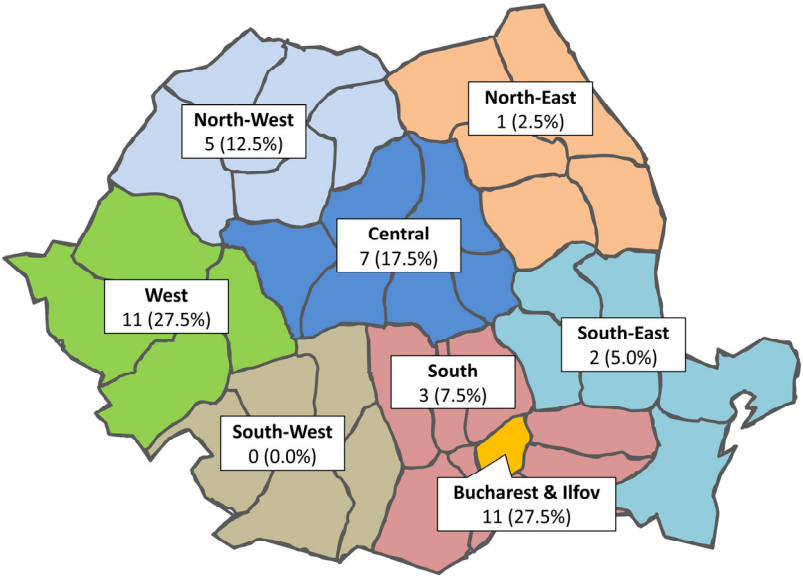
In respect of manufacturing plant size the sample distribution and its representativeness is presented in Table 16. The majority of the sample is consisted of medium-sized companies.

Table 16. Sample distribution and representativeness by size

Size	No. of companies	Pct.	Expected no. of companies
Medium-sized co.	32	80%	30.8
Large companies	8	20%	9.2
Chi-square (1, N=40) = .191, p=.662			

Figure 6 illustrates the distribution of the Romanian IMSS VI sample by region. Most of the companies are located in the capital and its close proximity, followed by the West and Central region.

Figure 6. Sample distribution by region



The sample is representative in respect of regional distribution as well, as it is shown in Table 17.

Table 17. Representativeness of the sample in respect of regions

Region	No. of companies	Pct.	Expected no. of companies
North-East	1	2.5%	3.1
South-East	2	5.0%	2.7
South	3	7.5%	7.0
West	11	27.5%	7.1
North-West	5	12.5%	5.2
Central	7	17.5%	8.8
Bucharest & Ilfov	11	27.5%	6.1
Chi-square (6, N=40) = 10.197, p=.117			

Similarly, in respect of the rural/urban environment the company is located in, the sample proved to be representative again as shown in Table 18.

Table 18. Sample distribution and representativeness by headquarter environment

Environment	No. of companies	Pct.	Expected no. of companies
Rural	5	12.5%	6.3
Urban	35	87.5%	33.7
Chi-square (1, N=40) = .327, p=.567			

5. Survey results

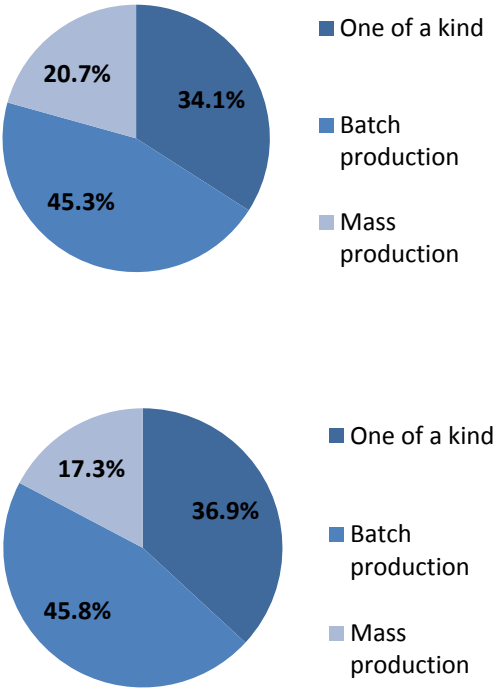
5.1. Sample characteristics

As previously shown, the Romanian IMSS VI sample, consisting of 40 manufacturing plants, is representative of the ISIC 25-29 industrial sectors, with a higher share of the ISIC 25 industry. Respondents generally represent medium-sized companies (80%), while 20% of them are coming from large companies. Companies are located mainly in the proximity of urban regions, and represent almost all development regions of Romania, with an inclination towards the capital of the country, and the West region. The sample is statistically representative both in respect of industry, size, rural/urban environment and development regions.

This section goes beyond basic descriptive statistics and presents the sample based on the characteristics of internal operations and supply chain management and business performance improvement.

Considering the production process type used, respondents had to indicate in percentage terms to what extent they use the following three production processes in fabrication and in assembly: one of a kind production, batch production and mass production. The distribution of the sample shows a similar structure for fabrication and assembly: batch production is the most frequent process type used, followed closely by one of a kind production which enables a high degree of customization. Mass production is also used, on average, to an extent of around 20%. The exact distributions for fabrication (left side) and assembly (right side) are shown on Figure 7.

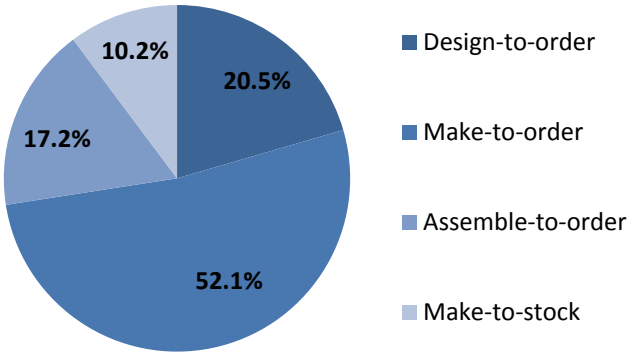
Figure 7. Production process types used in fabrication (up) and assembly (down)



In respect of the way manufacturing companies respond to customer orders, respondents could indicate, in percentage terms, to what extent they use the following order policies with their customers: design-to-order, make-to-order, assemble-to-order, make-to-stock. The distribution of the average percentage values is shown on Figure 8. Results indicate that, in concordance with batch

and one of a kind production, companies use order policies which enable a higher degree of customization. The majority of the companies use make-to-order policies, with design-to-order ranking second. Mass production is used, on average, only about to an extent of 10%.

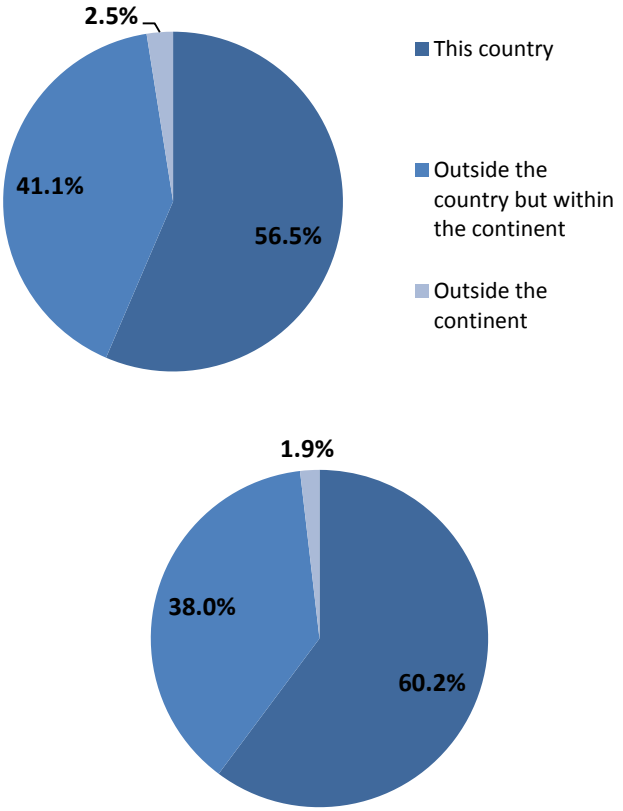
Figure 8. Average percentages of different order policies used



In respect of the internationalization of supply chain operations (sourcing and selling) respondent plant managers had to indicate to what extent the sourcing of raw materials, parts, components and subassemblies, and the sales of products and services are carried out within the same country, outside the same country but within the same continent, or outside the continent. Average percentages are presented on Figure 9. Results indicate that the internationalization of sourcing and selling show similar patterns on average. The majority of sourcing (56.5%) and selling (60.2%) operations is carried out within the borders of Romania. On the other hand, sourcing and selling outside the country, but within the same

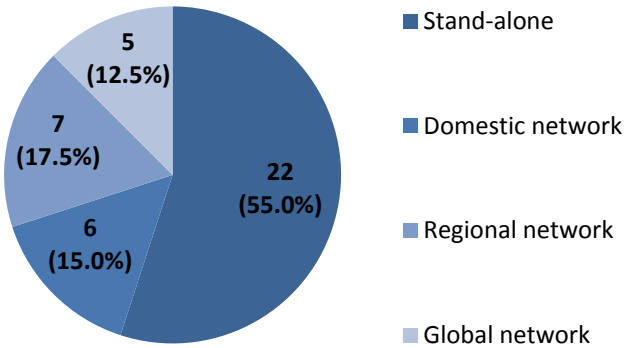
continent, seems to also have a dominant role with around 40%, showing the embeddedness of Romanian plants into the European economy. However, operations carried out with partners outside continent are rather infrequent. Altogether, it seems that Romanian manufacturing plants have a strong local and regional role, but their global embeddedness is still quite low.

Figure 9. The average level of internationalization of sourcing (up) and selling (down) operations



Manufacturing plants are frequently members of an international manufacturing network consisting of multiple plants belonging to the same company. These networks may span throughout a country, a continent or even globally, comprising more than one continent. In respect of the global manufacturing network IMSS VI respondents had to indicate whether their plant operates as a single plant within a company or as part of a domestic, regional (one continent) or global network. Figure 10 shows the distribution of the Romanian sample in this respect. Most of the manufacturing plants in our sample (55%) operate as single plants of a company. However, the remaining 45% of the plants are active members of a domestic, regional or global manufacturing network, with a fairly even distribution of the three network types.

