REVERSE LOGISTICS

of defective products in management of manufacturing enterprises

Monograph

Marta Starostka-Patyk

Reverse logistics of defective products in management of manufacturing enterprises

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2nd edition, changed, corrected and supplemented

Katowice, 2017

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The monograph is based on the research results of the project financed by National Science Centre in Poland according to the decision no. DEC-2012/07/D/HS4/02071.

The first edition of this book was published in 2016 in Polish language under the title: Logistyka zwrotna produktów niepełnowartościowych w zarządzaniu przedsiębiorstwami produkcyjnymi by Polskie Wydawnictwo Ekonomiczne (PWE) with ISBN 978-83-208-2275-5. The book was reviewed by Prof. dr hab. Ewa Bojar, Prof. dr hab. Czesław Skowronek and Prof. dr hab. Jarosław Witkowski.

Number of publication's sheets – 10.793

ISBN (print): 978-83-65929-00-6

ISBN (e-Book): 978-83-6529-01-3

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Introduction

The concept of logistics management has been functioning in literature of the subject and economic practice for numerous years, and it has developed research methods related to other disciplines of knowledge. The realities of current global economy force the enterprises to consider the sustainable development concept as well. This concept, by assuming sustainability in implementation of economic, social and environmental objectives, exerts impact on the management strategy of contemporary enterprises. This also results from the advancing globalization and the increasing scale of production along with negative phenomena that emerge in the environment and economy, i.e. environmental degradation and depletion of resources. Hence, the sustainable development concept may be sought first of all in strategies adopted by manufacturing enterprises, the operations of which are based on technological processes, distribution and sales, as well as post-sale services and the possibility to manage the final products or reuse of the materials.

The strategies for sustainable development of manufacturing enterprises imply the strive for improvement in operations and acquisition of additional economic and ecological benefits. It is also significant within the strategic operations carried out by the enterprises to develop and maintain the competitive advantage, and to limit the adverse environmental impact exerted by the products and services, reduce the consumption of materials and energy and decrease the amount of waste and emissions.

Therefore, the reverse logistics is embedded into the concept of sustainable development of enterprises.

The analysis of the literature of the subject, both international and Polish, identified a certain mismatch in the approach to the subject of the reverse logistics. In the international literature, the subject of reverse logistics is posed by waste and defective products, while the Polish literature mentions the reverse logistics concept first of all in terms of the waste. The Polish approach results from the fact that the reverse logistics is an environmentally-oriented logistics concept. Thus, its basic objective is to shape the flows of different materials and products in a direction opposite to forward flows, the strive for reduction of the amount of generated waste, to minimization of the adverse impact exerted by the waste on the natural environment and effective use of the waste that are recyclable through management[1].

However, it should be noticed that both the international literature and economic practice have recently pointed to a clear growth in interest with another dimension of the reverse logistics concept, which is related to the defective products' flows emerging in a form of returns. However, the returns may be also related to the products of full value. Then, they are grasped in forward flows, so they do not constitute a subject of reverse logistics. In turn, the returns of defective products, which are often characterized with an advance stage of life or its end, supply the reverse flows. The purpose of this is to use their value or manage them in another

[1] The problems of reverse logistics related to waste were raised in the publication drawn up among other by J. Szołtysek [2009], J. Szołtysek and S. Twaróg [2017], A. Sadowski [2010] and A. Mesjasz-Lech [2012].

form. The value recovery from defective products is an objective for implementation of the reverse logistics processes in manufacturing enterprises. This dimension of the reverse logistics concept is raised in a minor scope in Polish publications[2] as well as in works by authors from the neighboring countries[3].

The strive for ordering the terminology, specifying the essence and determining the practical application of the reverse logistics process related to the defective products in management of manufacturing enterprises have become a premise to raise the topic of this work.

Regarding the scope and terminological complexity level of the themes in question, the following was assumed for the need of drawing up the work:

a) A defective product is each product that is not waste, which however does not meet the quality and/or functional requirements against which it was manufactured, on various stages of its life.
b) The reverse logistics of defective products in management of manufacturing enterprises is brought down in the theoretical part to defective products' flows management in those enterprises[4]. As the defective products' flows management is identified with logistics management, narrowed down in this context to implementation of reverse logistics.
c) In the empirical chapters (3-6) the defective products' flows management is called the reverse logistics of defective products[3].
d) Within the scope of reverse flows of defective products within manufacturing enterprises, these products are subjected to the reverse logistics processes, i.e. gatekeeping, collecting and gathering, controlling and sorting as well as final disposal.
e) Reverse flows of defective products are called the defective products' flows interchangeably with the term of reverse flows[4].

This monograph is of an epistemological and empirical character. Its originality and innovative character are mainly related to the subject of the studies, i.e. the defective products, of the selected research background, i.e. the manufacturing enterprises, and the combination of the reverse logistics concepts with the defective products' flows management.

The main purpose of the monograph is to carry out an analysis and evaluation of the reverse logistics processes in the scope of the defective products' flows management in the Polish manufacturing enterprises.

The performed empirical studies are highly significant, and while supported by the mentioned theory they allowed reaching the main goal, detailed with particular objectives:

[2] The only previous integral academic work raising the issues of reverse logistics of products is related to the clothing industry and empirical studies performed in this scope in the Polish commercial enterprises [Jeszka 2014].
[3] The situation is similar in the Czech Republic, where there are not many authors who undertake these issues, and the research in reverse logistics is carried out by among others R. Skapa [2012], and they refer mainly to the results that the enterprises can obtain by employing those processes.
[4] These terms are identical in the context of this monograph.

1) Determination of new areas of reverse logistics in the manufacturing enterprises;
2) Conceptualization of notions and determination of the scope and specificity of the defective products' flows in the manufacturing enterprises, with specification of the reverse logistics processes as the basis for implementation;
3) Development of a descriptive model of reverse logistics of defective products, and its verification in the researched manufacturing enterprises;
4) Determination and evaluation of interdependencies between description of the defective products' flows in the manufacturing enterprises and results of the reverse logistics;
5) Find out whether the differences in evaluation of the main returns categories and actions of the reverse logistics related to the defective products' flows management are statistically significant in the groups of manufacturing enterprises selected according to the number of their employees.

The monograph employs the research methods that correspond to three field: theoretical, model and empirical. When it comes to the theoretical field, the analysis and synthesis methods for the literature of the topic, based on books and scientific articles in Polish and English. The literature studies allowed systematization of knowledge in the scope of issues discussed in the work. The techniques of literature studies, creative thinking and direct interview were employed in the model field what allowed developing an original descriptive model for the reverse logistics processes related to defective products in manufacturing enterprises. In turn, the empirical field, bearing in mind the need to diagnose the researched sphere in the conditions of the manufacturing sector, the primary data from the survey studies were employed, along with the statistical methods for their development.

The monograph is composed of the introduction, six chapters and a conclusion[5]. The introduction includes a justification for the motives of raising such a topic of the work, along with presentation of its objectives and structure. In the main part of the work, two first chapters include theoretical deliberations, while the remaining chapters cover the performed empirical studies (the fourth chapter additionally refers to the model approach).

The issues from the first two chapters were presented within the theory for manufacturing enterprises management. The first chapter describes the sustainable development concept and its impact on management of contemporary enterprises, especially those manufacturing ones. What is more, the notions of logistics management were discussed, and the reverse logistics concept along with the possibilities of its application in management of enterprises that strive for implementation of the sustainable development priorities were described. In turn, the second chapter is devoted to identification of the reverse logistics, its implementation in enterprises, and its processes in relation to the defective products' flows management. This is where the basis for the theory of forward and reverse flows are

[5] There are also the subject lists and the survey questionnaire included.

presented in the circumstances of the logistics of enterprises. Afterwards, there was the specificity of reverse flows of defective products discussed, and further the reverse logistics was identified in the processual dimensions, supporting the defective products' flows management in enterprises.

The subsequent four chapters pose the research part, based on practices undertaken by the manufacturing enterprises.

The third chapter presents the methodological assumptions and organization of the research process, employed in the empirical studies. The goal of the studies and criteria for the research sample selection in the Polish manufacturing enterprises are demonstrated here. There is also a general discussion of the reverse logistics in the defective products' flows management in the Polish manufacturing enterprises, based on the analysis and interpretation of primary data. The data was acquired as a result of the survey studies performed on a representative sample of the Polish manufacturing enterprises. There were also certain premises for introduction and implementation of the reverse logistics in those enterprises identified.

The fourth chapter covers the issues of reverse logistics of the defective products in a model manner. It presents the organization and operation of reverse logistics in manufacturing enterprises, based on the decisions in the scope of managing its processes. This is where an original descriptive model for the reverse logistics processes was developed in the field of the defective products' flows, which was afterwards verified based on research carried out in a form of a direct interview, in five selected manufacturing enterprises.

The last two chapters present the statistic estimations in the analyzed sphere. The fifth chapter covers the significance of relationships and reverse logistics processes in management of defective products' flows in Polish manufacturing enterprises.

The x^2 measurements and the φ - Yule's coefficient were adopted for that purpose, evaluating particular interdependencies between the factors that determine this management. In turn, the sixth chapter presents the simulations of relationships between the reverse logistics processes in the defective products' flows management, employing the distance weighted least squares smoothing method. By employing the Mann-Whitney U test there were also certain differences between the returns categories and actions in the scope of the defective products' reverse flows management pointed out among groups of the Polish manufacturing enterprises.

The conclusion describes the conclusions drawn from the performed studies. The emphasis was put on the significance of achieved results for the practice of enterprises, especially in the field of formulating recommendations for the managerial staff.

The content of this publication poses one of the main results of the project entitled "*Logistics management of defective products in Polish manufacturing enterprises*" financed by National Science Centre with the decision no. DEC-2012/07/D/HS4/02071, under implementation between 2013 and 2017, a manager of which was the author of this monograph.

THEORETICAL PART – IN TERMS OF MANAGEMENT OF MANUFACTURING ENTERPRISES

1. Logistics aspects in contemporary management

1.1. Sustainable development in the concept of management

Economic conditions and reality that contemporary enterprises are forced to operate in are changing in a highly dynamic manner and are dramatically different from those that dominated a dozen of years or several decades ago. Therefore, the enterprises must be capable of adjusting to the changes that take place, as this adaptation attribute guarantees not only their development but also existence [Lichtarski 2011; Jagoda, Lichtarski 2010]. Thus, the current approach to the matter of enterprises management, which apart of being based on the traditional forward theory, which it derives knowledge and inspiration from, must be complemented and extended on ongoing basis so the enterprises can adjust to the contemporary economy [Nogalski 2007].

Currently, one of the most important challenges that must be faced by the enterprises and various economies is to implement a sustainable development concept. It strives for an integrated economic, social, environmental, spatial as well as institutional and political order [Strezov, Evans, Evans 2017]. This order determines and creates reality by formulating conditions and objectives for all actions in the economic, social and environmental scope [Skowrońska 2009]. Hence, it seems justifiable to refer to the definition of sustainable development.

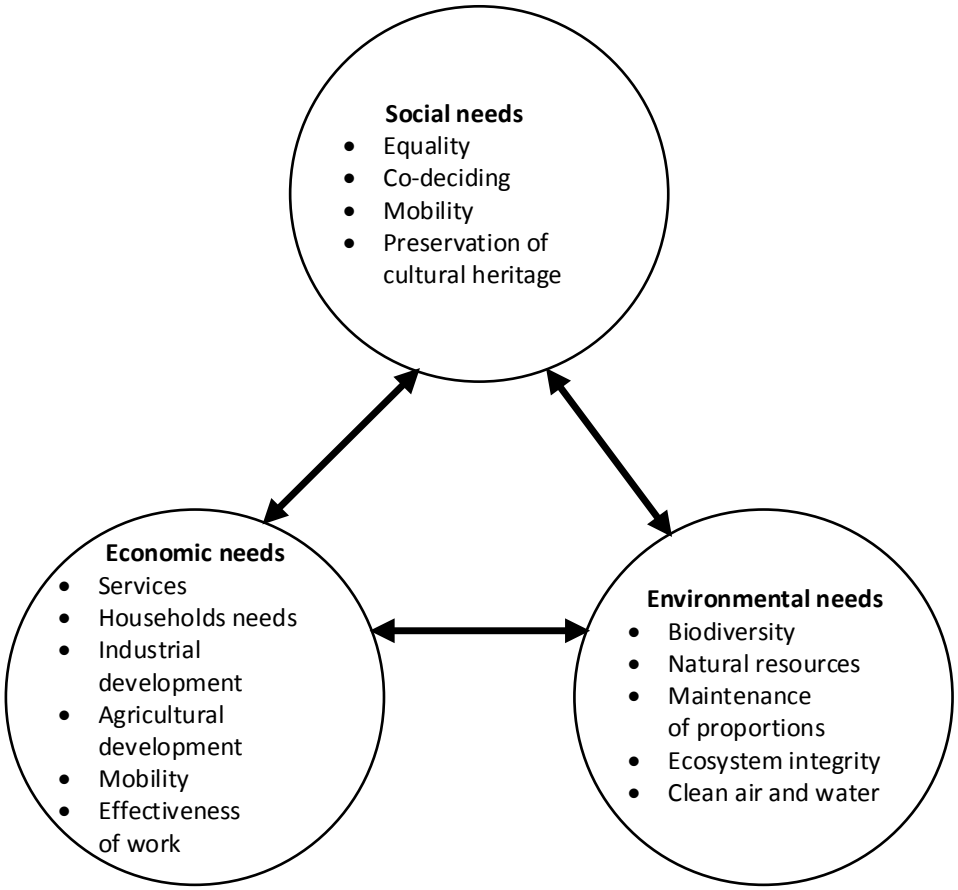
In its basic, statutory definition, it is found out that the sustainable development is such socio-economic development which integrates political, economic and social actions, with preserverance of natural balance and stability of basic natural processes, in order to provide for a possibility to fulfill basic needs of particular communities or citizens, of both the contemporary and future generations [the Act: Environmental Protection Law 2001].

Other definitions can be encountered in the Polish and foreign literature apart that one, as numerous authors provide their own sustainable development definitions [Brand 2015]. Regarding their abundance, it is impossible to cite all of them, and what is more, despite the fact that the definitions differ, the concept stays the same. It is worth mentioning the definition according to which the sustainable development is the strive for maximum benefits from economic growth, at the same time guaranteeing the ability to recreate usefulness and quality of natural resources, while the economic growth means here not only the increase of profits *per capita* but also improvement of other elements of social well-being along with structural changes both in the economy and in the society [Pearce, Turner 1990]. It also must be emphasized that the essence of sustainable and permanent development is provision of lasting life improvement in contemporary and future generations, by shaping adequate

proportions between three kinds of capital economic, human and natural [Pionek 2003].

The sustainable development concept is to develop some correlations between social, economic and ecological needs along with their development (Fig. 1.1).

Figure 1.1. Social, economic and ecological needs in the sustainable development concept

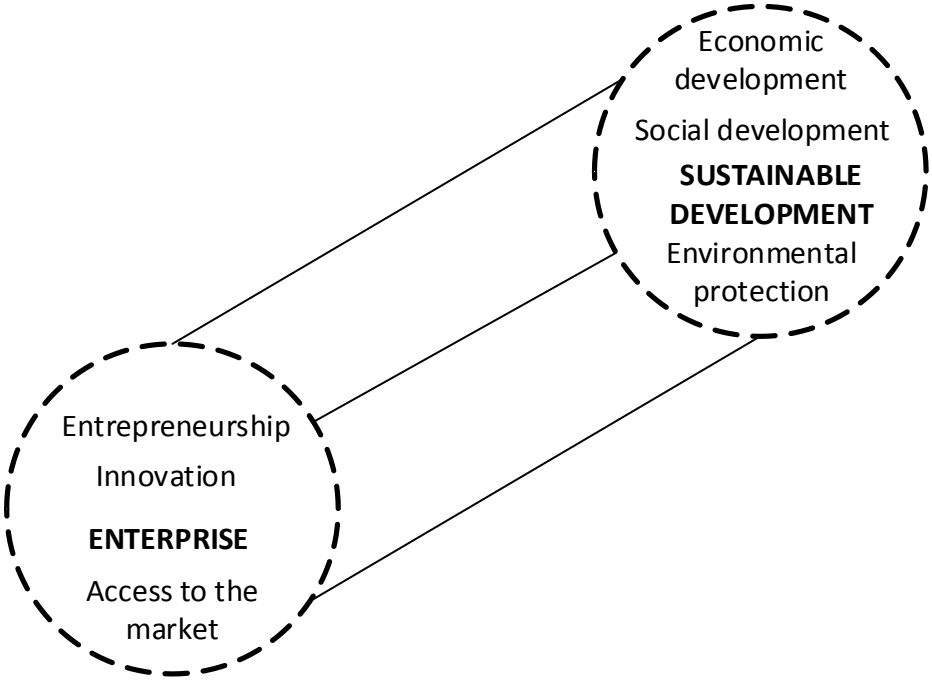


Source: Own work based on [Nitkiewicz 2004].