Figure 10. Global network membership of Romanian plants



Respondents were also asked to rate their actual business performance in terms of 2012 sales and profitability levels. 27 manufacturing plants (67.5% of the total sample) reported annual sales

below 10 million €, while the remaining 13 plants reported a sales volume between 10-50 million €. In respect of profitability 4 respondents (10.0%) reported negative return on sales (ROS). Most of the manufacturing plants reported low ROS ratios: 17 plants (42.5%) indicated a ratio between 0-5%, while further 16 plants (40.0%) reported a ROS ratio of 5-10%. Only 3 respondents (7.5%) reported a ratio of 10-20%, and none of the plants had a return on sales exceeding 20%. Results are summarized in Table 19.

Table 19. Actual business performance of manufacturing plants

Sales			Return on sales (ROS)		
Value	**No. of responses**	**Pct.**	**Value**	**No. of responses**	**Pct.**
< 10 mil. €	27	67.5%	<0%	4	10.0%
10-50 mil. €	13	32.5%	0-5%	17	42.5%
50-100 mil €	0	0.0%	5-10%	16	40.0%
100-500 mil. €	0	0.0%	10-20%	3	7.5%
>500 mil. €	0	0.0%	>20%	0	0.0%
Total	**40**	**100%**	**Total**	**40**	**100%**

In respect of business performance improvement the respondents had to indicate on a 5-point scale how their performance has improved in the last three years (2009-2012) in respect of sales and profitability (ROS - return on sales). Results are illustrated in Table 20. It is interesting to observe that most companies reported that in the years of the crisis they managed to maintain a similar level of sales and profitability. However, it is also worth noting that only 15% of the companies reported an improvement of business performance during the 2009-2012 period. Moreover, 22.5% of respondents reported a decrease of sales, while 32.5% reported a decrease in profitability during the years of the economic crisis.

Table 20. Business performance improvement in the last three years

Scale	Sales		Return on sales (ROS)	
	No. of responses	Pct.	No. of responses	Pct.
1 – much lower	3	7.5%	4	10.0%
2 – lower	6	15.0%	9	22.5%
3 – similar	25	62.5%	21	52.5%
4 – higher	5	12.5%	3	7.5%
5 – much higher	1	2.5%	3	7.5%
Total	**40**	**100%**	**40**	**100%**

Looking at the two business performance improvement indicators together there is a high significant correlation between the two measures. Companies that experienced a drop in sales generally had to face a decrease of profitability as well, and vice versa. The combination of the two indicators is shown in Table 21. It can also be seen that most of the companies managed to keep both their sales and profitability figures constant in the last three years (17 companies, 42.5%). 15 companies (37.5% of the total sample) experienced at least some kind of drop in sales and/or profitability. On the other hand, only 8 companies (20.0% of the total sample) reported at least some improvement in sales and/or profitability.

Table 21. Cross tabulation of sales and return on sales improvement measures

		ROS improvement				
		1 – much lower	2 – lower	3 – similar	4 – higher	5 – much higher
Sales improve-ment	1 – much lower	3	0	0	0	0
	2 – lower	0	3	2	0	1
	3 – similar	1	5	17	2	0
	4 – higher	0	1	2	1	1
	5 – much higher	0	0	0	0	1

Having a high correlation between sales and profitability improvement ($r(38)=.566$, $p<.001$), an aggregated business performance improvement indicator (*PerfImp*) has been created as the mean value of sales improvement (1-5 scale) and return on sales improvement (1-5 scale). The distribution of aggregated business performance improvement values are shown in Table 22. Based on these values three different groups of companies were created:

1. Worst performers (*PerfImp* < *3*): at least one of the two business performance indicators (sales and profitability) has decreased over the last three years, i.e. companies that experienced at least a slight drop in business performance.
2. Constant performance (*PerfImp* = *3*): both business performance indicators have remained approximately the same over the last three years.
3. Best performers (*PerfImp* > *3*): at least one of the two business performance indicators (sales and profitability) has increased over the last three years, i.e. companies that experienced at least a slight improvement in business performance.

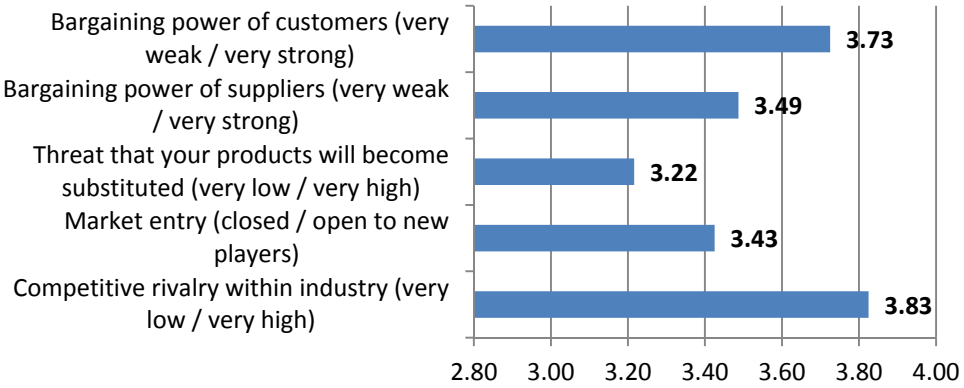
Table 22. Company categories based on overall business performance improvement

	PerfImp	No. of responses	Pct.	Total responses	Total pct.
"Worst performers"	1.0	3	7.5%	14	35.0%
	2.0	4	10.0%		
	2.5	7	17.5%		
"Constant performers"	3.0	18	45.0%	18	45.0%
"Best performers"	3.5	5	12.5%	8	20.0%
	4.0	1	2.5%		
	4.5	1	2.5%		
	5.0	1	2.5%		

5.2. Business environment and strategy

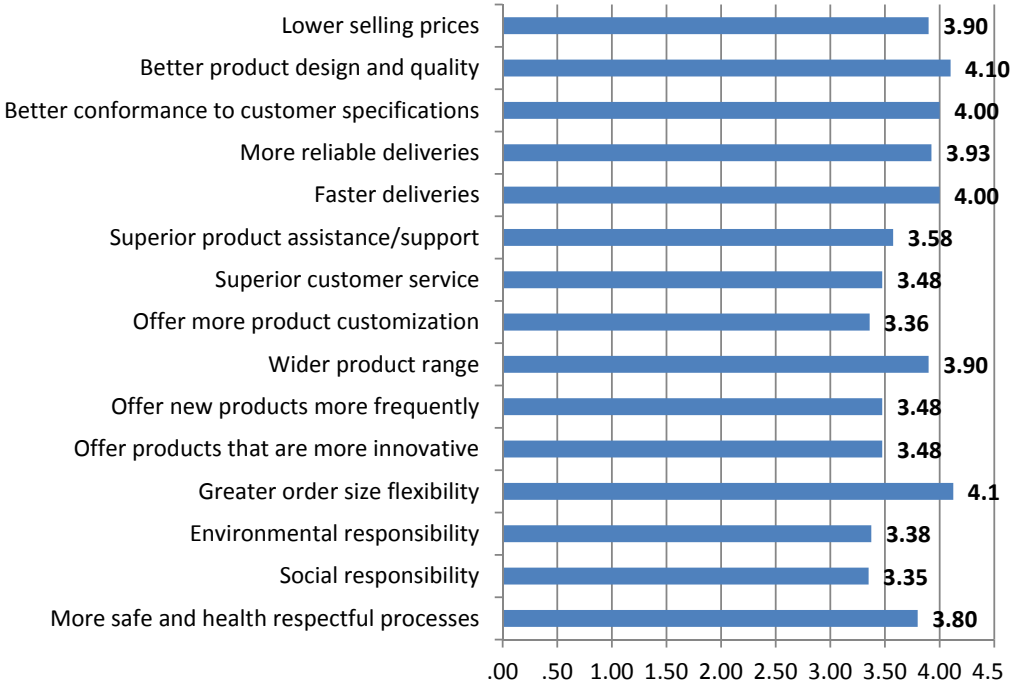
The first section of the IMSS VI questionnaire enquired about the perceived characteristics of the business environment respondents operate in, and about the strategies pursued by these plants. Average results in respect of the business environment are presented on Figure 11. Each characteristic was measured on a 1-5 Likert scale. The meaning attached to the end-points of the scale is presented in parentheses next to each market characteristic. On average, companies perceived a high competitive pressure within their industries, scoring higher than the midpoint of the scale (3) on each of the five characteristics. Competitive rivalry within industry received the highest score, followed by the high perceived bargaining power of customers.

Figure 11. Perceived characteristics of the business environment (1-5 scale)



In a highly competitive industry it is also important to explore the strategies pursued by manufacturing companies. Respondents were asked to rate the importance in the last three years of several different attributes in winning the orders from their major customers. The importance of strategic goals was measured on a 1-5 Likert scale, ranging from "Not important" (1) to "Very important" (5). Average scores are illustrated on Figure 12. Results indicate that the most important attributes in winning the orders from customers are related to flexibility (greater order size flexibility), quality (better product design and quality, better conformance to customer specifications) and delivery (faster deliveries). The top ranking of order size flexibility is not surprising during the years of economic crisis, where companies had to adapt their systems to the increased variance in market demand. On the other hand, product customization, environmental responsibility and social responsibility are the lowest ranking factors among the possible order winners.