The sustainable development concept, implemented in the enterprises' operations, is of special significance for their management (Fig. 1.2). The enterprises undertake implementation of the sustainable development concept being aware that they exert intensive influence on the environment by utilizing natural resources, emitting pollution or generating waste, and the expectations towards their operations are focused on the trends towards limitation of use of materials and resources and improvement of contribution to the social life [Clark et al. 2016]. Furthermore, the still increasing social awareness regarding the natural environment protection is reflected in greater expectations and requirements of customers towards the enterprises. At the same time, the enterprises themselves seek manner to develop and strengthen their competitive advantage, looking for solutions in implementation of eco-minded activities that consist in among other reduction in materials and energy consumption, creation of new sales markets and utilization of their management possibilities,

expansion of the products' and services' life cycle and broadening of their scope or co-creation of the social well-being [Nitkiewicz 2013].

Figure 1.2. Relationships of an enterprise with sustainable development



Source: Own work based on [Bajdor 2012b].

However, to place the sustainable development concept in management of contemporary enterprises, it is necessary to analyze the contemporary concept of enterprises management along with determinants that shape it [Szkutnik 2010].

To a high degree, management in contemporary enterprises depends on their proneness and adaptive skills regarding the transformations in civilization, cultural, social and economic areas, which influence all aspects of their operations and are characterized with novelties, high pace, intensity and complexity, and thus are difficult or unpredictable [Buckingham, Kina 2015]. Premises that refer to sustainable development and decide directly on change of assumptions in the enterprises management are related to [Osbert-Pociecha 2011]: development of new organizational forms, dynamic development of new technologies, escalation of competition, intensification of the globalization processes, increase in actions on international markets, concentration on customers' requirements and needs, emergence of new markets and disappearance of the existing ones.

While undertaking the relationship context of the presented assumptions, it is necessary to state that the basis of sustainable development is development of new organizational forms, e.g. networks, which by formulating the cooperation objective strive for implementation of sustainable development of networks. Similar interdependencies also exist in relation to new technologies and competitiveness or other assumptions [Holden, Linnerud, Banister 2017].

Analyzes related to the evolution of globalization processes remain in the direct context, continuously leading to uniformity of markets and creating global competition and the need for enterprises to adjust to the international environment's conditions [Firlej, Bargieł 2014; Malara 2009]. Globalization[6] caused the need to introduce changes in the organizational management [Urbanowska-Sojkin 2011], and the process of that changes takes place on several plains [Adamczyk 2009; Gierszewska, Wawrzyniak 2001]:

- structural - visualization,
- work systems - flexible systems,
- competence - creation of new knowledge,
- technology and organizational procedures - e-business,
- values - corporate social responsibility, CSR.

The sustainable development may be directly positioned in the corporate social responsibility [Kolk 2016]. This means that globalization changed the manner and models for organizational operation dramatically, and caused that numerous standards and rules that were in force previously in the field of management have changed to a considerable degree [Sudoł 2012; Stabryła 2011]. The standards and rules that were modified are especially related to sustainable development.

The turbulent character of economic changes causes significant economic transformations, and as it is impossible to impose any boundaries in the economy, these changes - emerging with unpredictable intensity - penetrate various elements of its theory what is reflected in the new, currently appearing concepts, one of which may be the sustainable development [Hák, Janoušková, Moldan 2016].

These concepts integrate with management processes because of the common objective determined within the sustainable development concept. Objectives and benefits that arise from implementation of the sustainable development concept in enterprises are presented in Table 1.1.

The transformation process of the traditional approach to management takes place slowly [Borowiecki, Kiełtyka 2011]. However, it should be observed that generation of new theories does not correspond to their immediate practical application - there is a need for a certain implementation delay, which is inevitableas the management sciences are of an application nature that is the main priority for their development [Lichtarski 2011]. The sustainable development is a typical example of the need to develop a concept because of dynamics of economic development along with negative results of those operations [Chang et al. 2017].

[6] Currently, apart of the term "globalization", the following terminology is encountered: global information society, global state, global economy, global finances, global product, global bank, global economy or global strategy [Bojar 2007].

Table 1.1. Basic objectives and benefits that are characteristic for each dimensions of the sustainable development concept implemented in enterprises

Dimension of sustainable development	Basic objectives of enterprises	Benefits for enterprises
Economic	- increase in efficiency, - greater security of business, - safety of recipients,	- balance in the surroundings, - good reputation of the enterprise, - higher level of well-being of the closest social surroundings
Social	- greater satisfaction of the recipients, - competitiveness in relation to the remaining energy carriers, - strengthening of the brands' position	- greater demand for products, - certainty of deliveries of the final product
Ecological	- reduction in the pollution emission level, - not exceeding the granted limits, - adopting the production technology that is friendly to the environment and resident,	- smaller or not environmental penalties, - greater level of achieved profits, - increase in the company's value, - good reputation of the enterprise

Source: Own work based on [Bajdor 2017].

The review of literature of the subject suggests that both the practitioners and theoreticians that deliberate the management theory, while being aware of the consequences of emerging changes, seek new managements concepts in an active and intensive manner [Cairns, Martinet 2014]. Numerous scientific papers in that field emphasize that the management sciences use the knowledge on the principles of enterprises' operations and development along with the management rules[7]. Based on that, the development of theory and practice on the management sciences contributes to changes of a differentiated character.

The contemporary management concepts allowed undertaking the attempt to specify their four main components, which while influencing one another create a model of a perfect enterprise (sustainable enterprises). These components that are responsible for the permanent success of the enterprises are: trust, knowledge,

[7] The literature undertakes certain topics regarding the concepts of management sciences, and the authors of the most popular works in this field are: W. Chan Kim, C. Christenses, J. Collins, R. D`Aveni, G. Hamel, D. Jamali, R. Mauborgne, H. Mitzberg, T. Peters, M. Porter or C. Zook. They stress the significance of changes for development of new concepts in management along with the fact that those changes are of a deep and complex natures, causing certain difficulties in management, and this in turn is reflected in complexity and multidimensionality of the management concept.

innovation and entrepreneurship [Hejduk 2016]. Hence, the model approach is identified with the sustainable development.

The sustainable development aspect is intended to improve effectiveness of enterprises both in the technical and economic dimensions as well as in the social sphere [Broman, Robèrt 2017]. This is turn brings the need to connect the "hard" management elements such as a strategy, structure, operation systems, with the "soft" ones, i.e. a mission, culture, leadership, people, and first of all the need to consider the reactions from the stakeholders towards direct effects of the enterprises' operations [Nowakowska-Grunt 2013; Bratnicki 2009].

Exposure of the sustainable development by enterprises requires consideration of such attributes as: flexibility and the ability for innovative and quick adaptations, innovativeness, entrepreneurship, intelligent actions, skillful knowledge management and gathering of intellectual capital [Shepherd, Patzelt 2017]. Evolution of those attributes shaped the contents of the new approach in the management sciences. Therefore, apart of constant transformation taking place in the organization and its surroundings, these are the attributes that are treated as conditioning the effective management, allowing the achievement of assumed objectives [Romanowska 2011]. All the listed attributes of contemporary enterprises are embedded in the sustainable development concept. The greatest impact on the final shape of the concept is exerted by: flexibility[8], innovativeness[9] and entrepreneurship[10].

Currently, the management is based on the organization's ability to deal with the constant change, organization of networks [Niemczyk, Stańczyk-Hugiet, Jasiński 2012], establishment and development of relationships with partners or concluding alliances and creating a strong market position thanks to competitive advantage [Grudzewski, Hejduk 2006]. Therefore, it might be assumed that the organizational development in the 21st century will be first of all directed at increase in entrepreneurship, innovation and competitiveness [Stańczyk-Hugiet 2011].

[8] The enterprise's flexibility is expressed with the ability to adjust to new situations and circumstances, making quick decisions, finding, testing and implementing new ideas and solutions or the ability to introduce innovations. It is also fast and skillful response to the constantly changing customers' needs and expectations on given market. When it comes to organization, flexibility means a broadly understood skill of adjustment to the changeable conditions of the surroundings, which in today's world are characterized with high dynamics [Stańczyk-Hugiet 2013] - the changes are rapid, unexpected and they require an immediate response.

[9] The management of innovations in the organization is the same as management of other functions or processes, and it may be treated as a collection of ordered actions: planning and making decisions, organization, leadership and control [Nowicka-Skowron, Pachura 2009]. An enterprise that is willing to manage an innovation process should also specify a strategy of the innovative operations [Czakon 2012], covering among other the selection of the innovative operations' directions, manners of data, information and knowledge acquisition [Sopińska 2012], which are necessary for its development, use of innovations while considering the political, legal, financial, administrative, social or environmental aspects.

[10] The entrepreneurship causes emergence of new economic activities that create a specific value or influence the emergence of new jobs [Wu 2013]. However, first of all, the entrepreneurship contributes to improvement in the organizational competitiveness not only in its closest surroundings but also on a global scale [Wu, Huarng 2015]. Apart from the international entrepreneurship related to internationalization of enterprises there is also regional and local entrepreneurship related to particular territories. Existence of the latter is conditioned by creation of an entrepreneurship environment, which is often the same as the innovative surroundings [Skowron-Grabowska 2013]. The literature describing entrepreneurship also distinguishes a strategic type of entrepreneurship, the main role of which is to use the opportunities during the strategic development of the organization [Brzozowska 2013]. In this aspect, the entrepreneurship is based on interaction of developmental opportunities, strategic factors and organizational competences [Chodyński 2009].

The intellectual capital will also be of great significance [Stachowicz 2011], covering among others the well-educated and experienced employees, who thanks to the held skills will be capable of designing modern production and service provision systems, or develop new management techniques that will allow to meet the customers' expectations.

The above deliberations justify the statement that contemporary management in based on numerous different variables, which are related to the areas connected with economy, society and environment. Thus, the contemporary management concepts, while implementing the actions from those three areas, at the same time consider the priorities of the sustainable development concepts [Duran et al. 2015a]. Globalization, growth and dynamics of production, reduction in products' life cycles, diversification and specialization of production, technological and research development, innovation processes, depletion of natural resources, degradation of the environment and many other factors cause the need to plan and direct the development [Barbier, Burgess 2015]. This is intended to prevent the regress, and it leads to permanent use of all available capitals and resources, as well as to consolidation of results from developmental actions [Dziadkiewicz, Całus 2011]. The sustainable development mechanisms are necessary to maintain the results of the developmental actions, as development essentially takes place in a non-sustainable manner [Skowrońska 2009].

The sustainable development concept is implemented in the enterprises in a form of a strategy, very often posing a substitute for the previous main developmental strategy or its complementation with environmental and social issues [Dogaru 2013]. The sustainable development strategy may pose a general strategy of an enterprise or one of the main functional strategies. Then, there might be other functional strategies, executing other groups of the sustainable development priorities (e.g. social) or horizontal functions of an enterprise (e.g. sales) [Shapira, Ketchie, Nehe 2017]. However, it is always necessary to integrate it with the hierarchy of objective in an enterprise, implemented developmental strategies and operational practices, so it is possible to achieve the assumed effects [Gierszewska, Romanowska 2009; Lichtarski 2007; Krupski, Niemczyk, Stańczyk-Hugiet 2009; Bratnicki 2011].

The discussed sustainable development concept is currently a standard of manufacturing and market behaviors for numerous states and economic units. What is more, it influences the consumers' behaviors, who, while being more aware, impact the production of enterprises to an increasing degree [Kurniawan, Managi 2017]. This causes that boththe strategies and methods of production operations are re-evaluated [Brzeziński 2016].

A special case in the analyzed sphere is posed by manufacturing enterprises, which base their key operational parameters on the products, material and energetic resources, adopting in the manufacturing process, manners of storage and distribution, post-sales services, possibilities for final disposal of products, their re-use or recycling, etc. [Keeys, Huemann 2017]. All of those processes can be significantly reflected in the potential for seeking the possibilities for production dematerialization, reduction

of its energy consumptions, introduction of low-emission and waste-free manufacturing system, limitation of dysfunctions of products in their life cycles, generation of material and power feedback and their use to supply some new cycles [Siva et al. 2016]. These actions combine economic and ecological benefits, and indirectly also some social advantages, thus they pose a determinant for a specific direction for the manufacturing enterprises management [Nitkiewicz 2013].

A great spectrum of notions for the sustainable development, dynamics of the globalization processes, with simultaneous and explicit attitude of the consumers, i.e. societies that prefer an ecological approach to manufacturing [Szymczyk 2015] - these are the basic premises for changes in the economic theory and practice [Caiado et al. 2017]. The new sustainable development concepts, in their otological foundations directly refer to the problems of enterprises management, as the economic entities are on one hand an imperative for organizational and technological changes, and on the other a recipient of social signals that flow from the market [Duran et al. 2015b].

The consumers' interest in the notions of sustainable development created a new operational sphere in the enterprises, thus determining the plain for changes in the management processes [Dvořáková, Zborková 2014].

Hence, it may be concluded that the sustainable development concept has become an integral and increasingly more acceptable problem in the enterprises management [Oelze et al. 2016]. What is more, they contributed to emergence of numerous new management concepts. Some of them are oriented on the enterprise management process, other are focused on management of changes and some on other organizational forms.

The group of the enterprise management concepts oriented on the management process covers logistics management intended to rationalize the materials flows to achieve high operational effectiveness and at the same time reduce costs.

1.2. Logistics management

The shape and increase in significance of logistics management in contemporary enterprises have been influenced first of all by rapid and virtually continuous transformations that take place on the markets [Voortman 2004]. The organizations willing not only to show themselves but also develop in the current economic reality must be characterized with a high competitive position reached among others through implementation of varied solutions that are intended to meet the customers' expectations and needs [Barcik, Jakubiec 2016].

Therefore, the logistics management belongs to one of the most dynamically developing management concepts [Fernie, Sparks 2014; Pyka 2011], the purpose of which is to maximize the value delivered to the final recipients, and at the same time maintain the costs on the lowest level possible [Świerczek 2006].

The logistics management is also one of the components that increase the value, both for the enterprises and their customers [Kisperska-Moroń 2006].

The literature most often emphasizes the logistics management objective that implements the 7R principle covering the following components [Michlowicz, Smolińska, Zwolińska 2015]:

- right product,
- right customer,
- right quantity,
- right time,
- right place,
- right quality,
- right price,

This principle suggests that the goods intended for a customer should be delivered to a right place and in right time, it cannot differ from the ordered goods, both in terms of quantity and quality, it should be supplied to the right recipient and handed upon a previously agreed charge has been paid [Jacobs, Chase 2013].

First of all, the logistics influences the enterprise's areas where the resources' flows take place (raw materials, materials, finished products), from the place of their acquisition to the final recipient, with the accompanying information and financial flows [Nowosielski 2008; Skowronek, Sarjusz-Wolski 2012].

In turn, the logistics management is "a decision-making process, which covers a logical chain of actions that compose a process of creating a general concept of logistics actions in an enterprise [Schönsleben 2016], specified in a logistics plan, and the implementation process in a properly shaped organizational form and with adoption of adequate control and monitoring systems" [Sołtysik 2003].

The contemporary enterprises base organization of their work on the processes, and their management is intended to ensure greater effectiveness of actions with consideration of the customers' preferences and needs, along with the time and space criterion [Zeng 2003].

Therefore, the processes in logistics management must be emphasized, among others the flow processes what takes place in the following definition: "logistics management covers the following components: strategy formulation, planning, steering and controlling (carried out effectively, in a manner allowing to minimize the global costs) the processes of the raw resources flow and storage, stocks and work-in -progress, finished goods and adequate information - from the point of acquisition to the point of consumption - in order to adjust to the customer's needs to fulfill in the best possible way" [Abt 1998].

Hence, while analyzing the processes implemented within the logistics management, we need to stress their significant differentiation within particular enterprises [Saenz, Koufteros 2015]. Their essence, character and scope, as well as the purpose of this work justify mentioning of two selected classifications.

The logistics management processes can be divided into [Piennar, Vogt 2015]:

- internal processes, which comprise of: internal flows coordination processes, supply processes, warehouse management processes in relation to materials,

raw resources or semi-finished products, warehousing processes, material management processes, communication and information processes,

- external processes that cover: reverse logistics processes, packaging management processes, warehouse management processes in relation to finished products, ordering processes, transport processes, customer service processes.

Apart from the above, the logistics management also encompasses the processes that do not belong to any of the above groups, and are related to production manufacturing and implementation of marketing actions [Piennar, Vogt 2015].

The logistics management processes can be also divided according to the task criterion [Miller, Vollman 1985], into:

- flow processes related to material streams, from the moment of purchasing the raw resources/materials, until the moment of sales of finished products,
- regulatory processes, which are intended to adjust the production means and workforce to the need for finished products,
- control processes, related to quality of finished products, realization of orders and course of the production processes,
- information processes, which are intended to update data and information on ongoing basis within the IT system of the enterprise [Borgi, Zoghlami, Abed 2017].