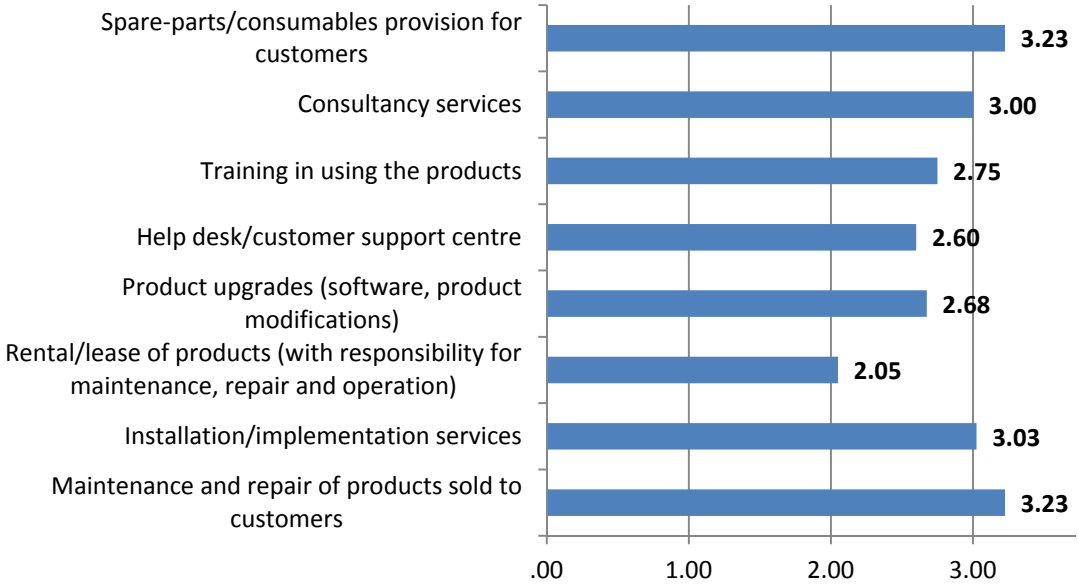
Figure 12. Strategic goals of manufacturing – the importance in the last three years of different attributes in winning the orders from major customers



Beside strategic goals, another important aspect of strategic initiatives of manufacturing plants has been investigated in detail, namely servitization. Servitization refers to the process of adding more and more services to their products sold with the objective to create bundles that offer a complete solution to customers' problems. First, respondents had to indicate on a 1-5 Likert scale to what extent different types of services are offered alongside with the core products manufactured. Average results are summarized on Figure 13. The most frequent services offered by manufacturers are basic product related services: spare-parts/consumables provision for customers, and maintenance and repair of products sold to customers. These are closely followed by installation/implementa-

tion services and consultancy services. The lowest score is clearly received by the rental/lease of products (with responsibility for maintenance, repair and operation), suggesting that manufacturers are rarely involved in coupling their products with more sophisticated financial constructions which might also imply a different approach to the sales of products (selling products versus selling useful functioning of products).

Figure 13. The extent of different services offered by manufacturing plants



In respect of the financial consequences of servitization respondents had to indicate the percentage of annual sales attributable to services compared physical goods, including assembled products, and parts and components. Table 23 illustrates these figures. On average, more

than 15% of annual sales are coming from the sales of services. The highest share is still possessed by products, followed by parts and components. The table also illustrates the minimum and maximum percentages for each category. It is worth noting that the highest share of services in total sales reaches as high as 70%.

Table 23. Percentage share of services in annual sales compared to parts, components and assembled products

Sales type	Pct. of annual sales	Min.	Max.
Parts and components	36.90%	0%	100%
Assembled products	47.82%	0%	100%
Services	15.28%	0%	70%

Another important strategic aspect of manufacturing is the way a manufacturing plant is organized in respect of human resource management. Respondent manufacturing plants had indicated, on average, to have 4.08 organizational levels (from plant managers to workers inclusive). The lowest figure indicated was 2, while the highest was 7 organizational levels.

The number and the distribution of blue collar workers in terms of type of employment and teamwork is illustrated in Table 24. The average number of blue collar workers is 123.1 compared to the number of 146.2 which is the average total number of employees at respondent companies. The vast majority (89.35%) of the blue collar workers are permanently employed. More than half of these workers are working in functional teams, and an additional 36.6% in cross-functional teams.

Table 24. The number and distribution of blue collar workers of the respondent plants

	Mean	Min	Max
Number of blue collar workers	123.1	4	520
Employment			
permanent workers	89.35%	40%	100%
temporary workers	10.65%	0%	60%
Teamwork			
working in functional teams	51.55%	0%	100%
working in cross-functional teams	36.61%	0%	100%

Regarding the size of teams, the IMSS questionnaire also enquired about the average number of workers under the responsibility of one line supervisor. Results are detailed in Table 25. Average values are around 20 workers, however with a high variation in these numbers, ranging from 0 to 68.

Table 25. Average number of workers under the responsibility of one line supervisor

	Mean	St. dev.	Min	Max
In fabrication	21.5	16.9	0	60
In assembly	19.0	18.1	0	68

In respect of the workers' compensation, on average, 14.58% of their salaries are based on individual incentives, while a further 13.31% on work group incentives. Values range in both cases from 0% to 80%. On average, 24.08 hours of training per year are given to regular workers, values ranging from 0 hours to 250 hours per worker per year.

5.3. Manufacturing practices

An important part of the IMSS research project is to identify manufacturing practices used by manufacturing plants all over the world. Thus, the questionnaire contains more than 50 items that enquires about (1) the current level of implementation, and (2) the efforts undertaken in the last three years to implement different manufacturing practices. These practices are grouped into ten different categories based on the manufacturing or management area they are targeted at. Each of these manufacturing practice categories contains several action programs that are aimed to increase the performance and competitiveness of manufacturing firms. Practice categories and examples of corresponding action programs are presented in the following list, while each practice category is presented in more detail in the following subsections:

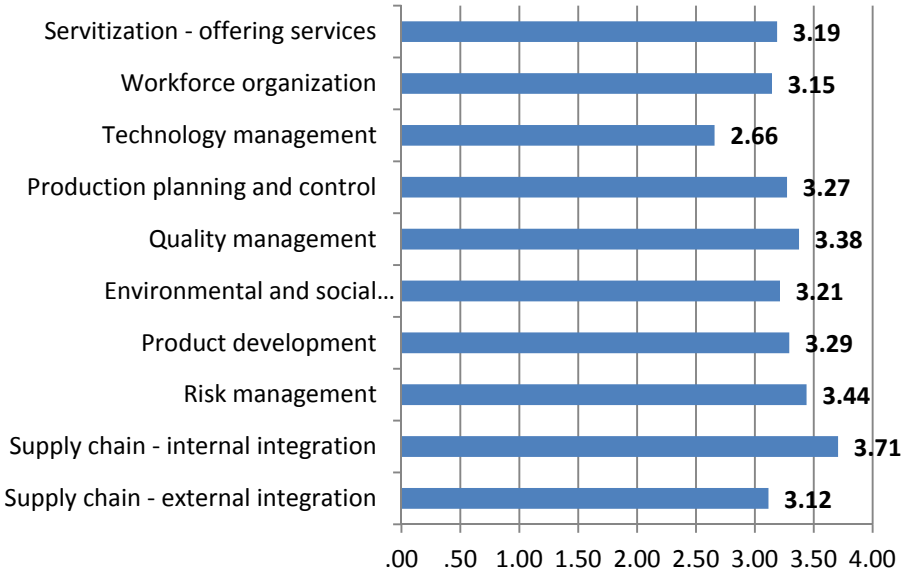
- *Servitization*: action programs targeted at the expansion of service offering or improving the process of offering services
- *Workforce organization*: including programs like increasing the delegation and knowledge of the workforce, improving communication between managers and workers, creating autonomous teams, improving workforce flexibility etc.
- *Technology management*: improving the level of manufacturing technologies used
- *Production planning and control*: improving the methods used for the planning and control of manufacturing activities
- *Quality management*: improving the methods used in quality control and improvement
- *Environmental and social sustainability*: engaging in environmental and social responsibility actions

- *Product development*: improving the methods used in the process of (new) product development, for example the better integration of product development and manufacturing, standardizing product development processes, improving the communication technologies used in product development etc.
- *Risk management*: implementing action programs to prevent, detect, respond to, and recover from operational risks
- *Supply chain – internal integration*: action programs aimed at improving the information sharing between, and joint decision making of, the manufacturing department on one hand, and the sales and purchasing departments on the other hand
- *Supply chain – external integration*: action programs aimed at improving the information sharing and joint decision making with suppliers and customers

For each category of practices the average score on the current level of implementation (see Figure 14), and on the efforts undertaken in the last three years to implement (see Figure 15) individual practices has been computed. Both the level of implementation and the effort to implement practices were measured on a 1-5 Likert scale, ranging from “None” (1) to “High” (5).

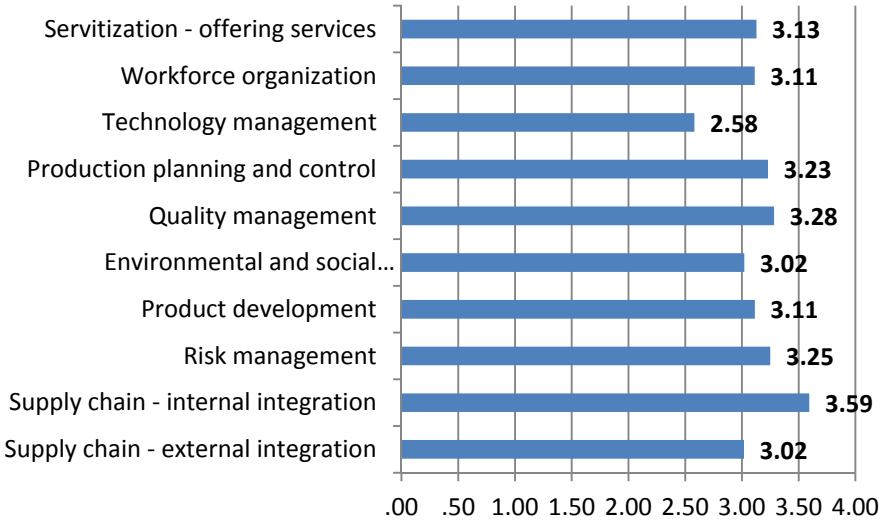
Romanian manufacturing plants indicated that the internal integration practices with the purchasing and selling department are implemented on the highest level among all possible practice categories, followed by risk management and quality management. Technology management has clearly received the lowest score among implemented manufacturing practices, indicating that there is still much room for to improve to reach a high technology manufacturing.

Figure 14. The current level of implementation of broad manufacturing practice categories



Efforts undertaken to implement manufacturing practices have a very high correlation with the current level of implementation, which indicated that the highest level has been reached in those areas in which the highest effort was invested in the last three years. In concordance, the highest effort was invested in internal integration practices in relation with supply chain activities, followed by quality management, risk management and production planning and control techniques. The lowest effort was invested in technology management related practices.

Figure 15. Average effort undertaken in the last three years to implement manufacturing practice categories



5.3.1. Servitization

The IMSS questionnaire enquired about three different action programs that aim at extending the service portfolio and at improving the service offering of the company. Both the level of implementation and the effort to implement servitization practices were measured on a 1-5 Likert scale, ranging from "None" (1) to "High" (5). The three servitization related action programs are:

- Expanding the service offering to customers (e.g. by investing in new service development)
- Developing the skills needed to improve the service offering
- Designing products so that the after sales service is easier to manage/offer (e.g. design for maintenance)

Figure 16 and Figure 17 illustrate the average scores of the Romanian sample.

Figure 16. The current level of implementation of servitization related manufacturing practices

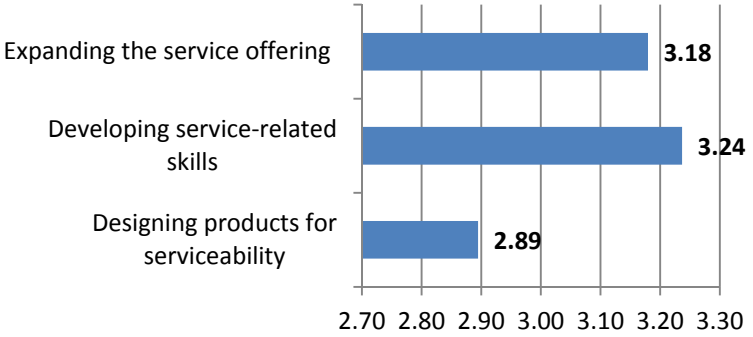


Figure 17. Average values of efforts undertaken in the last three years to implement servitization related practices

The highest effort was invested in the last three years in developing the the skills needed to improve the service offering, and, accordingly, this area has the highest level of current implementation. Actions undertaken to expand the service offering are slightly above the mid-point of the scale in both respects. On the other hand,

designing the products so that the after sales service is easier to manage/offer is at a low level of current implementation, despite the somewhat higher efforts undertaken in the last three years to improve this aspect. These efforts, however, are still at the lowest level compared to the other two types of practices.

5.3.2. Workforce organization

The IMSS questionnaire enquired about seven different action programs that aim at improving the knowledge, flexibility and organization of the workforce. Both the level of implementation and the effort to implement servitization practices were measured on a 1-5 Likert scale, ranging from “None” (1) to “High” (5). The seven workforce related action programs are:

- Delegation and knowledge of workers (e.g. empowerment, training, encouraging solutions to work related problems, pay for competence or incentives for improvement results)
- Open communication between workers and managers (information sharing, encouraging bottom-up open communication, two-way communication flows)
- Lean organization (e.g. few hierarchical levels and broad span of control)
- Continuous improvement programs through systematic initiatives (e.g. kaizen, improvement teams, improvement incentives)
- Autonomous teams (e.g. teams responsible for planning, execution and control, workers sharing experience, knowledge and skills, formalization of team composition and responsibilities, work group incentives)
- Workers flexibility (e.g. multi-tasking, multi-skilling, job rotation)
- Use of flexible forms of work (e.g. temporary workers, part time, job sharing, variable working hours)

Figure 18 and Figure 17 illustrate the average scores of the Romanian sample.

Figure 18. The current level of implementation of workforce organization practices

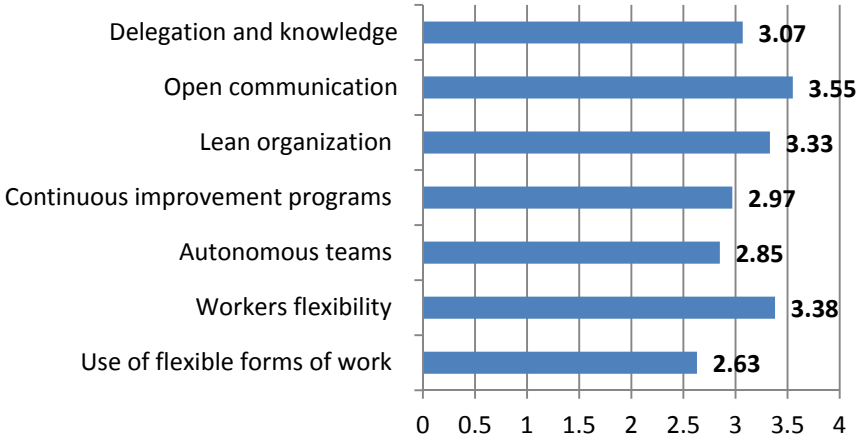
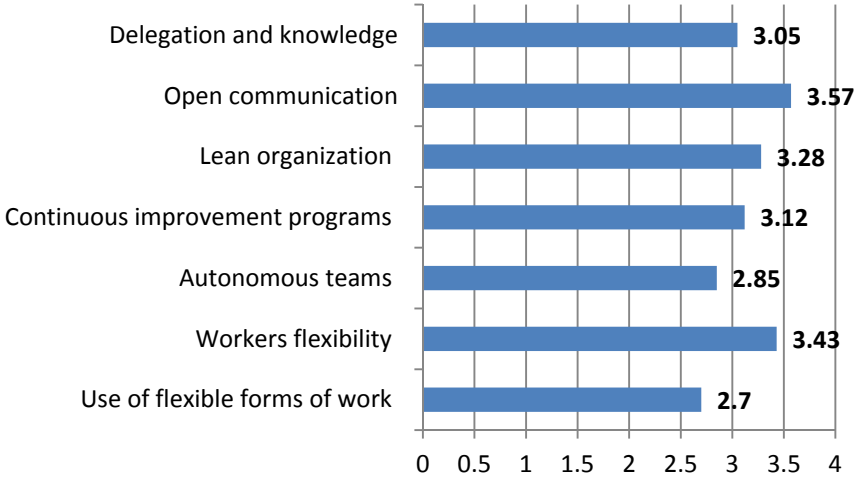


Figure 19. Average values of efforts undertaken in the last three years to implement workforce organization practices



Respondents considered that the three most highly implemented action programs were the improvement of open communication between workers and managers, workers flexibility and the development of a lean organization. Accordingly, the implementation of these three action programs has been in the focus in the last three years. The use of flexible forms of work (e.g. temporary workers, part time, job sharing, variable working hours), however, received the lowest scores in both respect. Similarly, autonomous teams were not preferred by respondents either.

5.3.3. Technology management

IMSS questions related to technology management referred to the dominant activity of the plant (since often even a single plant may perform a variety of very different manufacturing activities, respondents are requested to consider the "dominant activity of the plant", i.e. the activity, which is considered to best represent the plant). The questionnaire also enquired about the complexity of the dominant activity of manufacturing plants. Results are detailed in Table 26. Respondents indicated that, on average, they manufacture rather complex products that contain many parts and material types, where production requires many different steps.

Table 26. The complexity of the dominant activity of the plant (1-5 scale)

	Mean	St. dev.
Modular product design (1) vs. Integrated product design (5)	3.18	1.275
Very few parts/materials, one-line bill of material (1) vs. Many parts/materials, complex bill of material (5)	3.68	1.016
Very few steps/operations required (1) vs. Many steps/operations required (5)	3.56	.940

The IMSS questionnaire enquired about three different action programs that aim at improving the level of manufacturing technology. Both the level of implementation and the effort to implement technology management practices were measured on a 1-5 Likert scale, ranging from “None” (1) to “High” (5). The three technology management action programs are:

- Use of advanced processes, such as laser and water cutting, 3D printing, high precision technologies
- Development towards “the factory of the future” (e.g. smart/digital factory, adaptive manufacturing systems, scalable manufacturing)
- Engaging in process automation programs (e.g. automated machine tools and handling/transportation equipment, robots).

Figure 20 and Figure 21 illustrate the average scores of the Romanian sample.

Figure 20. The current level of implementation of technology improvement practices

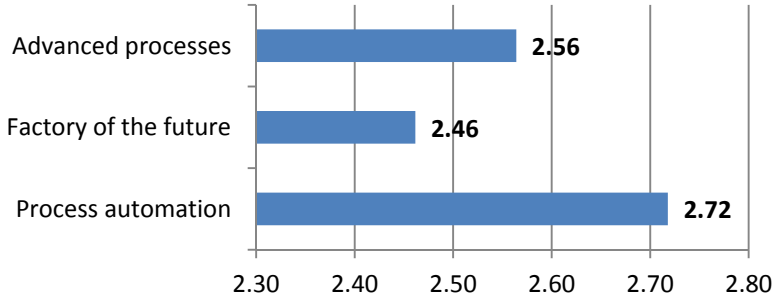
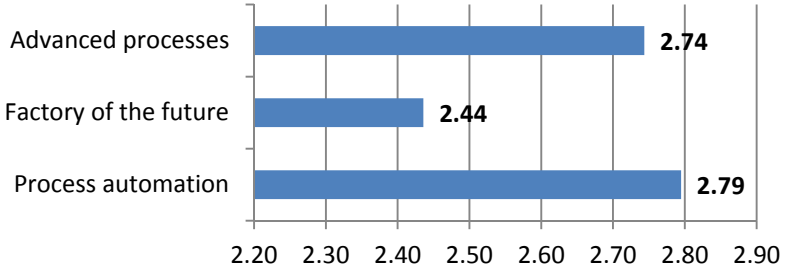


Figure 21. Average values of efforts undertaken in the last three years to implement technology improvement practices



All three technology management practices are implemented only to a lower extent, none of them reaching the midpoint of the 1-5 scale. Process automation seems to be the most popular among the three practices, while the "factory of the future" concept seems to be still unused by respondent manufacturing plants. Relatively high effort was undertaken to implement advanced processes, but their level is still quite low, leaving much room for future improvement.

5.3.4. Production planning and control

The IMSS questionnaire enquired about six different methods that can be used to manage fluctuations in customer demand. The degree of use of these methods was measured on a 1-5 Likert scale, ranging from “None” (1) to “High” (5). Average scores are presented in.

Table 27. The average degree of use of methods to manage demand fluctuations

Method	Mean	St. dev.
Slack and redundancies (e.g. inventories, equipment overcapacity)	2.56	1.142
Change the balance between outsourcing and insourcing of production	2.83	1.196
Workforce flexibility (e.g. flexible working hours, temporary workers, overtime, lay-off)	3.43	1.152
Adjust ordering policies (MTO, MTS, etc.) and warehousing levels to demand changes	3.18	1.083
Eliminate or reduce the need for adjustments in system capacity (level production)	3.05	1.085
Demand management (change in prices, promised delivery times, customer service)	3.20	1.114

Demand fluctuations are most frequently managed with workforce flexibility, including flexible working hours, temporary workers, overtime, lay-off etc. Demand management techniques and adjusting ordering policies receive a high score as well. Slacks and redundancies, including inventories and equipment overcapacity, are the most infrequent methods applied, probably due to the high costs attached to them.