Following the aforementioned characteristics of the logistics management processes in an enterprise and leading themes of this monograph, it is possible to separate those processes that are strictly connected to justification of recognition of logistics management as an integral component of the enterprise management through the coordination of actions in base processes in order to obtain a higher value of results achieved by the enterprise and integrate the auxiliary processes with the base processes to improve the value of results from base processes [Witkowski 2010]. These processes are base processes that group the actions related technologically into the processes of results production (products) that are a market offer, supporting processes that group actions ensuring direct service of operations included in the scope of the market results generation process and the supporting processes for input and output of the base processes or the internal supporting processes [Słowiński 2010].

Based on the presented classifications, it may be concluded that the logistics management consists in planning, coordinating and controlling of the logistics processes, i.e. such the implementation of which requires interdependence with other processes because of the places and/or times of realization as well as principles for generation and delivery of results [Kempny 2010].

The logistics processes pose one of the key categories of processes within enterprises and they consist in physical shift of goods within subsequent stages of the undertake economic activities [Sindi, Roe 2017]. These processes cover - within an enterprise and between enterprises - the flows of raw resources, materials, semi-finished products, finished products, goods and returns along with co-existing

information [Rushton, Courcher, Baker 2010]. The basic logistics processes are: transport, warehousing, handling and packing, which while creating a coherent composition, consisting in numerous interconnected elements, establish a physical flows process [Grant 2012].

The logistics processes also have significant influence on creation of the enterprise's value, e.g. through adequate warehouse management [Harrison, Hoek, Skipworth 2014]. Furthermore, bearing it in mind that the logistics processes play a significant role in shaping of the costs in the enterprise, it might be assumed that any modifications influencing their more effective implementation, have measurable impact on the financial results of the whole enterprise [Ganapathi, Nandi 2015].

In contemporary enterprises, the logistics processes are considered as integrated material flows (substantive, physical) and information flows [Nowakowska-Grunt, Nowakowska 2012; Skowronek 2010], related to implementation of such actions as transport, manipulation, warehousing, packing, servicing, etc. [Selviaridis, Norrman 2015].

The logistics processes combine all those actions undertaken by the enterprises and are intended to improve the exchangeable and utility value of the products in the spatial and time context [Hart, Taraba, Tomastik 2014; Pfohl 1998]. Improvement in the value of products in the spatial aspects is related to efficient delivery of the product to its destination, while in the time aspect it is related to consideration of an adequate delivery moment, which results from the direct demand [Ballou 1987].

What is more, the logistics processes also play an ordering role, i.e. they determine the change of quantity and grade of goods by the processes mainly in goods flows (transport, warehousing and handling) along with auxiliary processes in the goods flows (packing and marking) [Pfohl 1998].

Considering the proper functioning of contemporary enterprises, the logistics processes that take place within them must be managed skillfully, having knowledge about them, as because of that it is possible to monitor, control them, and integrate them with other processes, coordinate their flows, inspect effectiveness and costs or combine with information flows [Ciesielski, Długosz 2010]. The essence of logistics processes is to find the best solution regarding production and distribution of goods, while considering their use by the markets and recipients [Bass 2015].

In turn, the essence of logistics management in contemporary enterprises is an ordered and cohesive concept of adopting the management functions and instruments in the area of logistics processes related to materials flows and the accompanying flows of information [Farahani, Rezapur, Kardar 2011].

The increase in significance of logistics management has been influenced first of all by rapid and virtually continuous transformations that take place on the contemporary markets [Bloemhof-Ruwaard 2015]. The organizations willing not only to show themselves but also develop on the market must be characterized with a high competitive position reached among others through implementation of varied solutions that are intended to meet the customers' expectations and needs, by making their offer to stand out from the others. This causes that currently the logistics

management belongs to one of the most dynamically developing management concepts, the purpose of which is to maximize the value delivered to the final recipients, and, at the same time, maintain the costs on the lowest level possible [Świerczek 2006].

The logistics management theory brings a lot of definitions, out of which a group of those oriented on the materials and finished products flows can be separated, along with adequate information, at the same time suggesting the these are the material flows, as logistics processes, are the element that combines various approaches to this notion into a single whole [Kersten, Blecker, Herstatt 2007].

The logistics management can be defined in the scope of processual management: "examination of materials and information flows in the cross-section of various functions and specialties, description of its course and each time a given operation has been implemented, the analysis of input, performed transformations and utilized resources, and output or obtained products" [Brilman 2002].

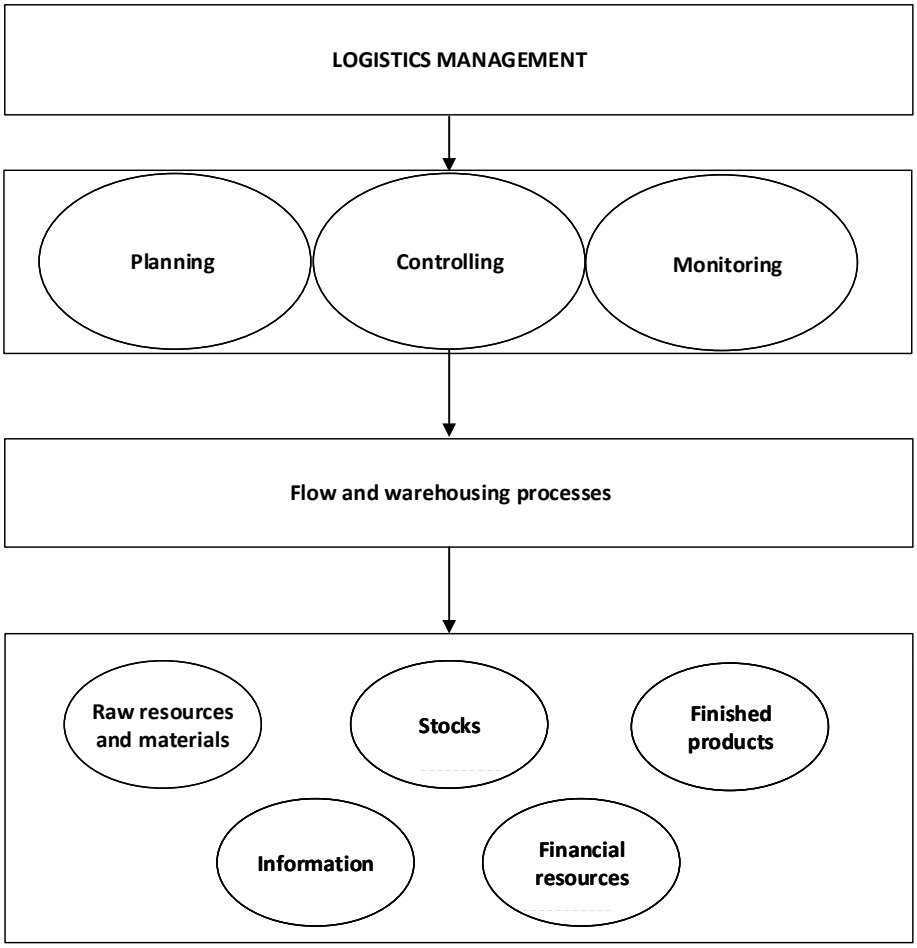
In turn, from the perspective of the systemic approach to management, the logistics management is based on a holistic and integrated approach to planning, organizing and controlling of material flows and the interconnected information [Tyagi, Agarwal 2014], thanks to which both the enterprises and their customers obtain measurable advantages in a form of a shorter delivery time, transparent cooperation in business surroundings, better service, reduced probability of damaging or destructing the product, better adjustment of the products to the customers' requirements and introduction of the just-in-time principle [Ailawadi, Singh 2012].

Hence, the logistics management allows efficient and effective overcoming of time and spatial limitations during the products transport, and it consists in physical shifting of materials (resources, products), while striving for implementation of the enterprise's objective and contributing to economization of this process [Kisperska--Moroń 2006].

What is more, the logistics management may be treated as compilation of the management and logistics functions, based on the fact that logistics management consists in undertaking of actions that cover planning, organizing, controlling and monitoring of the logistics processes in such a manner so the enterprise's objectives can be achieved [Sobotka 2005].

The presented definition also suggests the character of logistics management (Fig. 1.3), first of all covering the improvement of the supply, warehousing, transporting and distributing processes with consideration of improvement in contacts with the external recipients and the customer service quality within enterprises [Szkutnik 2005; Chaberek 2000].

Figure 1.3. Logistics management diagram



Source: own work based on [Abt 1998].

The result of studies on application of various management functions, i.e. planning, organizing and controlling, in logistics operations of enterprises there was the development of tasks that the logistics management needs to face [Wu et al. 2013]. These are as follows [Kisperska-Moroń 1999]:

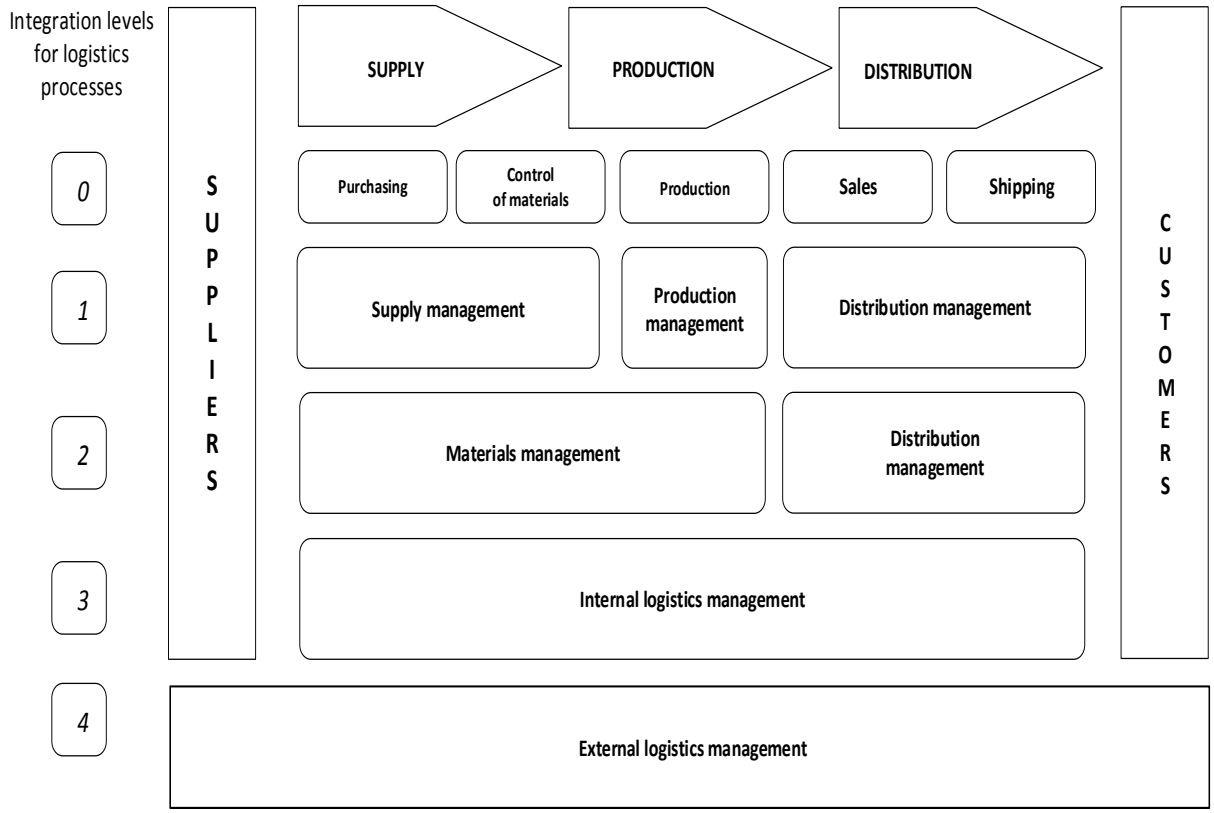
- detailed exploration of various logistics processes in the economy, their correlations and relationships of the logistics processes with other fields of management,
- seeking and verifying the increasingly more effective examination tools for logistics processes,
- development and verification of the methods for effective implementation of the logistics processes in the economy,
- promoting effective management patterns for logistics processes in the economic practice.

The logistics management takes place along with processes related to distribution, stocks and flows of different elements, while there is a need to coordinate and integrate them with other processes that take part within the whole enterprise [Mesjasz-Lech 2012].

The purpose of coordination is to ensure that the logistics processes and other related procedure are adjusted to each other, and not only within a single organization but also in case of cooperating enterprise [Fugate, Sahin, Mentzer 2005]. This coordination consists in cooperation and penetration of particular elements of logistics within the management and operational structure in the enterprise [Brekalo, Albers 2016]. The significance of coordination was stressed in the definition stating that the main task of the logistics management is planning and coordinating the logistics processes with other procedures, considering own and partners' goals [Harrison, Hoek, Skipworth 2014].

In turn, integration leads to consolidation of organizational functions and units, which carry out the logistics tasks that they have been entrusted with - what is presented in Fig. 1.4 [Sołtysik 2003].

Figure 1.4. Integration of logistics processes with an enterprise



Source: own work based on [Baran et al. 2008].

While deliberating the logistics processes integration within an enterprise, there are five levels that can be distinguished [Kot, Starostka-Patyk, Krzywda 2009]:

- a zero level is specified as functional isolation, emerging with independence of particular departments of the enterprise, which are focused on implementation of their own tasks and goals; this isolation is also characterized with each department having its own separate database, which poses the basis for the employed IT system (each department has its own IT system);

- the first level is determined as intra-functional integration, displayed with internal integration of logistics processes: supply, production or distribution: each distinguished phase of the material flow has its own IT service;
- the second level is specified as intra-functional integration 1: here the logistics processes of supply and production are integrated with IT service of each distinguished phase of the material flow;
- the third level is determined as intra-functional integration 2, where the material management and distribution are integrated with all external phases of the material flow; this is the level where complex IT services occur [Kiełtyka 2011];
- the fourth level is determined as external integration, where the logistics processes of the enterprise are integrated with the closer logistics surroundings, so-called integration of the internal material flow with suppliers and recipients of the 1st tier, along with complex IT services.

Based on those deliberations, certain tasks and function of logistics management can be presented according to operational spheres of the enterprise (Table 1.2).

Regarding variety of undertaken actions that are embedded into the sphere of logistics management in an enterprise, there are several orientation types distinguished [Wincewicz-Bosy 2013].

- The partner orientation to a customer, which is based on the common planning of the time, spatial and technological orientation with the enterprise's partners [Rokita 2005]. What is important here is the exchange of information, as well as the development of common supervision, monitoring and control systems arising from the partnership [Jeżak 2013]. This orientation covers the employed motivational systems as the attitude of the employees to the whole process plays an important role.
- The orientation on flows, where a basic assumption is the decisive role of the flows in the competitive fight. They should be planned and implemented adequately. This orientation forces strict cooperation of all departments of the enterprise, from the moment of planning until the final stage.
- Orientation on planning, the main assumption of which is development of an adequate plan that would cover all processes. This plan should be controlled and corrected if there is such a need. It should cover with its scope the whole logistics of the enterprise.
- The orientation on costs, the main purpose of which is to strive for reduction of costs for such a level that would ensure competitive advantage and sustainable functioning of the company [Barcik, Bilovodska 2015].
- Orientation on effectiveness assumes accurate planning of the whole logistics of the organization. There is also an analysis carried out here allowing here solving problems and eliminate any disturbances that emerge already on the level of planning.

Table 1.2. Tasks and functions of logistics management according to operational spheres of the enterprise

Type and character of advantages		Basic tasks and functions of logistics management in the field of:		
		distribution	**production**	**supply**
Logistics tasks and processes	**Long term**	Planning of warehousing and transport processes Planning of the warehouses location Planning of the distribution structure Planning of the finished products stocks Planning of the external logistics scope	Planning of the warehousing and transport processes Planning of the warehousing and transport means Planning of the manufacturing systems structure Planning of the manufacturing potential protection	Planning of the warehousing and transport processes Planning of the warehousing spots Planning of the supply structure Planning of the materials and raw resources flows Planning of the external logistics scope
	Medium- and short-term	Planning of the means of transport application Controlling and executing orders Planning the dates for goods deliveries Controlling the finished products stocks Commissioning and packaging of goods Exchange of information	Planning of the means of transport application Planning and controlling the production Controlling the materials and semi-finished products flows Controlling the use of personnel and technical devices Exchange of information	Planning of the means of transport application Planning and controlling the material flows Planning the delivery dates, types of packagings Controlling and monitoring of the materials acceptance and storage Exchange of information
Coordination tasks for action processes and spheres	**Long term**	Planning and determining the distribution programs Planning of the distribution strategy Selection of commercial enterprises and customers	Planning and determining the manufacturing programs Planning of the manufacturing strategy Planning of the production location	Planning and determining the supply programs Planning of the supply strategy Evaluation and selection of suppliers

	Medium- and short-term	Determination of the needs regarding distribution Determination of sales, transport and warehousing programs Determination of the delivery service levels	Determination of the needs regarding manufacturing Determination of the load to machinery Planning of the production batches	Determination of the needs regarding supply Determination of purchasing, transport and warehousing programs Determination of the size of deliveries

Source: [Blaik 2010].