Additionally, the IMSS questionnaire enquired about five different action programs that aim at improving production planning and control methods. Both the level of implementation and the effort to

implement production planning and control practices were measured on a 1-5 Likert scale, ranging from “None” (1) to “High” (5). The five production planning and control programs are:

- Restructuring manufacturing processes and layout to obtain process focus and streamlining (e.g. reorganize plant-within-a-plant; cellular layout)
- Undertaking actions to implement pull production (e.g. reducing batches, setup time, using kanban systems)
- Improving forecasting and planning accuracy (methods, software, frequency…)
- Increasing information integration (monitoring and control the processes in real time by a dedicated information system)
- Engaging in product/part tracking and tracing programs (bar codes, RFID)

Figure 22 and Figure 23 illustrate the average scores of the Romanian sample.

Figure 22. The current level of implementation of production planning and control practices

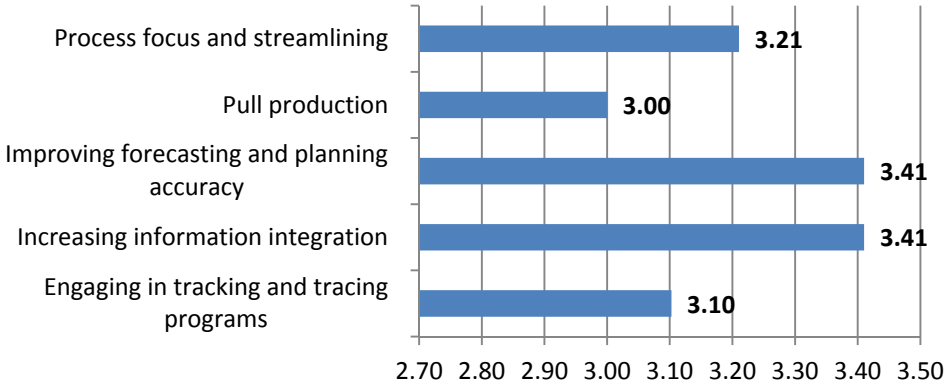
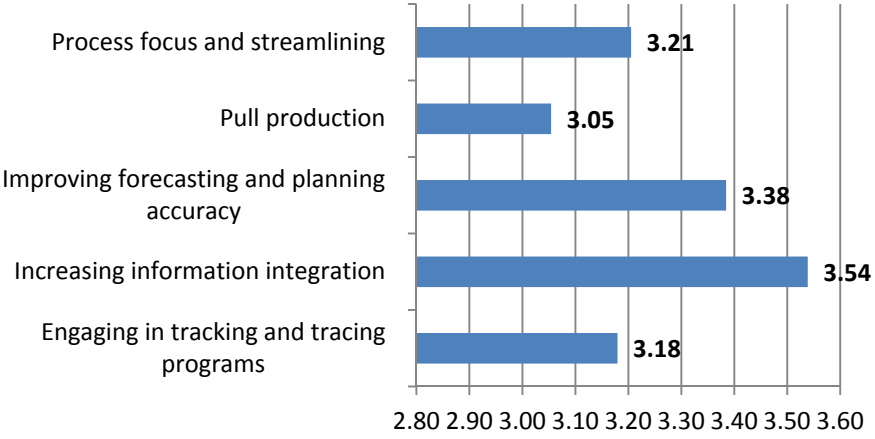


Figure 23. Average values of efforts undertaken in the last three years to of production planning and control practices



The most efforts undertaken in the last three years were targeted at improving the information systems to increase information inte-

gration, reaching a high level of current implementation. A similarly high level was reached in case of forecasting and planning systems with somewhat lower efforts. The lowest scores on both measures were reached in respect of pull production and tracking and tracing programs.

5.3.5. Quality management

The IMSS questionnaire enquired about three different action programs that aim at improving the quality of production. Both the level of implementation and the effort to implement quality management practices were measured on a 1-5 Likert scale, ranging from “None” (1) to “High” (5). The three quality related action programs are:

- Quality improvement and control (e.g. TQM programs, six sigma projects, quality circles)
- Improving equipment availability (e.g. Total Productive Maintenance programs)
- Benchmarking/self-assessment (e.g. quality awards, EFQM model)

Figure 24 and Figure 25 illustrate the average scores of the Romanian sample.

Figure 24. The current level of implementation of quality management practices

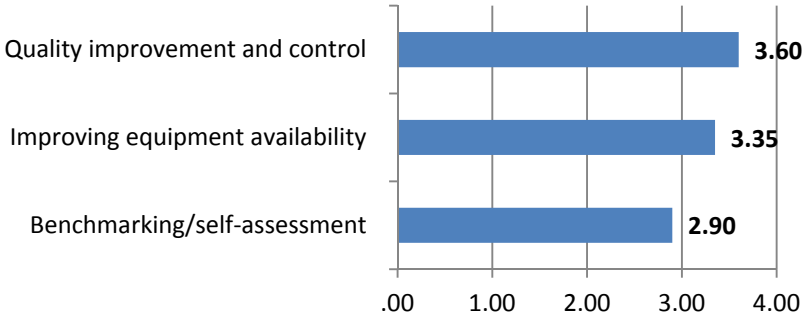
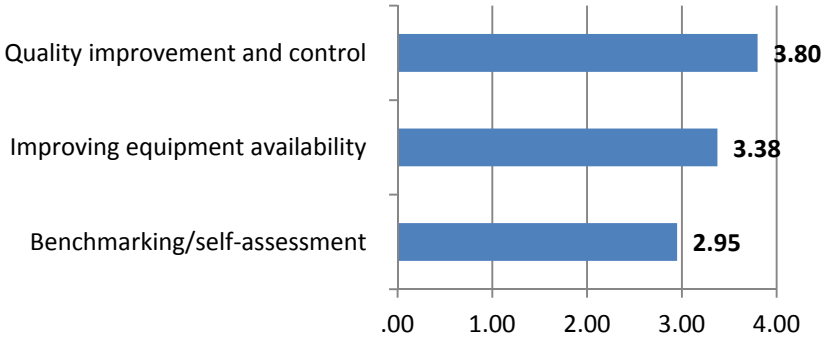


Figure 25. Average values of efforts undertaken in the last three years to implement quality management practices



Average responses indicate that respondents invest the highest effort in implementing quality improvement and control programs, and also reach the highest level of implementation in case of this area. Benchmarking/self-assessment techniques are below the mid-point of the 1-5 scale both in respect of effort and in respect of the current level of implementation.

5.3.6. Environmental and social sustainability

The IMSS questionnaire enquired about ten different action programs that aim at improving environmental and social sustainability management related to the dominant activity of manufacturing plants. Both the level of implementation and the effort to implement sustainability management practices were measured on a 1-5 Likert scale, ranging from "None" (1) to "High" (5). The ten sustainability management action programs are:

- Environmental certifications (e.g. EMAS or ISO 14001)
- Social certifications (e.g. SA8000 or OHSAS 18000)
- Formal sustainability oriented communication, training programs and involvement
- Energy and water consumption reduction programs
- Pollution emission reduction and waste recycling programs
- Formal occupational health and safety management system
- Work/life balance policies
- Suppliers' sustainability performance assessment through formal evaluation, monitoring and auditing using established guidelines and procedures
- Training/education in sustainability issues for suppliers' personnel
- Joint efforts with suppliers to improve their sustainability performance

Figure 26 and Figure 27 illustrate the average scores of the Romanian sample.

Figure 26. The current level of implementation of sustainability management practices

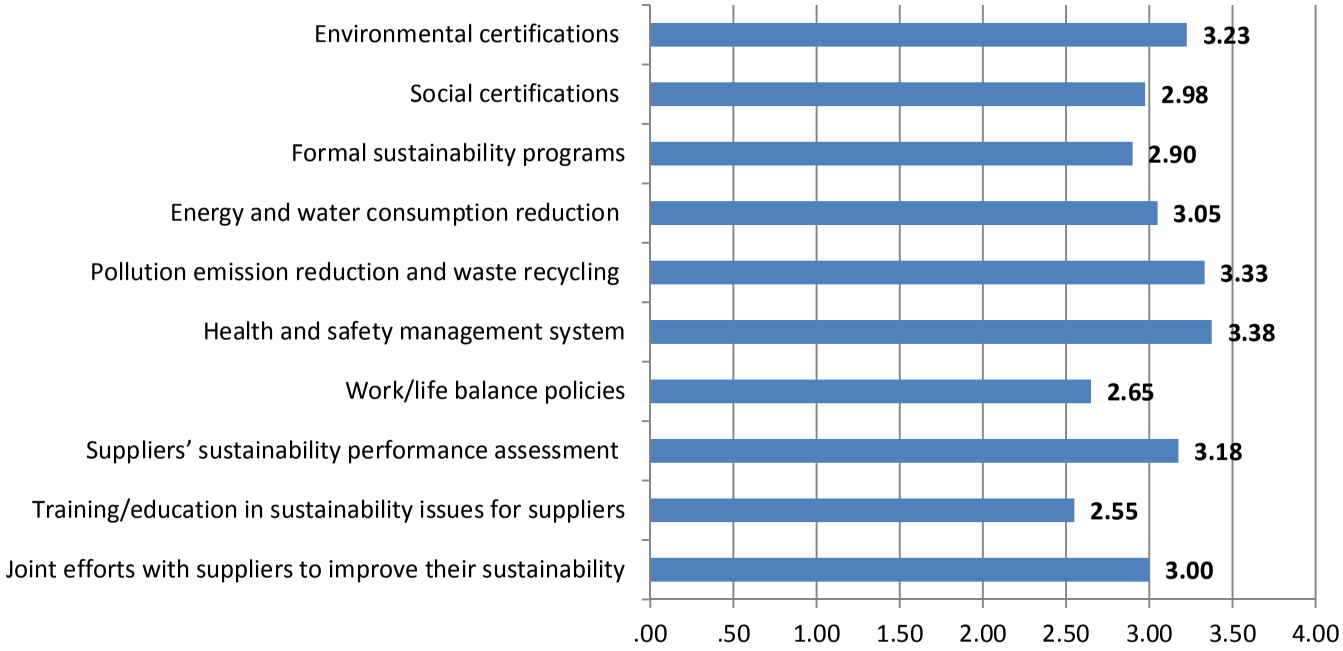
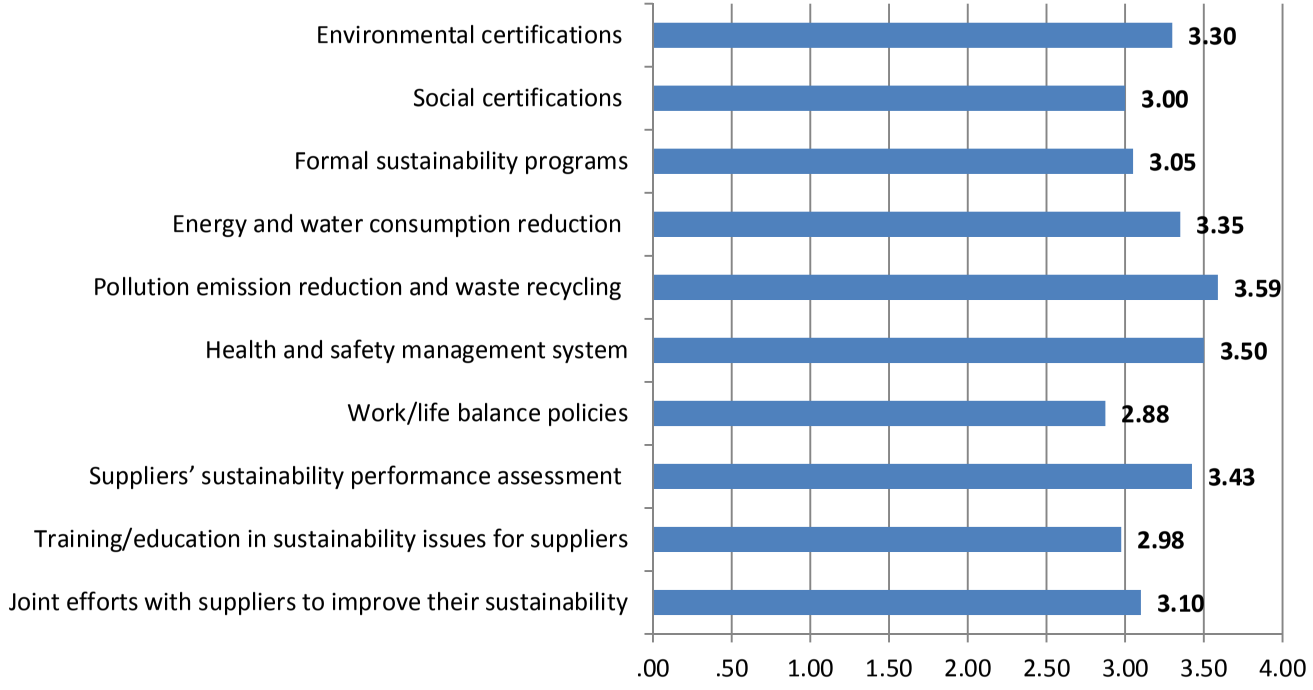


Figure 27. Average values of efforts undertaken in the last three years to implement sustainability management practices



Respondent manufacturing plants have invested the highest effort in pollution emission reduction and waste recycling programs, and in implementing formal occupational health and safety management system, reaching the highest level of implementation in respect of these programs compared to other sustainability management practices.

5.3.7. Product development

The IMSS questionnaire enquired about seven different action programs that aim at improving product development activities. Both the level of implementation and the effort to implement product development practices were measured on a 1-5 Likert scale, ranging from “None” (1) to “High” (5). The seven product development action programs are:

- Informal mechanisms, such as direct, face-to-face communication, informal discussions, ad-hoc meetings
- Design integration between product development and manufacturing through e.g. platform design, standardization and modularization, design for manufacturing, design for assembly
- Organizational integration between product development and manufacturing through e.g. cross-functional teams, job rotation, co-location, role combination, secondment and coordinating managers
- Technological integration between product development and manufacturing through e.g. CAD-CAM, CAPP, CAE, Product Lifecycle Management
- Integrating tools and techniques, such as Failure Mode and Effect Analysis, Quality Function Deployment, and Rapid Prototyping

- Communication technologies such as teleconferencing, web-meetings, intranet and social media
- Forms of process standardization, such as a stage-gate process, design reviews and performance management

Figure 28 and Figure 29 illustrate the average scores of the Romanian sample.

Figure 28. The current level of implementation of product development practices

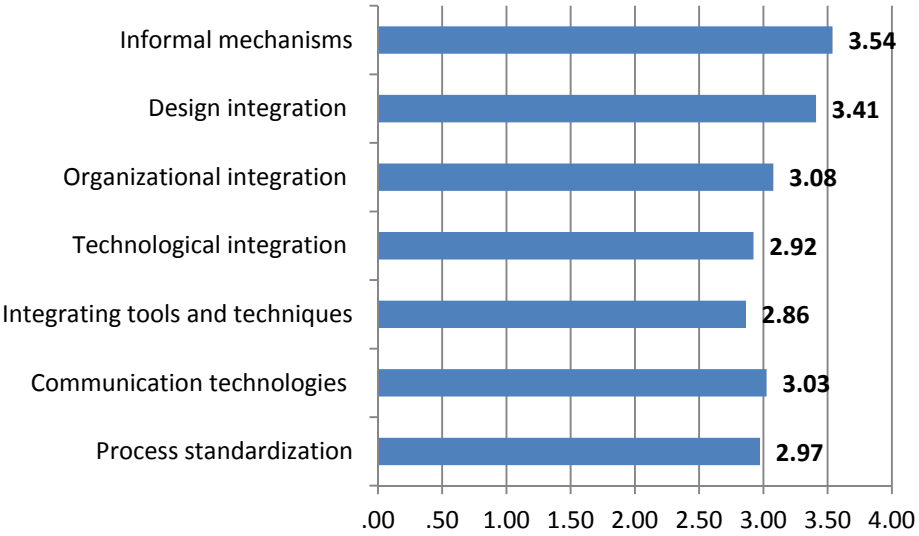
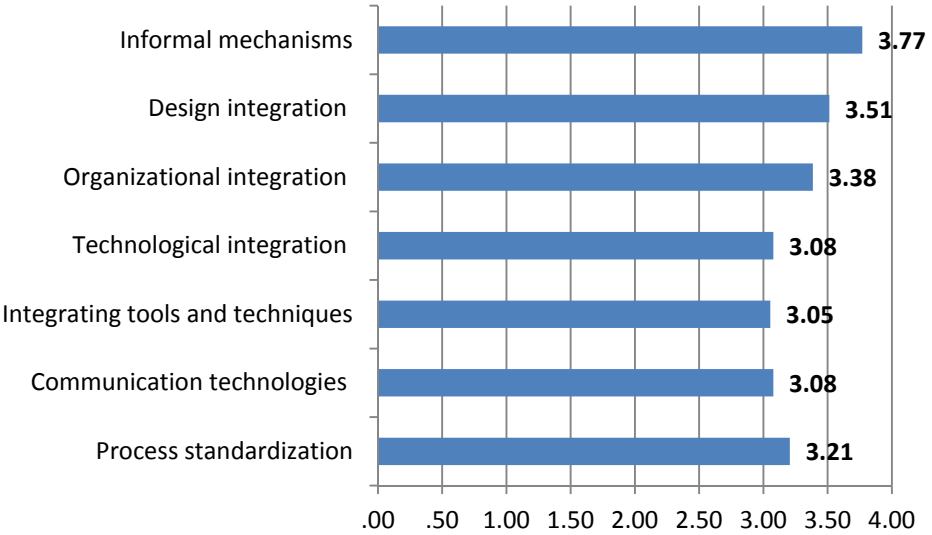


Figure 29. Average values of efforts undertaken in the last three years to implement product development practices



Average scores indicate that informal mechanism received the highest attention in the last three years in product development related activities, and in the same time they are the mostly implemented practice in this area. Technology related methods (technological integration, integrating tools and techniques, communication technologies) received a lower attention, and are currently on a lower level of implementation.

5.3.8. Risk management

In respect of risk management activities the IMSS questionnaire aimed at assessing the probability and impact of different risk factors related to purchasing, manufacturing, and distribution. Results are detailed in Table 28.

Table 28. The average probability and impact of different risk factors in operations

Risk factor	Probability of occurrence		Impact	
	Mean	St. dev.	Mean	St. dev.
A key supplier fails to supply affecting your operations	2.41	1.117	3.36	1.088
Your manufacturing operations are interrupted affecting your shipments	2.13	1.105	3.18	1.211
Your shipment operations are interrupted affecting your deliveries	2.11	1.226	2.97	1.305

Average figures indicate that the overall probability of occurrence of different risk factors is considered quite low by the respondents. The highest score is attached to the risk of supply disruption. On the other hand, the possible impact of risk factors is considered much higher, with the highest score being attached similarly to the risk of supply disruption.

The IMSS questionnaire also enquired about four different action programs that aim at improving risk management activities at respondent manufacturing plants. Both the level of implementation and the effort to implement risk management practices were

measured on a 1-5 Likert scale, ranging from “None” (1) to “High” (5). The four risk management action programs are:

- Preventing operations risks (e.g. select a more reliable supplier, use clear safety procedures, preventive maintenance)
- Detecting operations risks (e.g. internal or supplier monitoring, inspection, tracking)
- Responding to operations risks (e.g. backup suppliers, extra capacity, alternative transportation modes)
- Recovering from operations risks (e.g. task forces, contingency plans, clear responsibility)

Figure 30 and Figure 31 illustrate the average scores of the Romanian sample.