The main advantages for the enterprise, resulting from efficient operation of logistics management are among others: significant reduction of costs in purchase of materials and sales costs, shortening and simplifying the transport processes (both external and internal), minimization of the raw resources' stock, materials and finished products, unification of packaging and storage systems as well as the systems responsible for information flows [Ailawadi, Singh 2012]. The logistics management effectiveness depends to a great extent on the knowledge level of numerous various economic notions, but also on the ability of analytical and abstract thinking [Gołembska 2006].

The social goal in the logistics management deserves to be stressed. The social priority in logistics management in enterprises is inseparably related to the corporate social responsibility concept (CSR) [Barcik, Jakubiec 2014], which states that the enterprises direct their actions not only on deriving their own benefits, but also on the benefits that will be brought to the society thanks to their operations [Chandra, Ghosh, Srivastava 2016]. This among others refers to relationships between enterprises and customers, employees, local community, etc. [Bachorski-Rudnicki, Kroik 2012]. When it comes to logistics management in the enterprise, this concept is presented mainly in the enterprises' strive for products and services quality, effective customer service, partner relationships with the business surroundings enterprises, continuity of research and development works, innovativeness, seeking and implementing new technologies, etc., what serves the society among other through customers' satisfaction with the commercial and service offer, development of long-standing partner relationships, creation of new jobs, etc. [Witkowski, Baraniecka 2011].

In turn, the ecologic priority, related to environmental protection, is related first of all in logistics management in enterprises with the scale, which the raw resources and the energy are employed along with emissions. Operations within the logistics management in enterprises should head towards improvement or at least to non-hindering the natural environment condition [Bajdor 2012a]. It is possible as thanks to employment of modern technologies and methods for effective management of resources and remains, the negative environmental impact is minimized [Bing et al. 2016; Burchard-Dziubińska, Rzeńca, Drzazga 2014].

The priorities of sustainable development in the logistics management are carried out among others through introduction of the reverse logistics concept in the operation of enterprises, as in the era of globalization and dynamically developing markets the enterprises seek new and more effective possibilities related to management of their operations. An additional stimulus is the increasingly stricter legal acts, intended to take care of and protect the natural environment, in the scope of economic activities, especially those related to manufacturing. The enterprises, by accepting those changes, have developed a new concept in the scope of reverse logistics in the recent years.

1.3. Reverse logistics

Nowadays, the reverse logistics concept has gained recognition and become a significant sphere in the enterprises management. Direct influence on the increase in significance of this concept in organization was exerted by greater importance of the environmental protection and sustainable development aspects [Lewandowski 2000], legal conditions, shaping of the socially responsible policy and increase in competition on the domestics, international and global markets [Witkowski 2015]. This concept, introduced into the manufacturing enterprises, allows competitive advantage to be acquired, recognition in the customers' eyes, and adjustment of the manufacturing operations to the current legal, environmental, social and economic requirements [Blaik et al. 2013].

The main premises of the reverse logistics concept development in the enterprises may be looked for within the contemporary conditions, where these units operate [Huscroft et al. 2013]. One of the determinants here will be the sustainable development and involvement of the enterprises in implementation of its three main priorities: economic, social and ecological aspects. The economic aspect of the sustainable development in the reverse logistics concept is justified with the possibility to derive profits from its implementation. The social aspect is related to the response to the growing requirements from the purchasers and the growing awareness in the scope of the corporate social responsibility for the operated business [Muniz Jr et al. 2017]. In turn, the ecological aspect is related to the enterprises' undertaking actions related to the natural environment protection.

Therefore, the reverse logistics is a part of the sustainable development concept, and implementation of its processes is directed at implementation of the sustainable development principles on the level of an enterprise [Jiang, Feng, Ouyang 2017]. It should also be emphasized that the reverse logistics carried out in the scope of the enterprise is based on objects separated from its structure. It implements the logistics processes of this enterprise, and in order to ensure own effectiveness, efficiency and efficacy it adopts the functions, methods and instruments for management of those processes.

The main idea, around which the reverse logistics concept oscillates is the strive for solving environmental and economic issues [Skowronek 2010], related to shorter

life cycles of the products, through extending them by reverse flows, as only such an approach allows to re-use the value included in the returned products/materials [Sajjanit, Rompho 2017]. At the same time, this approach avoiding the loss of value as a result of non-acceptance of the returns, the consequence of which is an increase in the quantity of waste that is harmful for the environment, quantity of natural resources employed in production and outlays for these materials, as well as reduction in financial advantages from the re-use of products, components or raw materials [Mondragon, Lalwani, Mondragon 2011].

While characterizing the reverse logistics, it may be concluded that it is related to the sequence of actions related to taking-over of the returns of products from the customers/ participants of the business surroundings in order to acquire any value from them, which then can be re-introduced to forward or reverse flows in a secondary form [Mesjasz-Lech 2011]. Hence, thanks to the reverse logistics processes, the returned products, i.e. the returns, are brought back to the conditions that they can be re-used [Dhakal, Smith, Newbery 2016].

Till half of the last century, the returns in logistics flows were not recorded in studies or literature. Not until the beginning of 1970s did the first premises appear regarding the products returned to reverse flows [Pokharel, Mutha 2009; Mutha, Pokharel 2009][11]. They evolved later into the reverse logistics concept [Rubio, Chamorro, Miranda 2008], and eventually the concept was expanded with a gatekeeping process and a procedure for preventing the returns in the study from 2001 [Croxton et al. 2001][12].

The first attempts to define the reverse logistics in the environmental aspect were undertaken at the end of 1990s. [Carter, Ellram 1998] what eventually resulted in emergence of the first definition that was generally accepted within the scientific environment, stressing the purpose of the concept. According to the definition, the reverse logistics is the process of planning implementing and controlling the cost effectiveness, flows of raw materials, manufacturing materials, final goods and the interconnected information from the consumption spot to the starting point in order to regain the value or manage properly [Rogers, Tibben-Lembke 1999]. In the same time, there were several other authors who defined the reverse logistics, taking into account its various perspectives [Stock 1998; Dowlatshahi 2000; Srivastava 2008].

[11] The first mentions about the reverse logistics appeared in the literature along with emergence of the reverse goods flow notion [Guiltinan, Nwokoye 1975; Murphy, Poist 1989] and reverse channels [Ginter, Starling 1978]. Afterwards, in 1980s, there were first definitions of the reverse logistics mentioned, focusing on the flows directed reversely than in the forward logistics, and these flows were called" going the wrong way" [Murphy, Poist 1989], treating them as a side effect of operation of the enterprise, which however was not perceived negatively; it only proved that they existed.

[12] In Poland, the reverse logistics emerged in the literature studies at the end of 1990s, and following its occurrence in 1999 in the American, generally-available, first coherent literature position analyzing this concept in detail, drawn up by D. Rogers and R. Tibben-Lembke [Rogers, Tibben-Lembke 1999]. This book has become the basis for further development of science in this scope, and the foundation for subsequently emerging research trends. At the beginning, the were not many scientific articles in the Polish literature regarding reverse logistics, gradually developing the concept within the Polish economic conditions. Several years later, there were several monographs published, devoted to the reverse logistics and its processes, presented in various perspectives, the authors of which hardened this concept in Poland [Szołtysek 2009; Szołtysek, Twaróg 2017; Sadowski 2010; Mesjasz-Lech 2012; Jeszka 2014].

The reverse logistics was presented from the perspective of distribution planning, stock management and planning of production by M. Fleischmann [Fleischmann et al. 1997], as a field of science focused on the environmental aspects of transport by C. Carter and L. Ellram [Carter, Ellram 1998], in combination with the developmental theory for successful implementation of the reverse logistics processes, with consideration of various strategic and operational factors by S. Dowlatashi [Dowlatashi 2000] or consideration of the proposals made by C. Prahinski and C. Kocabasoglu [Prahinski, Kocabasoglu 2006], analyzing the existing practices in this scope, the critical notions and management techniques before the reverse logistics is implemented. There are also numerous papers that present the literature review in the scope of creating of flows in reverse logistics [Fleischmann et al. 2000; Akcali, Cetinkaya, Üster 2009; Chanintrakul et al. 2009; Sheriff, Gunasekaran, Nachiappan 2012].

The definition of reverse logistics intensively evolved since the beginning of the 21st century, extending its scope and adjusting to the cognitive process of its operations. At the beginning, both the scientists and practitioners ignored the presence of the reverse logistics processes and emergence of reverse flows, often not realizing that they existed [Bernon, Cullen 2007]. However, the economic growth caused that the enterprises need to notice the transformations that were taking place, and expand the management and logistics with the reverse flows of products, directed from the point of consumption of the goods to the source spot [Rogers, Tibben-Lembke 2001].

While deliberating the reverse logistics definition, and considering the literature works in this scope, it is necessary to pay attention to the fact that the literature of the subject often adopts names that are similar or identical to reverse logistics, along with similar concept notions. Therefore, it becomes necessary to explain and justify the emergence of those similarities as well as to explain the differences between them.

The English literature regarding the reverse logistics presents the concept of industrial ecosystems, product life-cycle stages management, reverse supply chains, closed-loop supply chains integrated supply chain management, green/sustainable supply chains [Seuring 2004][13].

The Polish literature of the subject brings functioning of the reverse logistics concept down to implementation of processes related to the communal, industrial and hazardous waste management [Szołtysek 2009; Sadowski 2010; Mesjasz-Lech 2012; Szołtysek, Twaróg 2017]. A small number of papers is related to the reverse logistics implemented in the area other than waste. A. Jeszka, in her monograph entitled "Reverse logistics", undertook an analysis of the reverse logistics processes in the clothing industry, stressing the role of the reverse logistics actions in the scope of the reverse flows management, which includes the products and re-usable materials in the clothing sector [Jeszka 2014].

[13] The reverse logistics also functions in the Polish literature under varied names: reversed logistics, waste logistics, eco-logistics, recovery logistics, disposal logistics, repeated management logistics, waste management logistics, etc. The reverse logistics term, which constitutes an usus, has been most strongly embedded in the Polish literature tradition in the scope of the logistics terminology [Krzemińska-Krzywda 2008].

Meanwhile, the reverse logistics should be considered in a broader context, where its processes are related to the reverse flows management supplied not only with waste but also products and other materials that do not constitute waste as understood in their definitions.

The definition developed in the logistics terms dictionary by the Council of Supply Chain Management Professionals determines the reverse logistics as a specialised segment of logistics focused on flows and management of products and resources after they are sold and delivered to the final recipient [*Council...*].

In turn, according to the definition developed by the Council of Logistics Management, in its general meaning, the reverse logistics is related to the logistics management of skills and actions involved in the management, organization and disposal of the reverse flows contents in the business surroundings of the enterprise. In a more specific scope, the reverse logistics is a process of planning, introducing and controlling the efficiency, cost effectiveness of the raw materials flows, stock, final products and the interconnected information from the consumption point to the starting point, in order to recover some value or carry out the final disposal correctly [*Reuse...* 1993].

Therefore, the reverse logistics processes are related to the physical, reverse product flows, from their standard destination to the starting point in the enterprise, assuming the recovery of value or a different kind of correct final disposal. Emerge of the reverse logistics processes upon an accomplished fact, i.e. when the reverse flows are supplied, is highly significant in reverse logistics [Batarfi, Jaber, Aljazzar 2017]. Then, all of its operations are related to management of those flows and the interconnected information. In turn, the reverse logistics processes are not applicable, when the reverse flows have not products or materials, meaning when the products and materials are already in their final destination, having finished the circulation in the forward logistics flows, and have not yet been qualified to the reverse flows, so they remain outside the circulation of the logistics flows [Herbert-Hansen et al. 2017].

The literature thematically related to the reverse logistics stresses that is brings measurable advantages to the organizations differentiated in term of profiles and industries, as well as the whole sector and branches of the economy[14]. Regarding the increasing significance of the reverse logistics processes, numerous manufacturing enterprises started to assume it as a tool strategic for acquisition of economic advantages and improvement of the social image of the company [Kannan et al. 2012].

[14] Examples of the reverse logistics operation in particular enterprises and branches (sectors) are presented in the following works: Kodak and recovery of structural elements of final products from the market [Jayaraman, Luo 2007]; Dell and reverse logistics processes on a computer production line [Kumar, Craig 2007]; editorial sector and possible, potential advantages after implementation of reverse logistics [Wu, Cheng 2006]; electronic industry in China and problems related to introduction of the reverse logistics processes [Lau, Wang 2009]; manufacturing industry in China and problems related to management of products that came to an end of life in the reverse logistics flows [Subramanian et al. 2014]; food containers and reverse logistics in their recycling and re-use [Jayaraman, Patterson, Rolland 2003]. Implementation of the reverse logistics processes in various sectors is presented in the following works: production of carpets [Biehl, Prater, Realff 2007]; retail [Bernon, Rossi, Cullen 2011]; bottling industry [González-Torre, Adenso-Diaz, Artiba 2004]; production of paper [Ravi, Shankar 2006]; goods-packaging enterprises [González-Torre, Adenso-Diaz 2006]; production of cell phones [Rathore, Kota, Chakrabarti 2011]; pharmaceutical industry [Narayana, Elias, Pati 2014]; recycling of batteries [Wang et al. 2014].

What is more, the enterprise also noticed that better understanding and use of the reverse flows, as well as effective implementation of the reverse logistics processes allow getting the competitive advantage [Stock, Mulki 2009]. Despite the fact that numerous industrial branches adopt the reverse logistics processes in their operations [Kot, Grabara 2009], seeing them in the categories of sustainable competition and acquisition of market advantage, there are still certain discrepancies and deficiencies in information about adaptation and implementation of the reverse logistics processes [Richey et al. 2004].

The enterprises, by running certain economic activities, transform the products. This transformation consists in qualitative change of products during the manufacturing or consumption processes, as well as in time and space changes, where the manufacturing processes is combined with consumption in the distribution procedure, related to shifting and warehousing of products. The time and space transformation
of goods in the enterprise's logistics is based on management and implementation of the emerging logistics processes [Guo et al. 2017].

In the enterprises, the activities of which are based on manufacturing of products, and the products supply the physical flows, the logistics processes management is a highly significant sphere that covers seven key area [Brzeziński, Brzozowska, Korombel 2014], the last out of which is the reverse logistics (Table 1.3).