Figure 30. The current level of implementation of risk management practices

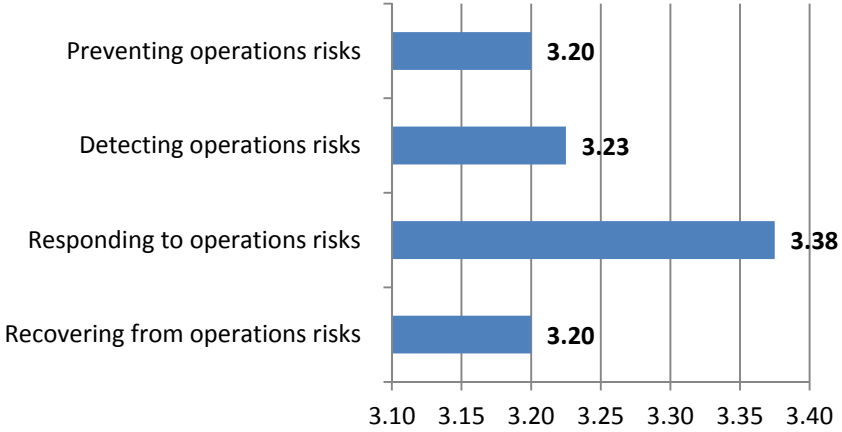
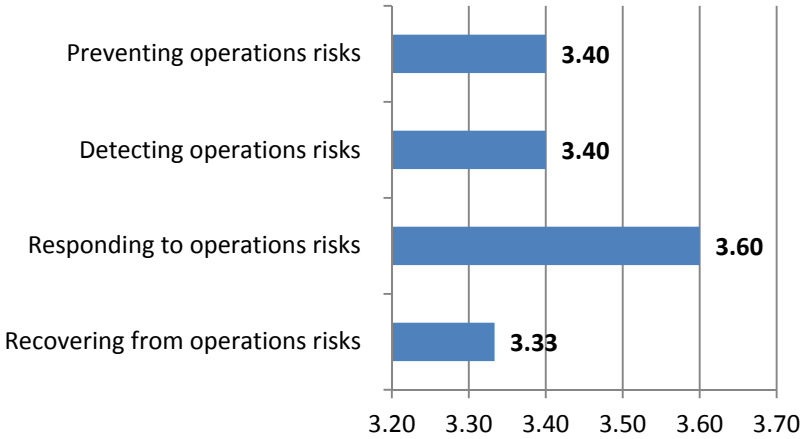


Figure 31. Average values of efforts undertaken in the last three years to implement risk management practices



Respondents indicated a high level of effort undertaken to implement risk management practices. The highest level was reached in case of

practices aimed at responding to operations risks. Accordingly, respondent manufacturing plants consider that they have already reached a quite high level of implementation of risk management practices, although there is still some room for further improvement.

5.3.9. Supply chain management

The IMSS questionnaire enquired about internal and external supply chain practices. The first category refers to programs targeted at the internal purchasing and sales department, while the second category is related to the external suppliers and customers of the manufacturing plant.

The questionnaire asked about four different action programs aimed at improving internal supply chain activities. Both the level of implementation and the effort to implement internal supply chain management practices were measured on a 1-5 Likert scale, ranging from “None” (1) to “High” (5). The four internal supply chain action programs are:

- Sharing information with purchasing department (about sales forecast, production plans, production progress and stock level)
- Joint decision making with purchasing department (about sales forecast, production plans and stock level)
- Sharing information with sales department (about sales forecast, production plans, production progress and stock level)
- Joint decision making with sales department (about sales forecast, production plans and stock level)

Figure 32 and 33 illustrate the average scores of the Romanian sample.

Figure 32. The current level of implementation of internal supply chain management practices

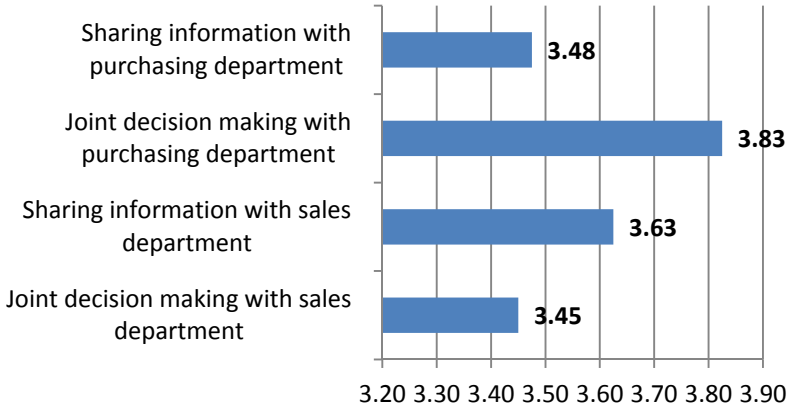
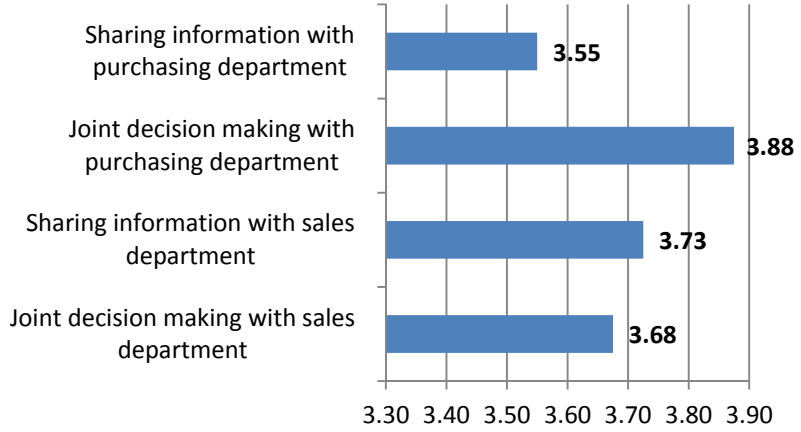


Figure 33. Average values of efforts undertaken in the last three years to implement internal supply chain management practices



Joint decision making with the purchasing department seems to have received the highest level of implementation efforts, and is

currently used the most intensively among internal supply chain management action programs. Joint decision making with the purchasing department seems to receive higher scores than joint decision making with the sales department both in respect of the current level of implementation, and in respect of past efforts undertaken. On the other hand, sharing information with the purchasing department is more uncommon than in the case of the sales department.

In respect of external supply chain management, the questionnaire asked about ten different action programs. Both the level of implementation and the effort to implement internal supply chain management practices were measured on a 1-5 Likert scale, ranging from “None” (1) to “High” (5). The ten external supply chain action programs are:

- Sharing information with key suppliers (about sales forecast, production plans, order tracking and tracing, delivery status, stock level)
- Developing collaborative approaches with key suppliers (e.g. supplier development, risk/revenue sharing, long-term agreements)
- Joint decision making with key suppliers (about product design/modifications, process design/modifications, quality improvement and cost control)
- System coupling with key suppliers (e.g. vendor managed inventory, just-in-time, Kanban, continuous replenishment)
- Developing an international sourcing strategy (e.g. supplier scouting at the international level, develop an international purchasing office)

- Sharing information with key customers (about sales forecast, production plans, order tracking and tracing, delivery status, stock level)
- Developing collaborative approaches with key customers (e.g. risk/revenue sharing, long-term agreements)
- System coupling with key customers (e.g. vendor managed inventory, just-in-time, Kanban, continuous replenishment)
- Joint decision making with key customers (about product design/modifications, process design/modifications, quality improvement and cost control)
- Developing an international distribution strategy (e.g., open foreign sales office, develop an international distribution network)

Figure 34 and Figure 35 illustrate the average scores of the Romanian sample.

Figure 34. The current level of implementation of external supply chain management practices

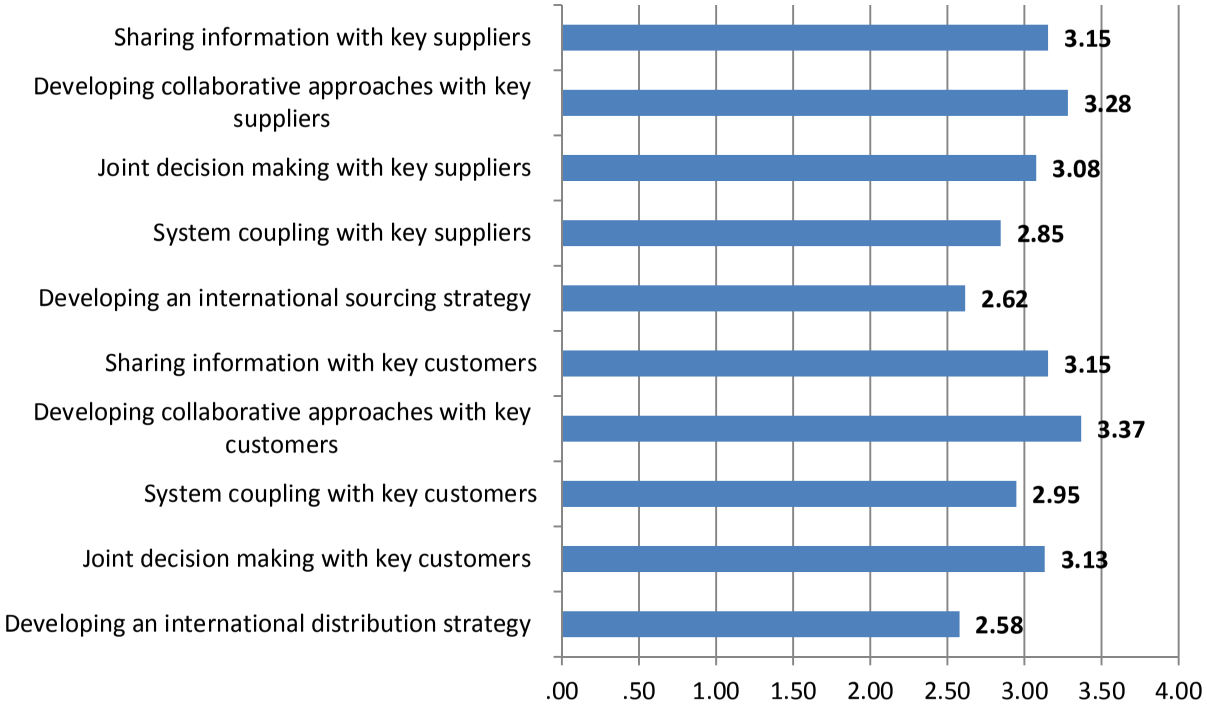
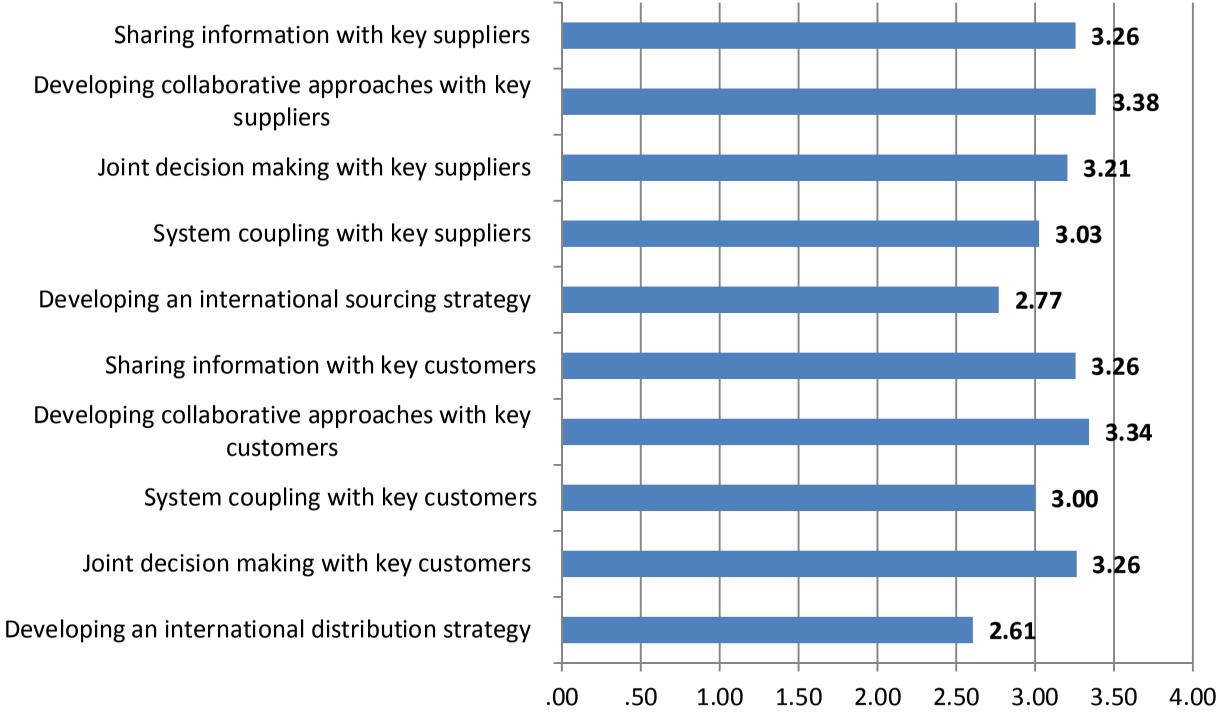