Table 1.3. Logistics management areas in contemporary enterprises

Logistics management area	Characteristics
Management of customer relationships	determines the developmental structure and maintenance of relationships with customers, along with product development
Management of customer service	allows direct contact and provides direct information on requirements of particular customers
Management of demand	creates a balanced structure between the customers' requirements and the manufacturing capabilities of a given enterprise
Implementation of orders	is related to all actions necessary for definition of the customers' requirements, designing of a logistics network and implementation of orders placed by customers

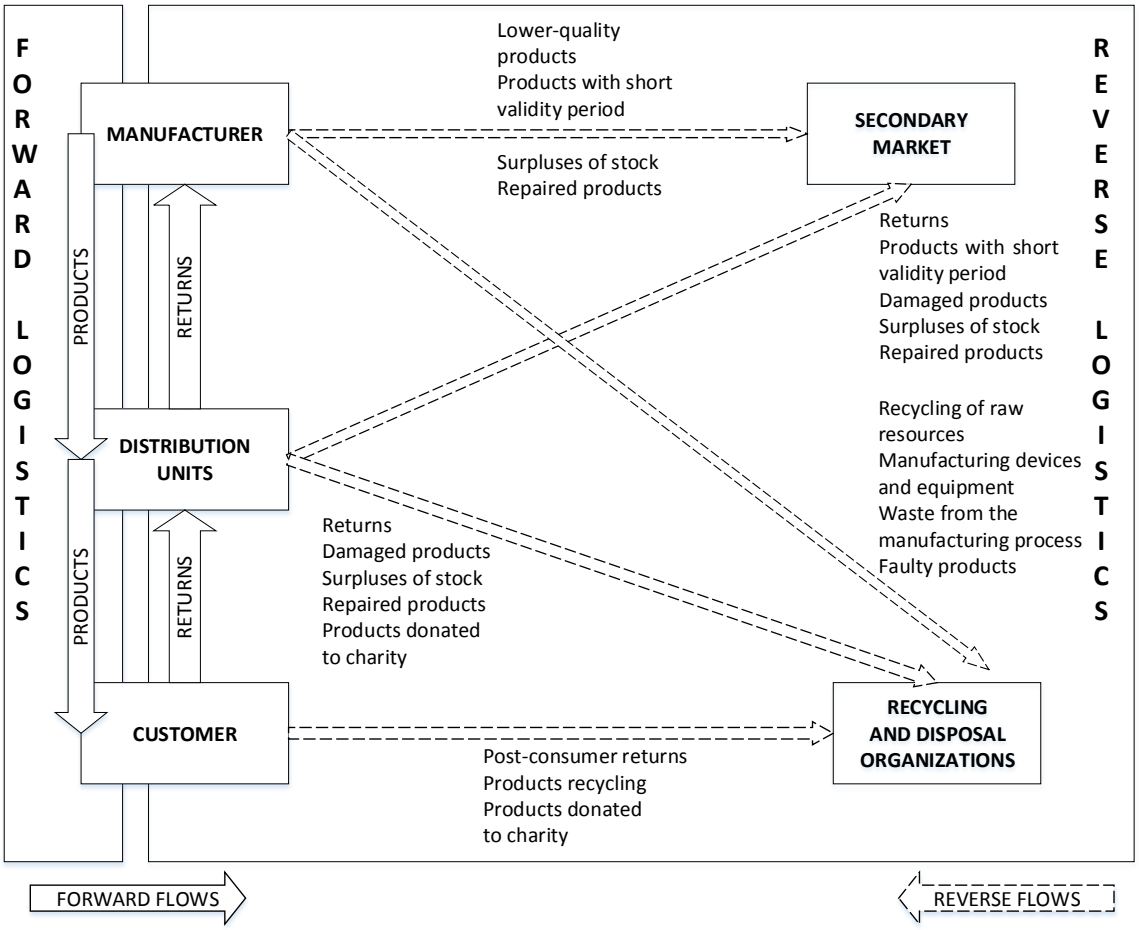
Manufacturing flows management	is related to all actions necessary to shift products between the production units and to acquire the implementation and manufacturing flexibility management in the enterprise
Management of relations with suppliers	creates a structure for development and maintenance of relationships with suppliers
Reverse logistics	is related to all actions related to the reverse flows management emerging in the enterprise

Source: Own work based on: [Croxton et al. 2001; Lambert, Cooper, Pagh 1998].

All of the areas listed in the above table are interdependent and they often condition adequate functioning of other areas with their regularity. Despite the fact that all of the aforementioned areas of logistics management in the enterprise evolve in certain time framework, adjusting to the continuously changing economic, political and social realities, the most significant area when it comes to the sustainable development concept, which currently is broadly promoted in management, is the reverse logistics indeed.

It should be noticed that the enterprises never function independently, but rather in cooperation with the business surroundings, where they remain. Therefore, the reverse flows cover not only the structure of a given enterprise, but also involve other participants of its surroundings [Morgan, Richey Jr, Autry 2016]. The groups of entities that participate in the reverse flow management, undergoing the reverse logistics processes, the following can be listed [Jeszka 2014]: base entities (manufacturer, agent, retailer), specialized intermediaries (recycling points, recovery organizations, etc.), public-private and charity organizations. These entities, by taking part in the reverse flows management, deal with numerous types of supplies for those flows, towards which the reverse logistics processes are implemented (Fig. 1.5).

Figure 1.5. Reverse and forwards logistics in an enterprise and its surroundings



Source: Own work based on: [Monahan 2004].

When flows in reverse logistics are analyzed, it can be seen that the returns emerge on each stage. For example, the reverse flows from the manufacturer or distribution units to secondary markets include: lower-quality products, products with short validity period, surpluses in stocks or repaired products, etc. The reverse flows from the manufacturer or distribution units to the recovery and disposal organizations cover the damaged products, surpluses of supplies, repaired products, goods intended for recycling and products donated to charity, faulty products, manufacturing devices and equipment as well as waste from the manufacturing process. In turn, the reverse flows from the customer are related to the post-consumer returns, products intended for recycling and charity donation [Kumar et al. 2017].

While deliberating various organizational aspects of reverse logistics in the enterprises, there must be certain differences pointed out between the reverse and forward logistics (Table 1.4).

Table 1.4. Differences between the forward and reverse logistics

FORWARD LOGISTICS	REVERSE LOGISTICS
Based on profits and costs optimization	Based on legal and environmental regulations, but also on profits and costs optimization
Relatively easier and direct forecasting of the demand for products	Much harder forecasting of the products returns
Smaller diversity in the products quality	Highly differentiated quality of products
Traditional marketing techniques can be employed	There are factors that make the marketing more complicated
The processing time and phases are well-defined	The processing time and phases depend on the condition of returned products
The goods are transported from one location to numerous destinations	The returned products are collected from various location and sent to a single processing destination
Speed is a competitive advantage	Speed is not a crucial factor
Standardization of the product packagings	Highly-differentiated packaging or no packagings
Standardization of the products structure	Modified products structure
Cost estimation is easier thanks to accounting systems	Determination and visualization of costs is complicated
Alternatives for products disposal are clear	The options for final disposal of the returned products depend on their condition
Consequent stocks management	Inconsequent stocks management
Financial implications are clear	Financial implications are not clear
High transparency of processes during product monitoring in real time	Low transparency of processes because of no information about the monitoring possibilities
Relatively easier management of changes in the products life-cycle	Adjustment to changes in the products life-cycle is harder
The manufacturers are most important	The processing units are most important

Source: Own work based on: [Gupta 2013].

The analysis of differences between the forward and reverse logistics presented in Table 1.4 suggests that they differ significantly what is a result of, first, the direction of logistics flows (forward or reverse), and second, the contents of those flows (products and product returns).

Despite the fact that currently the enterprises are somewhat forced to undertake actions related to implementation of the reverse logistics processes in the reverse flows management, implementation of such solutions poses a great challenge and numerous problems to overcome. Nevertheless, it also brings numerous advantages [Alshamsi, Diabat 2017]. The acceptance of reverse flows itself is less problematic in numerous enterprises, especially the larger ones, while implementation of the reverse logistics processes and the general implementation of this concept is often impossible as it encounters the external resistance - from the partner enterprises, and the internal one - from departments and employees of the company. Meanwhile, the advantages brought by adequately implemented and prepared reverse logistics processes are often reflected in measurable improvement in value of the whole enterprises, and acquisition of a positive result on the side of advantages is possible (Table 1.5).

Table 1.5. Determinants and barriers for implementation of reverse logistics in enterprises

DETERMINANTS	BARRIERS
Reduction in manufacturing costs	High costs and lack of support from the economic policy
Improvement of customer service	Lack of knowledge and awareness in the scope of the reverse logistics processes
Company's image promotion	The need to create adequate technologies
Support from policy and law	No supporting policies or laws
Fulfillment of environmental obligations	Unpredictability and differentiation of demand and supply
Involvement of the managing staff	Inadequate distribution of sources
Focus on the reverse logistics processes	Concerns against changes

Source: Own work based on: [Gupta 2013].

During the analysis of the determinants for implementation of reverse logistics in the enterprises, the foreground is the manufacturing costs reduction, which is possible through employment of returns as a source of spare parts, components and recycled materials. At the same time, the actions related to acceptance of the

returns allow the enterprise to improve the customer service department, and as a consequence improves the company's image. This image is also influenced by pro-environmental action, which is a consequence of implementation of the process of reverse flows management. An additional external incentive is constituted by legal regulations and policies that promote activity in the scope of adequate organization of the reverse flows management [Fancello et al. 2017]. Involvement of the managerial staff in preparation and introduction of changes is equally important, as it is directly reflected in the degree of the employees' involvement in new solutions. This involvement causes that the whole enterprise focuses its efforts both on manufacturing and on the reverse flows management, thus it is possible to reach certain balance between the forward and reverse flows, and this in turn is reflected in achievement of advantages, especially those of economic and environmental character [Bojar, Żelazna-Blichtarz 2008].

While analyzing the barriers for implementation of the reverse logistics in the enterprises, the Table 1.5 presents them in a general form, and for their better demonstration Table 1.6 lists the most frequent barriers encountered by the enterprises during implementation of the reverse logistics into the practice, describing them in detail. They were divided into barriers emerging in the business surroundings of the enterprises and barriers emerging in the enterprises themselves.

Table 1.6. Barriers for implementation of the reverse logistics in the business surroundings and in the enterprises

BUSINESS SURROUNDINGS LEVEL	
Barriers	**Characteristics**
No involvement of the managerial staff	Existing solutions in the partner enterprises adopted in the common business environment can be modified with implementations only in cooperation, and with support from the managerial staff. It should not exert any negative influence on the modified system.
No coherence between the management levels	The solution under implementation should be clearly formulated on each management level, and expressly communicated to all employees it concerns.
Impossibility or reluctance towards information sharing	Lack of communication constitutes a serious problem. Information flows are distorted because of lack of attention or reluctance what leads to serious problems in the flows processes and to impossibility to introduce new solutions Therefore, it is necessary to eliminate such adverse events.
No trust between the business surroundings participants	Lack of trust is a psychological barrier. In case of introduction of new solutions, it is highly harmful and it hinders the progress. Unfortunately, regarding its character, it is hard to eliminate.

Reluctance towards sharing the risk and success	Both the risk and success related to the implemented solution should be divided among the business surroundings participants. The risk should be taken with full awareness and included in the strategy on each level of management. Success motivates the employees, and lack of success becomes a demotivating factor.
No organizational and process flexibility	The organizational structure of each business environment participant should be designed in such a manner that it is possible to quickly and effectively match it to sudden and unexpected changes that results from the introduced solution.
Conflict and protectionism	Each participant of the business surroundings should openly share their knowledge in the scope of the solution under implementation. It is undesired to keep the information as this may lead to a conflict and as a result no cooperation over the implementation among the participants.
Inadequacy and contradiction of effectiveness measures	The effectiveness measures pose an important evaluation criterion for assessment of efficiency. Incorrectness of tools and methods is reflected in incompliance and incompleteness of evaluation of the introduced solutions. It is necessary to unify and develop those measurements in detail so it is possible to measure the expected results during the evaluation.
Reluctance and resistance against changes	Changes are an inevitable element of progress. The resistance towards them is negative and adverse, but almost always present within teams of employees. Overcoming of this phenomenon facilitates the enterprise's potential in the scope of introduction of innovative solutions.
Lack of trainings that would introduce new skills and ways of thinking	Continuous improvements are necessary and they might be achieved through execution of applicable trainings. Acquisition of new skills and change of thinking pose the key success factors while introducing the changes. Lack of them results in negligence of the opportunity to improve the implemented solutions.
ENTERPRISES LEVEL	
Company's policy	The enterprise's policy as regards the general dimension of its operations must be adjusted to the returns management processes. The policy transformation is a long-standing and complicated process, but lack of such changes can lead to a failure in reverse flows management.
Financial resources	A financial barrier usually constitutes a big problem. Investments in new processes in the scope of reverse flows management are often very expensive. If there are no resources, the new implementations should not be resigned from, but rather divided into stages.
Non-significance	The enterprises' employees may often see the problems related to reverse flows as not very significant. There is a need to change such an attitude, as no involvement of the employees in new implementations may cause that undertaking to fail.

Lack of adequate organizational solutions	Implementation of the reverse flows management requires re-organization of work in numerous departments of the enterprise. This is a time-consuming and strenuous process, but necessary for improvement of implementation of new solutions.
Legal circumstances	The applicable law often constitutes a barrier that cannot be overcome by enterprises that implement the reverse flows management. In this case it is necessary to seek other options for solving the problems with returns.
No attention from the managerial staff	The managerial staff must show involvement in the executed implementation No attention from that employees is reflected in loss of motivation of all workers, and it will not allow to become successful.
Incompetent personnel	All employees in the enterprise should be adequately and thoroughly trained in the scope of implemented solutions. Only such a behavior will allow maximum reduction of errors in the reverse flows management, caused by the human factor.

Source: Own work based on: [Gupta 2013].

While deliberating the significance of logistics management in enterprises, it needs to be stressed stress that the use of the reverse logistics processes for operation of the reverse flows absolutely facilitates its organization and exerts positive influence on creation of the added value, coming from repeated use of the product returns.

The presented deliberations allowed describing the logistics management characteristics, embedded in implementation of the sustainable development concept. They also allowed to determine the reverse logistics concept, where the processes implemented for the reverse flow management in the enterprises, allow realization of the sustainable development priorities. The presented theoretical approach forms a context and conceptual background for further deliberations carried out in this monograph, related to implementation of the reverse logistics processes in the field of defective products' flows in the manufacturing enterprises.

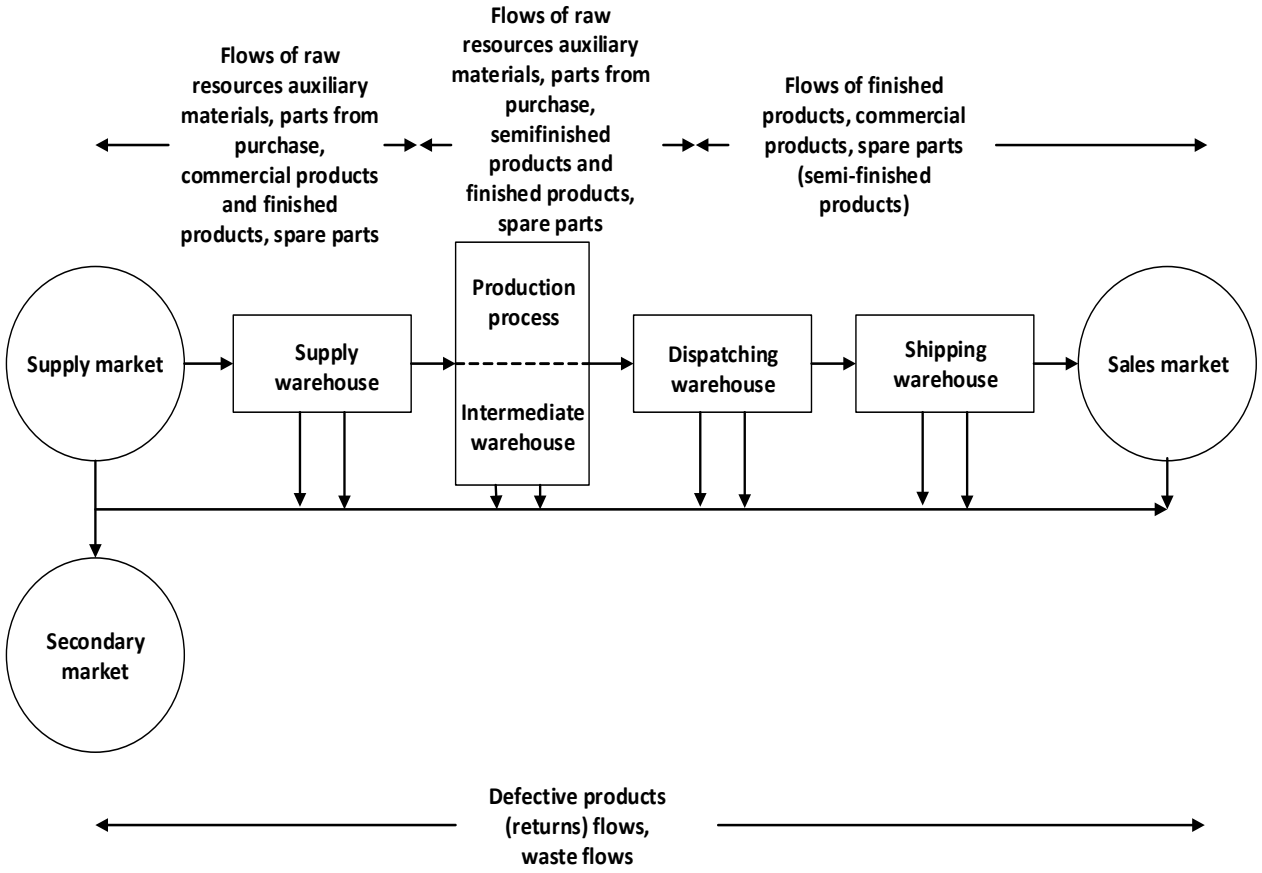
2. Reverse logistics of defective products

2.1. Reverse flows

In enterprises logistics, the management is related to the logistics processes [Sołtysik 2003] that are employed in case of various resources, especially materials and information [Blanchard 2007]. Generally, logistics of a given enterprise is based on correct operation of those flows, thus it is necessary to provide their efficiency and continuity via supervisions resulting from the logistics management function [Nowicka-Skowron 2009].

Logistics flows in an enterprise are presented in Fig. 2.1, where they are separated from the logistics of an economic entity, i.e. a manufacturing enterprise.