Figure 35. Average values of efforts undertaken in the last three years to implement external supply chain management practices



Collaborative approaches with both suppliers and customers received the highest attention in the last three years, and reached a high level of implementation accordingly. Some other external supply chain management practices (sharing information with suppliers and customers, joint decision making with suppliers and customers) received similarly high scores both in respect of past efforts and in respect of current implementation level. The lowest scores were attached to the development of an international sourcing or distribution strategy.

5.4. Manufacturing performance

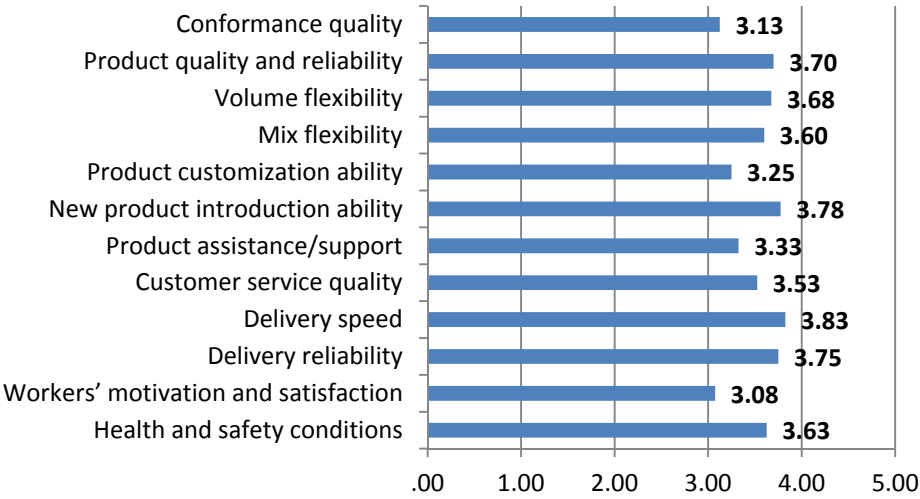
In the IMSS questionnaire manufacturing performance indicators were grouped into two categories: the first one contains measures where higher values represent better indicators (e.g. quality, reliability, flexibility), while the second group contains measures where the lower the value the better the indicator (e.g. costs, delivery time, lead time, energy consumption).

First respondents were asked to rate how their performance has changed in the last three years in several manufacturing areas. To measure change the following 1-5 scale has been used:

- 1 – Decrease (-5% or worse)
- 2 – Stayed about the same (-5%/+5%)
- 3 – Slightly increased (+5-15%)
- 4 – Increased (+15-25%)
- 5 – Strongly increased 25% or better

Average results are detailed on Figure 36.

Figure 36. Manufacturing performance changes in the last three years (1)



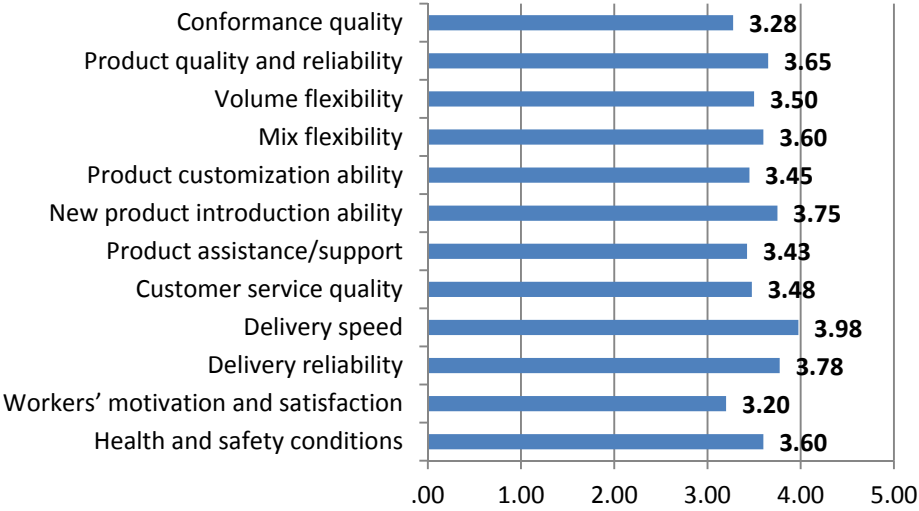
Altogether, high performance improvements have been reported in almost all areas. Highest performance improvements have been achieved in respect of delivery speed, new product introduction ability, delivery reliability and product quality and reliability. Lowest rankings have been achieved by workers' motivation and satisfaction and conformance quality.

Then, on the same set of performance indicators respondents had to indicate how they rate their performance relative to the performance of main competitors. To measure relative performance a 1-5 scale has been used with the following meanings attached to the scale:

- 1 – much lower
- 2 – lower
- 3 – equal
- 4 – higher
- 5 – much higher

Average results are detailed on Figure 37.

Figure 37. Manufacturing performances compared to main competitors (1)



On average, respondents indicated a better performance relative to competitors in all performance areas, all mean values exceeding the mid-point of the 1-5 scale. The highest rankings have been achieved in case of delivery speed, delivery reliability and new product introduction ability.

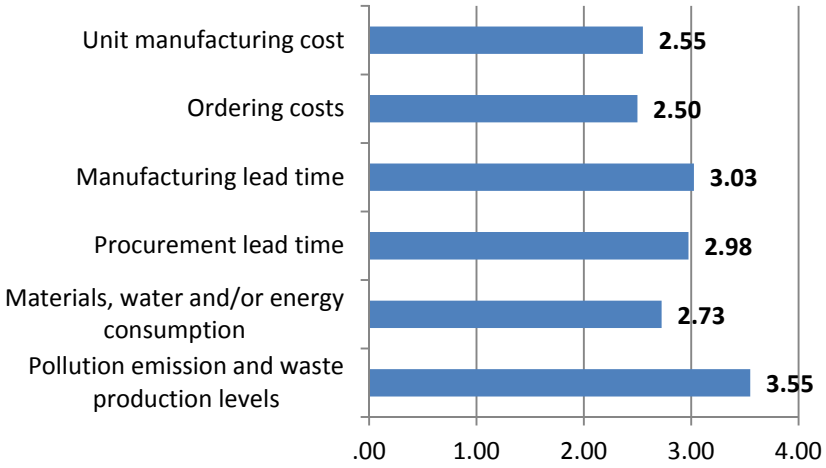
Following the first set of performance indicators, the same two measures were assessed on the second set of performance indicators containing measures where higher values represent better indicators. To measure how the performance of respondent manufacturing plants has changed in the last three years in the second set of manufacturing performance areas a reversed 1-5 scale has been used:

- 1 – Increased (+5% or more)
- 2 – Stayed about the same (+5%/-5%)
- 3 – Slightly decreased (-5/-15%)

- 4 – Decreased (-15/-25%)
- 5 – Strongly decreased (-25% or more)

Average results are detailed on Figure 38.

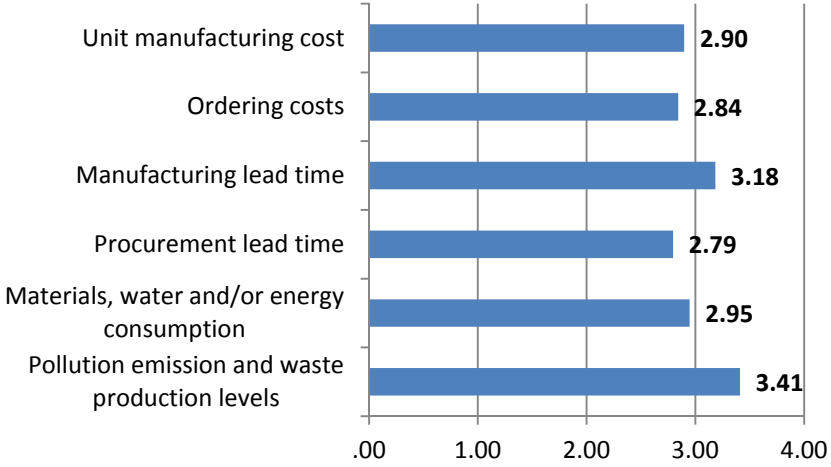
Figure 38. Manufacturing performance changes in the last three years (2)



Respondents indicated that the highest improvement in the last three years has been achieved in case of pollution emission and waste reduction. All other performance indicators have been only slightly improved.

Similarly to the previous set of indicators, respondents had to indicate for the second set of measures as well how they rate their performance relative to that of main competitors. To measure relative performance a similar 1-5 scale has been used than in the previous case. Average results are detailed on Figure 39.

Figure 39. Manufacturing performances compared to main competitors (2)



Respondents rated their performance to exceed that of competitors, the highest gap being reported in case of pollution emission and waste reduction followed by manufacturing lead time.