Figure 2.1. Flows of products and materials in a manufacturing enterprise

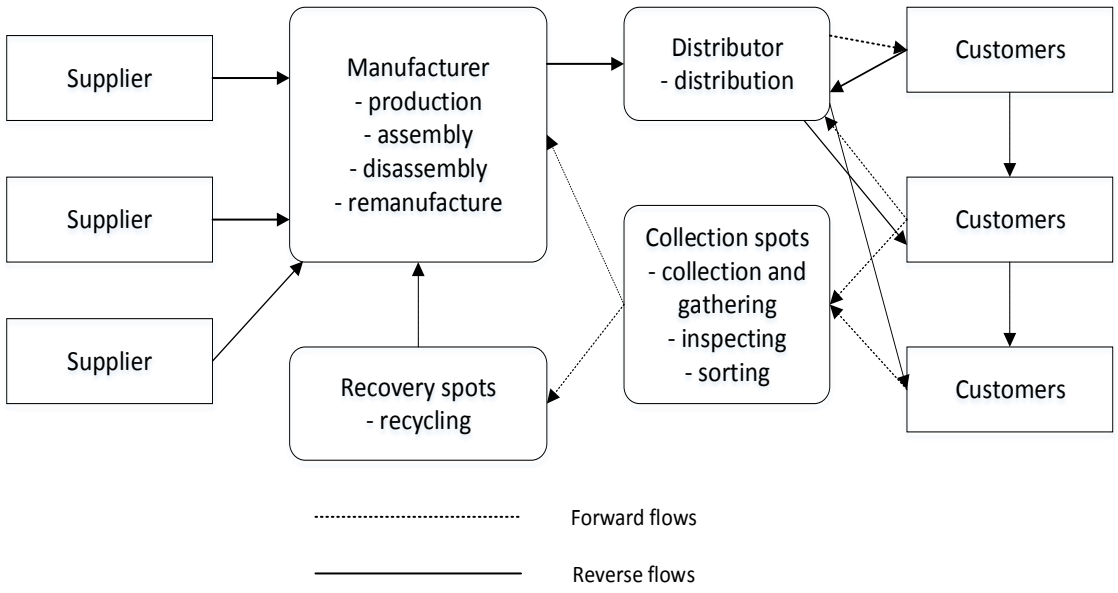


Source: Own work based on [Pfohl 1998].

When it comes to a manufacturing enterprise, logistics flows emerge in relation to supply with raw resources, auxiliary materials, etc., production, where the flows include finished or semi-finished products, and distribution, where the flows regard the commercial products and spare parts. There are also flows supplied with defective products and waste in the manufacturing enterprises [Pfohl 1998].

However, attention must be drawn to the fact that the flows are divided according to their direction (Fig. 2.2), into forward and reverse [Kisperska-Moroń, Sołtysik 1996].

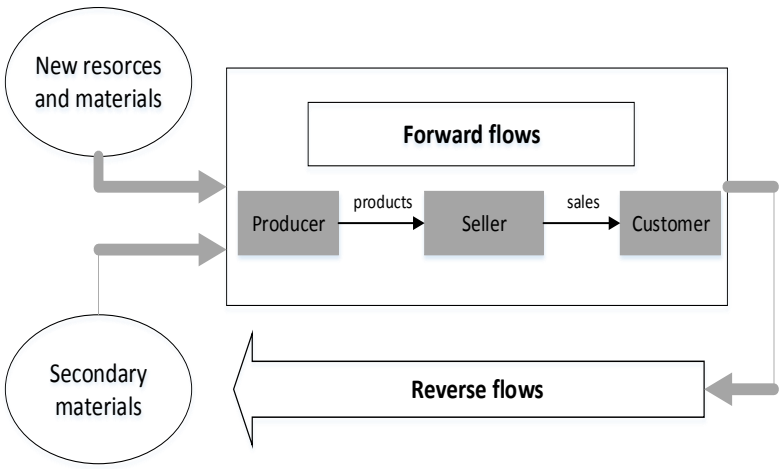
Figure 2.2. Forward and reverse flows in an enterprise and its business surroundings



Source: Own work based on [Lee, Chan 2009].

Forwards flows of materials are directed from the manufacturing spot to delivery to the final customer, along with the accompanying flows of information and finances [Ciesielski, Długosz 2010]. In turn, the reverse flows of materials take place in the opposite direction, i.e. from the final customer to the manufacturing spot or point of obtaining the raw materials for production, also with the accompanying flows of information [Lu, Bostel 2007] what is presented in Fig. 2.3.

Figure 2.3. Directions for forward and reverse flows in logistics



Source: own work based on [Silva et al. 2013].

Flows of materials from the operational perspective of any enterprise are the most important flows, as they ensure fluency of the course of the processes in all fields of operation of this enterprise and its business surroundings. Forward flows of materials include raw resources, semi-finished products, final products, while the reverse flows are supplied with product returns [Skowronek 2005]. These flows have a form of physical flows and they are carried out by adopting appropriate elements of the logistics structure. The material flows are stipulated as a general collection of actions related to physical shifting of products: from the places of their production, to spots where they are received by the final customers (forward flows); from places when they came to an end of life or end of use [Campos et al. 2017], to the spots where it is possible to recover value from them (reverse flows) [Kärkkäinen 2003]. The actions related to the flows of materials that support them are the transport and warehousing processes [Heragu 2008; Sule 2009; Tompkins 2003].

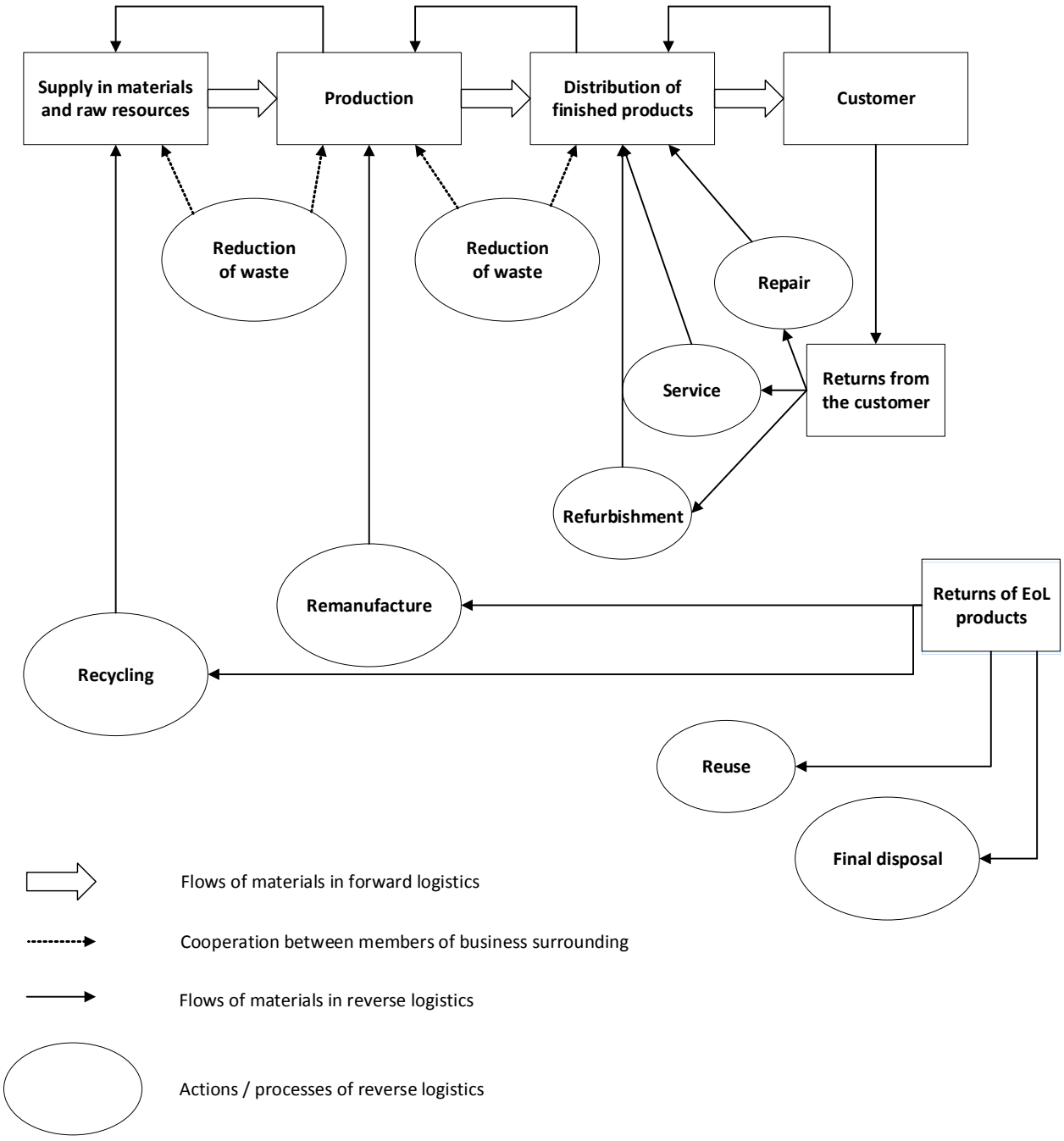
Physical flows of materials in enterprises are strictly related to the information flows that connect that enterprise with all participants of its business surroundings [Bukowski, Feliks 2015]. These flows are usually bi-directional what is intended to ensure continuity of information exchange, and hence effectiveness and efficacy of the performed actions [Jelonek 2010]. Information may be transferred in a form of physical flows of documentation of electronic flows of data and data carriers (both basic computer application and advanced information and IT technologies are employed for this) [Toyasaki, Wakolbinger, Kettinger 2013; Ketzenberg 2009; de Brito, van der Laan 2009].

For the flows of materials, forward or reverse, to function properly, they must be coordinated by logistics management with flows of information [Sawik et al. 2009]. Regarding the complexity level of an enterprise, the reverse and forward flows can be characterized with a smaller or greater level of difficulty in the scope of coordination and matching of particular elements [Barcik, Kubański 2011]. Additionally, when the direction of flows is varied, the predictability and possibilities to control the flows with logistics management are much more complicated (Fig. 2.4).

Figure 2.4 presents the complexity degree of the reverse flows along with basic actions from the scope of reverse logistics as regards their management. Hence, while analyzing the forward and reverse flows in the enterprises, it is possible to point to certain differences between them, which are presented in a table form (Table 2.1).

The aforementioned characteristics of differences between the forward and reverse flows poses the review material and presents the analyzed problem in a simplified manner. A detailed characteristics of the flows is an individual issue in each enterprises, and in numerous cases the forward flows may be more complex than the reverse flows, meaning it would be opposite to what is suggested by the analysis of the features from the table. It also needs to be mentioned here that the reverse flows usually emerge in the enterprises with less intensity than forward flows.

Figure 2.4. The flows of materials in an enterprise and its business surroundings along with basic operations of reverse logistics



Source: own work based on [Srivastava 2008].

When the reverse flows are identified in the enterprise's logistics, it is possible to separate two characteristic structures, an open and a closed loop, which result from the course of actions in the sphere of implementation of the reverse logistics concept.

Table 2.1. Differentiating features for the forward and reverse flows in an enterprise

Differentiating features	Forward flows	Reverse flows
Prediction of structure, content and routes of the flows	low complexity	complex
Distribution of flows	from one to many spots	from many spots to a single spot
Quality of products, packagings, information in the flows	uniformed	highly-differentiated
Routes and intended use of the flows	determined	non-determined
Decisions regarding organization of flows	clearly-stated	unclear, made spontaneously and under pressure
Speed of flows	is significant	is not significant
Stability of flows	stable	not stable
Clarity of the processes related to the flows	clear	unclear
Controlling the life cycle of a product by implementation of the flows	possible	impossible
Negotiations with participants of the business surrounding as regards implementation of the flows	easier	harder
Marketing methods that the flows are subjected to	well-known	marketing that is complex in multiple dimensions

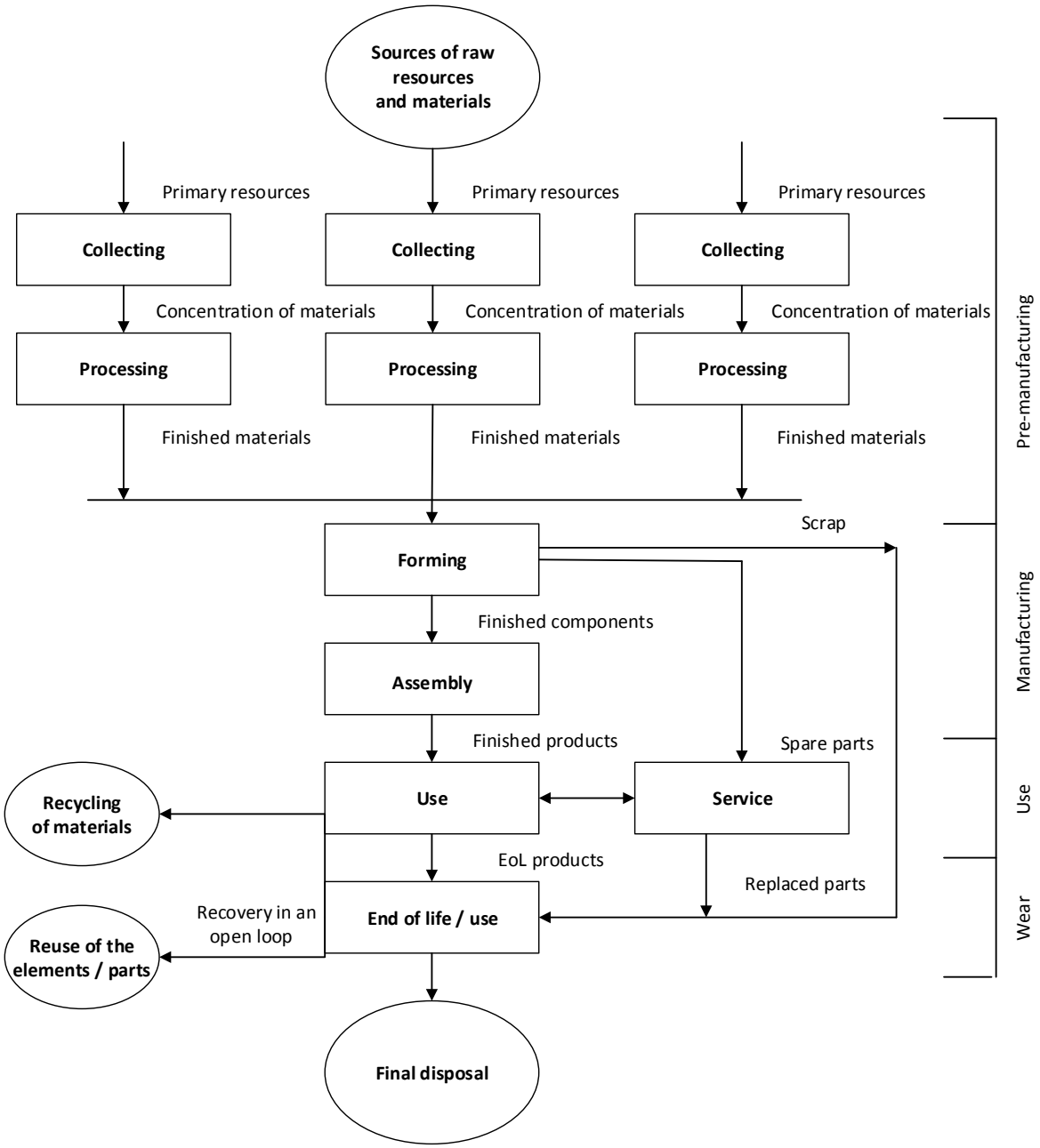
Source: Own work based on [Tibben-Lembke, Rogers 2002].

There are numerous significant publications encountered in the literature, characterized with the closed and open loop [Khatami, Mahootchi, Farahani 2015; Das, Posinasetti 2015; Blumberg 2005; Sarkis 2001; Bettac et al. 1999; Inderfurth, Teunter 2002; Krikke, Kokkinaki, van Nunen 2001; Minner, Kiesmüller 2002]. The loops are related solely to the reverse flows, as the forward flows in both loops have the same route - the raw materials supply the manufacturing process, a finished product

is generated which then is delivered to the final customer who makes use of it. When returns of waste appear in an enterprise, the reverse flows are created, and their course determines the type of the loop [Schenkel et al. 2015; Abbey et al. 2015; Chen, Chan, Chung 2015].

An open loop is when the reverse flows are directly addressed to the units that processes the returns and waste (e.g. recycling organizations) or to landfills (Fig. 2.5).

Figure 2.5. An open loop of reverse flows in an enterprise



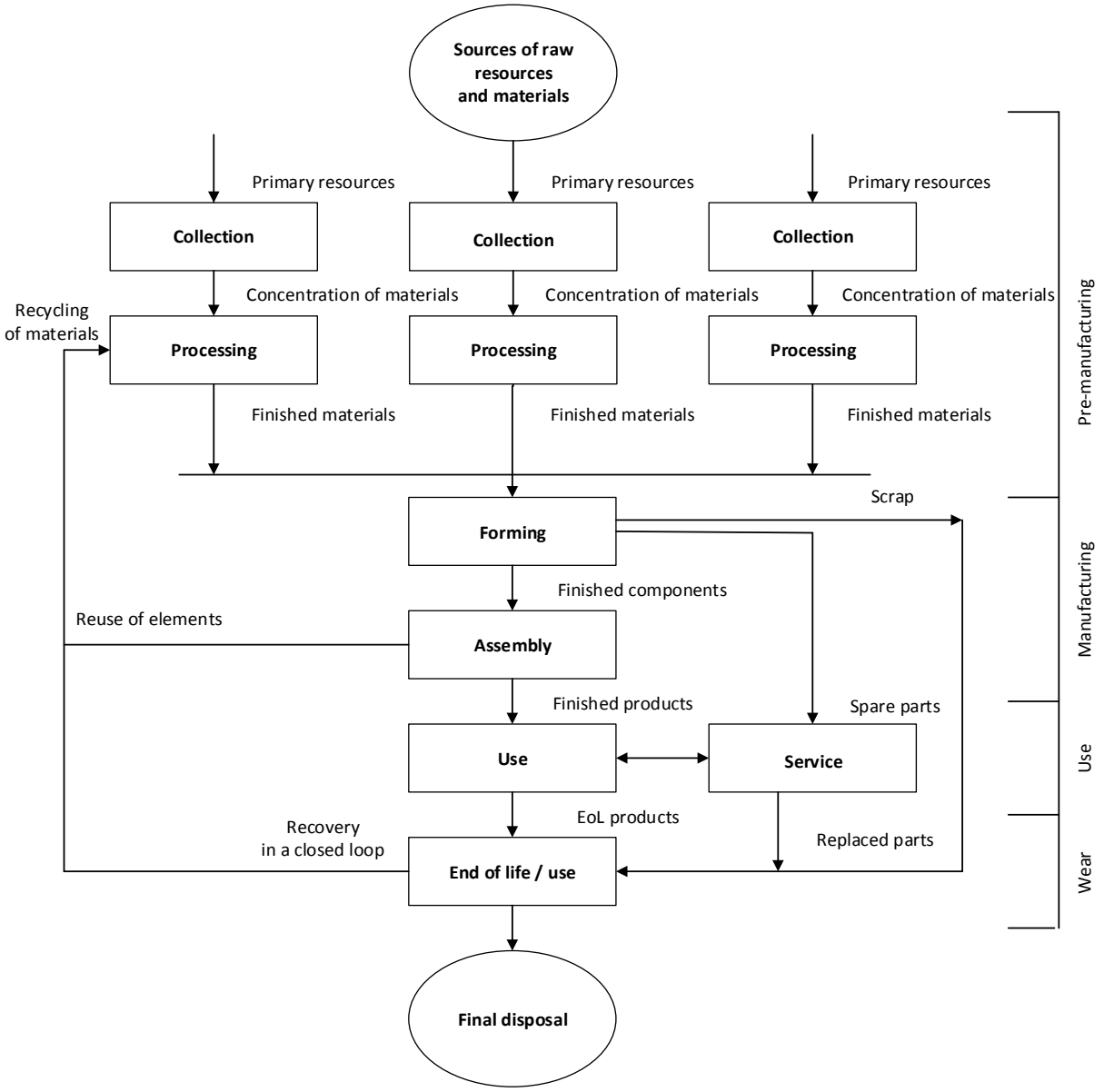
Source: own work based on [Gupta 2013].

In an open loop, the reverse flows in an enterprise are characterized with a much simpler course than in the closed loop. The content of the flows is not re-used, and it is most often deposited on landfills or delivered to specialized recycling

organizations for recovery of value, which however do it for their own use and this value does not supply the same enterprise in any manner whatsoever [Płaczek 2014]. The logistics processes related to reverse flows in an open loop are related to collecting returns and waste, their transport, warehousing and depositing on landfills.

In turn, the closed loop emerges when the reverse flows address their content to the spots that carry out the value recovery processes, and afterwards this content having a form of recovered materials is directed to the starting point of the enterprise, thus supplying the forward flows with secondary raw materials. The recovered value returns to the same enterprise in a closed loop (Fig. 2.6).

Figure 2.6. A closed loop of reverse flows in an enterprise



Source: own work based on [Gupta 2013].

The closed loop is characterized with recirculation of content of the reverse flows. These flows lead to the units, where the processes reinstating the value of products or waste are carried out, so they can supple the forward flows at the starting point of the enterprise in whole, partially, or in a form of secondary raw materials. The reverse flows in a closed loop are subjected to strict quality monitoring, as based on the results of that control there are certain decision made on final disposal and use of the flows contents [Meng et al. 2017].

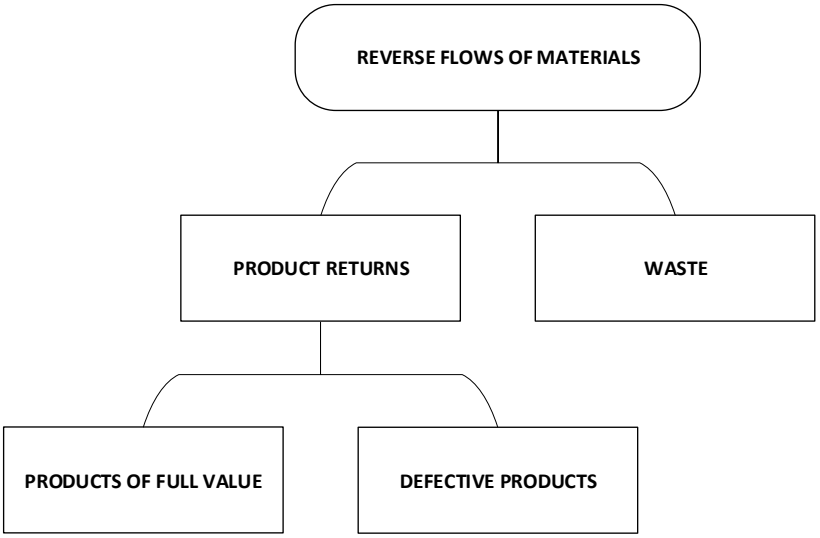
From the economic and environmental perspective, the closed loops of the reverse flows in enterprise are more advantageous, as they bring measurable financial advantages for the enterprise and participants of their business surroundings, in a form of added value that results from the use of secondary instead of primary raw materials along with ecological advantages in a form of being environmentally-friendly and limiting the emissions [Blasco et al. 2014]. At the same time, the closed loops are certainly more difficult in implementation and more complex in management, therefore their implementation causes plenty of problems in numerous enterprises, and in some of them they are not implemented at all. Here, an additional difficulty is posed by the technical and technological barrier, as often the investment in modern possibilities of value recovery overgrows the possibilities of the enterprise [Koppius, Özdemir, Laan 2015; Rezapour et al. 2015].

This chapter illustrates the reverse flows in the enterprise, pointing to the significance and necessity of correct management of those flows that are impossible to avoid in the economic practice, and which - while managed properly - may as a result allow to acquire many various benefits.

2.2. Specificity of the defective products' flows

The manufacturing enterprises, the main activity of which is manufacturing of goods that are afterwards offered to the customers on the market [Skowronek, Sariusz-Wolski 2012], have actually always needed to face the problem of return products, both of full value and defective, which support the logistics flows in a form of returns. The terms describing the returns, i.e. products of full value and defective products, are assumed in such forms for the needs of this work (Fig. 2.7).

Figure 2.7. Contents of the reverse flows of materials



Source: Own work.

In literature of the subject, when it comes to the works on reverse flows and their contents, and in the context of definitions mentioned in this scope, the most common term is "waste", which actually does not completely correspond to its Polish equivalent for waste considered in terms of municipal and industrial waste (possibly with stress put on the hazardous waste). The term "waste" employed in English works describing the reverse flows is of a slightly broader meaning, covering with its scope also the returned products - "returns" or "product returns". The emphasis on this broader meaning is significant because along with evolution of the concepts related to the reverse flows, these are the returned products, included in the term "waste", have become the main subject of interest. The cause of that is initial inclination of these concepts towards the post-sales services covering the returns [Rogers, Tibben-Lembke 1999], and afterwards towards defective products' flows management via the reverse logistics processes. Nowadays, the concept of reverse logistics is considered in two contexts: in relation to municipal and industrial waste management including the hazardous waste, and in relation to the defective products' flows management[15].

Furthermore, while classifying the contents of reverse flows of materials into the product returns and waste, it is necessary to make the first ones more detailed by further dividing them into returns of products of full value and returns of defective products. This division is based on the concept of reverse logistics, where the product returns, before supplying the reverse flows, are subjected to the gatekeeping process.

This is the basis for classification of the products as of full value - when the decision on their inclusion into the reverse flows is negative, and as defective - when the decision on their inclusion into reverse flows is positive. This division is significant

[15] In the monograph, the concept of reverse logistics is considered in relation to the defective products' flows management. However, it must be mentioned here that the waste is included in the empirical part in order to point out their place in the reverse flows and establish a comparative background and a reference point for the defective products.

from the perspective of performed deliberations regarding defective products' flows management, as the returned products of full value do not pose the content of the reverse flows, so management of those flows does not refer to them. The returns of products of full value are the first-quality products, which are returned by the customer in an identical and original condition that they were purchased or received in. Therefore, the only action undertaken towards those returns is their redirection for sales in forward flows. In turn, the returns of defective products supply the reverse flows and are therefore classified as products subjected to management of that flows within implementation of the reverse logistics processes. This type of returns includes all returns products and those that do not meet the criteria of products of full value, so they are products that have come to an end of life or end of use, but they still represent some value that can be used again [Nitkiewicz 2013].

Defective products' flows in an enterprise are subjected to the logistics processes management, where there are decisions made about them in the scope of implementation of the reverse logistics concept. The defective products' flows management can be defined as: "management of all logistics processes and operation related to the defective products returned by the final and original users to the supplier or manufacturer, with an intention for the cost-effective recycling, according to all legal standards" [Shulman, Coughlan, Savaskan 2011]. This means that the defective products' flows management covers a whole scope of activities related to implementation of the reverse logistics flows, beginning with the entrance into its processes through gatekeeping, and ending at leaving the procedures, where after the final disposal process, the value recovered from the defective products supplies the same or different flows of the enterprise or its business surroundings.

Hence, correct implementation of the defective products' flows management in enterprise poses some significant support for not only positive results from the reverse flows management, supplied with the returned defective products what is within the scope of competence of the reverse logistics, but it also improves the decision-making process in the area of possibilities for reduction of reverse flows and control over the value of those flows - the possibility for recovery and reuse.

The reverse flows management is usually related to the ecological activities of enterprises, forced by legislative and market influence. This is the basis, on which the manufacturing enterprises undertake actions for voluntary acceptance of the returns [Arora, Cason 1995; Khanna, Damon 1999]. Therefore, they ensure compliance with applicable law and at the same time the long-term presence on the market [Suchman 1995]. Of course, apart from ecological premises, the increase in global competition on the markets [Popa 2012] and shortening life cycles of products along with returns policy that is customer-friendly, contribute to the increase in the quantity of returned products what mobilizes the enterprises to introduce solutions in this scope, i.e. to introduce the reverse logistics concept [Guide, Harrison, Van Wassenhove 2003].

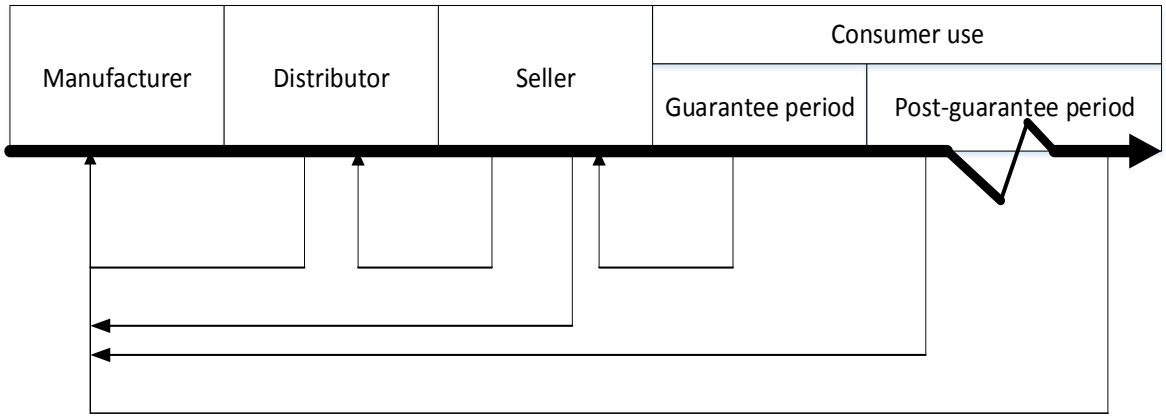
However, apart from the internal pressures exerted on the enterprises in the scope of introduction of solutions from the reverse flows management,

they themselves noticed the possibilities brought by effective management of the reverse logistic processes in a form of, among others, improvement in customer service, more effective supplies management or disposal of products [Norek 2002; Stock, Speh, Shear 2006; Mollenkopf, Russo, Frankel 2007; Mollenkopf et al. 2007; Mollenkopf 2010; Frankel, Mollenkopf, Russo 2010].

The topic of returns of the defective products has been especially applicable within recent a dozen or so year because of liberalization of the markets, their globalization [Czakon 2010] and liberal policy of the offering parties towards the customers, as well as because of emergence of modern techniques and technologies that cause the products to have shorter life cycles [Chatfield, Pritchard 2013]. Therefore, the notion of product return is faced by all manufacturers, and these are their decisions that influence the manner, which the enterprise will deal with this problem in.

The returned defective products and adequately organized handling should pose a significant point considered by the manufacturing enterprises while agreeing on the management strategy. The current market conditions distribute the problem of returns among all participants of the business surroundings, but the manufacturers are those entities that are especially required (Fig. 2.8) to organize the defective products' flows management [Srivastava 2007; Toffel 2004].

Figure 2.8. The returns that depend on the product's life cycle in the business surroundings of enterprises



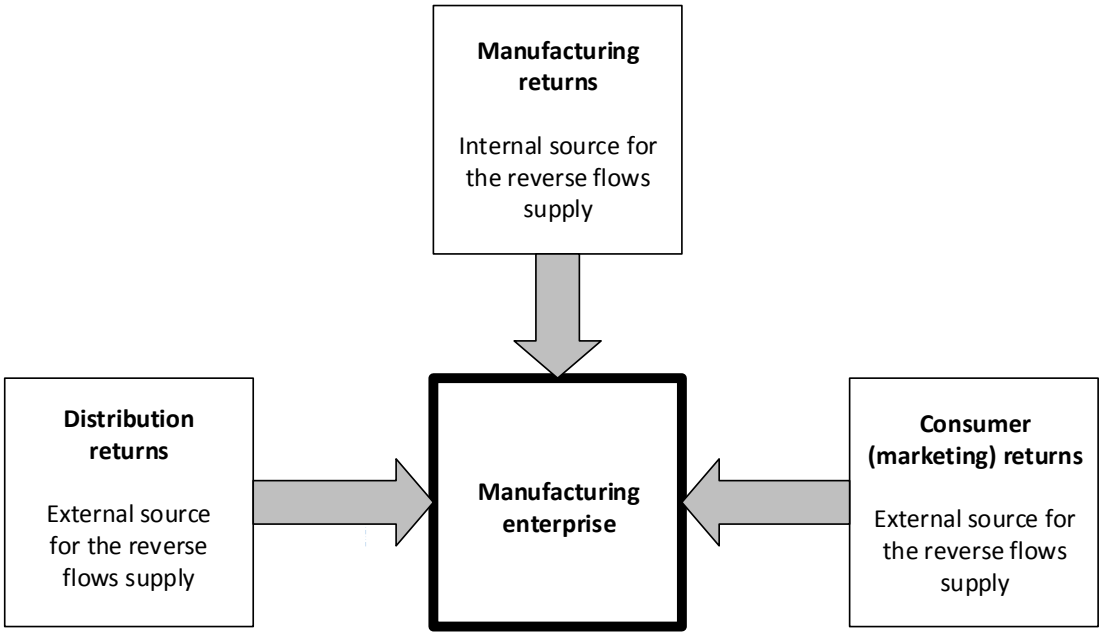
Source: Own work based on [Ait-Kadi et al. 2012].

Unfortunately, there are still some cases - although less frequent - that some manufacturing enterprises fail to see the benefits [Fleischmann, Kuik 2003], among others in a form of positive impact on the market share and increase in the competitive positions [Stankiewicz 2005], resulting from implementation of the reverse logistics processes in defective products' flows management [Jaayaraman, Luo 2007].

There are numerous types of returned defective products in the practice of manufacturing enterprises, which move within the reverse flows and must be correctly disposed based on adequate decisions in terms of the reverse logistics processes.

The literature of the subject presents a lot of divisions classifying the returns according to the differentiated features and sources of origin [Andel 1997]. According to the most common classical division executed in a general grasp, the returns that supply the defective products' flows are divide according to the place in the business surrounding of the enterprise where they emerged what at the same time is reflected in three phases occurring in the product life cycle (Fig. 2.9), into manufacturing returns, distribution returns and consumer (marketing) returns [de Brito, Dekker 2004].

Figure 2.9. Basic classification of returns of defective products



Source: Own work based on [Stindt, Sahamie 2012].

The manufacturing returns are the returns that result from the goods manufacturing processes and they pose an internal source of supply for the reverse flows. In turn, the distribution and consumer (marketing) returns come from external sources, thus it is impossible to subject them to the manufacturer's inspection, therefore their management is more complicated.

What is more, the manufacturing returns are characterized with the fact that they usually are not related to finished products, but only to their parts, components, by-products from the manufacturing process, products that do not meet the project specification, etc. but they sometimes include whole batches of final products, mainly out of quality reasons. This groups includes first of all the surpluses of raw materials, returns from quality inspections, post-production remains.

The distribution returns are the returned caused by damage (e.g. in transport), completion or weakening of sales (the source is posed by wholesalers and retailers), or generally understood pollution (e.g. in transport or displayed products), i.e. mainly commercial returns or surpluses of stock.

The consumer (marketing) returns are product that came to an end of life, end of use or which require a repair, service or were returned in the guarantee period. These returns come from the final market, from the final customer or user (division of returns made based on: [Talbot, Lefebvre, Lefebvre 2007]).

The second, classic division of returns presents their characters in more details, and refers to the quality of returned products to a greater degree. This division includes [Rogers, Tibben-Lembke 2001]:

- damaged products (failed during use, but may be repaired or reused);
- outdated products (still representing a certain value);
- seasonal products (they may be reused in the next season);
- products unsold in retail (they may serve as raw materials or components for repeated production, or they may be sold on another market);
- products withdrawn from sales (may be used as raw materials or components for repeated production);
- products erroneously taken as faulty (after refurbishment they may be sold again on the primary market);
- product components (still representing a certain value);
- waste- and by-products (must be neutralized or employed for production of energy);
- packagings (must return to the starting point or be delivered to the recycling organization)[16].

At the same time, the defective products that supply the reverse flows of enterprises may be divided into five main categories, taking into account the reason for the return. According to that divisions, they are as follows [de Brito, Dekker 2002]: returns of products with ended life cycle, commercial (or marketing) returns, guarantee returns (products with valid guarantee), post-production waste and by-products (mainly manufacturing returns) and packagings.

According to another division, reflected in the literature, there are five main categories of the returns differentiated, while the analysis of those categories approximates and complements them towards the division that was mentioned first (manufacturing, distribution and consumer returns) [Lambert 2008]:

1. Consumer returns - most numerous category of returns. They are made by the purchasers out of highly differentiated reasons (e.g. faults in products, not matching the purchaser's liking, no possibility to use the product), and they emerge mainly in manufacturing enterprises that are characterized with a liberal returns policy.
2. Marketing returns, made by the participant of the business surrounding. They are most often caused by the weak sales of the products, problems with quality or the need to free some space in a warehouse. This category additionally includes the returns that arise from withdrawal from or closure

[16] These two presented classic divisions are generally considered as crucial in the literature, which is why the further theoretical and research parts of this work adopt them for interpretation of the issues related to categorization of the returns.

of business activity (first-quality products, which are returned because the seller resigned from the contract with the manufacturer or liquidated their business), returns from a byout (related to the practices of unhealthy competition, when other manufacturer bough out a seller, and forbid the sales of products from other manufacturers in the contract), seasonal returns (returns of first-quality products returned because the sales period ended), returns from surpluses (returns of products ordered in excessive amounts). The marketing returns result from specificity of a given market and management practices implemented in an improper manner. What is more, they often pose a significant share in the general amount of returns.

3. Asset returns refer to the manufacturer's willingness to recover and/or reposition a part or whole value employed for creation of those products, meaning that the manufacturer attempts to have them returned. These returns are most often related to reusable packaging and transport materials.
4. Product returns pose a specific and unique category of returns. This form of returns is initiated by the manufacturer, who makes such a decision because the products failed to meet the security requirements or they show significant faults in quality. This category of returns may have a form of voluntary decisions (the customers make their own decision on whether to return the product

   or not), or obligatory ones (the customers are obliged to return the product, and the manufacturer must make sure they do so, e.g. following the governmental order). The characteristic features of those returns comprise of their suddenness and abundance, which is why they require an especially well-planned and well-organized management.
5. Environmental returns are related to products that include hazardous and toxic materials or that were permanently withdrawn from sales by applicable legal and environmental regulations. This kind of returns differs from the remaining ones because the applicable regulations may exclude, and thus limit, certain options for final disposal of such returns. What is more, full and comprehensive documentation is necessary in their case, and additional inspection and audits are often required.

The manufacturing enterprises' acceptance of the defective products returns is founded on three dimensions: economic, marketing and legislative (the applicable legal and environmental regulations) [Meyer 1999]. The returns can be accepted by an enterprise that seeks for the benefits in only one dimension, in two dimensions or in all three dimensions, as it generally depends on the type of products and kind of the industrial sector that a given enterprise operates within. The economic dimension is related to the companies' noticing certain financial benefits that arise from the possibility to process and dispose the returns. The marketing dimension is referred to meeting the customer's expectations, who finds it more comfortable to purchase products than to return the goods that are not satisfactory in any manner [Rubio, Jiménez-Parra 2017]. The legislative dimension somehow forces the manufacturers

to accept the returns, as they are either obliged to do so by legal provisions, or forced by environmental requirements, where rejection of returns may result in financial fines [Ait-Kadi et al. 2012].

Numerous authors refer to quantitative and qualitative research presenting the benefits for manufacturers, arising from effectively implemented reverse logistics processes in the area of defective products, in a form of an increase in sales [Jayaraman, Luo 2007] or an increase in profitability along with a decrease in the operational costs by reuse of the accepted product returns [Stock, Mulki 2009].

Furthermore, the analysis of the literature of the subject stresses certain determinants that encourage the manufacturing enterprises to implement an effectively functioning reverse flows management system. First of all, in some industrial sectors, the volume of defective products' returns is larger than in others[17], as a result of which the manufacturers must find a way to dispose the returns in an appropriate manner [Trebilcock 2002]. What is more, the returned defective products exert significant influence on the increase of costs in the enterprise, and this is where the reverse logistics operations are helpful, including reuse of materials or components, processing of goods or another manner of their disposal [Blackburn et al. 2004]. The enterprises, while analyzing their operations, notice that sales of the returned defective products on the secondary markets may provide them with a new source of income [Meyer 1999] what does not contradict the additional benefits arising from such an action in a form of following the legal regulations that are increasingly more advantageous for ecologic development and the ecologic and social liability for their products [Fishbein 1994; Toffel 2003]. The pressure exerted by customers on the manufacturers is also significant when it comes to new manners of products management. Especially such that are toxic or hazardous, as the customers are not willing to bear the liability for such goods on their own [Brzeziński 2012], and the manufacturer who intends to maintain good relations with the customers, must respect their expectations [Dües, Tan, Lim 2012]. Finally, a highly significant issue regarding the defective products' flows management, which in this case is at the same time closely related to the waste management process, is the limited and at the same time depleting capacity of landfills (with both municipal and industrial waste). Therefore, solutions regarding reverse flows management that employ the reverse logistics processes, other than depositing waste on landfills, are highly desired and met with a political and social approval [Thierry et al. 1995]. Determinants for implementation of the defective products' flows management are not limited to only those mentioned above, however those seem to be the most significant ones from the perspective of economy, law and society.

The defective products' flows that emerge in that fields in a form of returns, appear in majority in manufacturing enterprises, as it seems that it is impossible to eliminate them completely in the present reality [Rogers et al. 2001].

[17] For example, based on the literature review, they might be manufacturing of electronic devices, automotive equipment, household appliances, clothing or the publishing industry.

The product returns, especially the returns of defective products, are not desired within flows of the enterprises, as they usually prove failure of any of the strategic or operational actions [Misni, Lee 2017]. However, it is the nature of the returns that although being unwelcome, they are inevitable [DeCroix, Zipkin 2005]. Since they are an inevitable and necessary element in logistics of enterprises, the satisfaction from such actions can be ensured only by organization of proper handling both by the customers and participants of the business surrounding, including the manufacturers themselves [DeCroix, Song, Zipkin 2005].

To sum up the general characteristics and specificty of the defective products returns, it must be stated that it is necessary to emphasize one more aspect, namely the difficulties in management. All types of returns that supply the return flows are characterized with a high level of uncertainty [Kiesmueller, van der Laan 2001; Cheung, Yuan 2003], related to the moment of their emergence in the enterprise's flows, to the time and place they appear in, and to their quantity and quality [Lieckens, Vandaele 2007]. All of those elements, burdened with lack of information must be considered in the manufacturing enterprises - attempts must be taken to anticipate and forecast them [Grondys 2016], and facilitate the information flows, as this is the only way the correct organization of the defective products' flows management is possible, which covers implementation of the reverse logistics concept.

2.3. Reverse logistics processes in the defective products' flows management

There are numerous authors in literature of the subject who present the reverse logistics processes by differentiating the perspective, which the reverse flows are grasped in. However, while considering the reverse logistics processes in general terms, they may be presented in a graphical form, as in the Figure 2.10.

Within the scope of implementation of the reverse logistics, the defective products' flows are first of all subjected to the conventional operations in logistics, such as among others transport, warehousing or stock management[18]. However, they are complemented by specific processes (Fig. 2.10), related to collecting, gathering, controlling and sorting of returns, and making decisions about their further disposal [Simões et al. 2017].

Bearing in mind the reverse logistics processes presented in Figure 2.10, special attention must be drawn to two processes: avoidance of returns and gatekeeping, which are crucial when it comes to creation of reverse flows, therefore they influence the correctness and effectiveness of implementation of further reverse logistics processes in the enterprises within the area of defective products [Luthra et al. 2017].

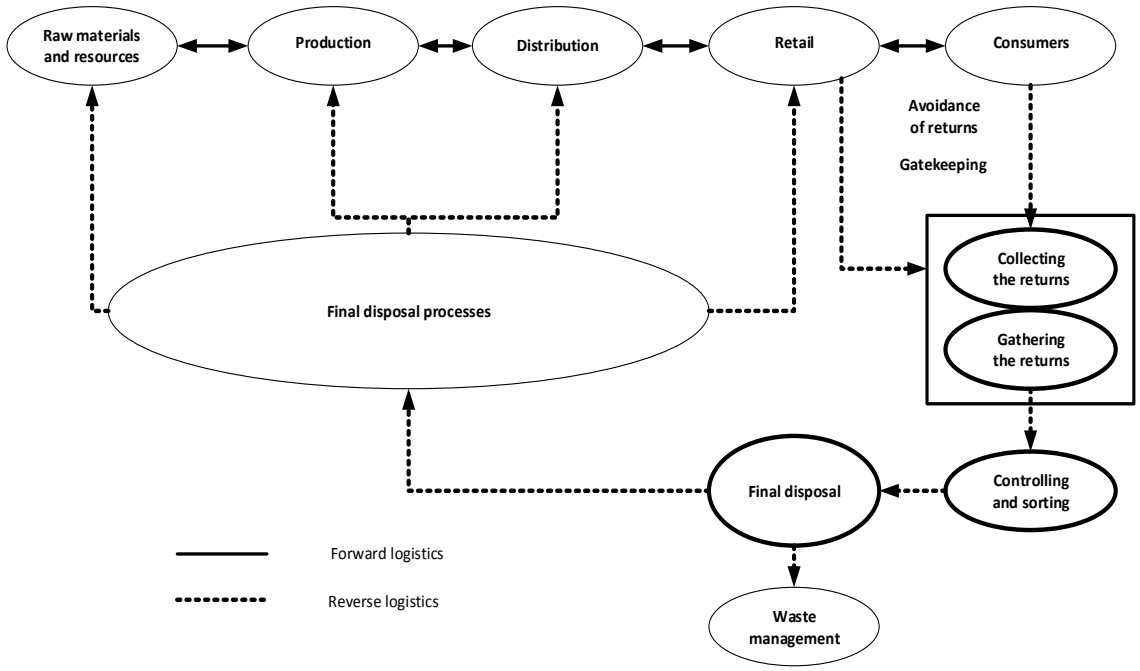
The process of avoiding the returns in the reverse logistics is certainly of a concept character.

It refers to seeking possibilities for minimization of the amount of returns that supply the reverse flows. Avoidance aims to find ways to minimize return requests

[18] The conventional logistics operations in the reverse logistics are based on the generally assumed theory and practice in this scope, thus the monograph does not describe these themes, rather focusing on the complementary processes that are specific for defective products' flows management in manufacturing enterprises.

[Rogers et al. 2002; Lambert 2004] or returns by developing and selling products in such a manner. It is first of all related to the decisions that will further ensure that before the products are sold and dispatched, their quality and user-friendliness for customers on a feasible level are ensured [Lisiecka 2013]. Hence, the final recipient, while receiving the product, will have no reservations or reasons to return it. This process also refers to numerous decisions that will change the promotional program in order to achieve the highest possible sales of products that have already been dispatched to the final recipients, and towards which it is already known that there have or will be certain problems with their sales in current conditions.

Figure 2.10. Defective products' flows and reverse logistics processes in the scope of their management



Source: Own work based on [Rogers, Tibben-Lembke 1999: Fleischmann et al. 2000; Fleischmann 2001; Guide, Wassenhove 2002].

Therefore, there is a need for interference that will avoid the possibility of returns [Janse, Schuur, de Brito 2010; Bernon, Rossi 2011; Genchev, Glenn Richey, Gabler 2011; Rogers, Melamed, Lembke 2012].

Gatekeeping takes place on the contact point of forwards and reverse flows in an enterprise. It consists in determination on whether the products accomplish the forward flows should be qualified for reverse flows. The gatekeeping activity is meant to guide the individual returns to the best individual disposition, given the returns cost and possible value recovery [Thierry et al. 1995]. This is the process where the crucial decision is made on which products will supply the reverse flows and take part in the further reverse logistics processes [Genchev, Glenn Richey, Gabler 2011; Rogers, Melamed, Lembke 2012; Meade, Sarkis, Presley 2007].

In the literature, the gatekeeping process is classified in the category of the first process of reverse logistics, as without it the remaining processes do not only lose their value and quality significantly, but are actually not implemented at all. When it comes to management of reverse flows, great emphasis is put on determination of practices employed by enterprises, intended to identify which products or materials meet the criteria of those flows, and which are not eligible, so they are not accepted there. The term gatekeeping applies to the moment the enterprise makes a decision in this scope, posing the essence of supplies acquisition for reverse flows.

Having gained the acceptance in the gatekeeping process, the returned products or materials that support the reverse flows undergo the collecting process, which is preceded by activities that are intended to derive them from various sources of origin. Afterwards, the content of reverse flows is controlled in term of the general conditions, first of all quality, and it is sorted to various categories of returns on that basis. The next stage is redirection of the reverse flows, according to the previous sorting, to the units that can repair, reuse, or employ them for repeated production, recycle them or adopt another action that will reinstate its efficacy and/or usefulness, or eventually deliver the product to a landfill.

Another process of reverse logistics - collecting of the returned defective products – consists in recovery of whole products, their parts, components and materials from final users to subject them to further processes intended to recover the value. This process is especially significant for operation of the reverse logistics, as the returns of defective products are characterized with a significant level of uncertainty as regards the time of their use, and it is impossible to predict when a product will transform from a product of full value into a defective one, and supply the reverse flows as a return [Fleischmann et al. 1997]. At the same time, collecting the returns of defective products, despite being the first stage in the reverse logistics, is also a process of the greatest significance regarding the fact that it is a basis for determination of profitability and effectiveness of further reverse logistics processes [Guide, Wassenhove 2003].

Another crucial process in reverse logistics is gathering of the returned defective products and their delivery to the specialized units that deal with their controlling, sorting and decision-making in the scope of further disposal. The gathering of returns is related to the actions, during which the enterprises become owners of the defective products, acquired previously within the collecting process, to manage them freely on the next stages of value recovery [Fleischmann, Van Nunen, Grave 2003]. Therefore, the main subject that realizes the process of gathering the defective product is the manufacturer. Its physical flows on the stage of collecting of defective products may be supplied with returns flowing from three directions: directly from the final users or indirectly, with consideration of intermediaries in a form of retailers or third parties [Kumar, Putnam 2008]. At the same time, the manufacturer does not have the possibility to gather the returns by employing one of the two alternative methods based on determination of the control degree (regarding quality and quantity) towards the returned defective products. In the first alternative, there is no control over

the returned defective products, and in the second, which is the individual gathering method, the manufacturer has full control over the returned products [Webster, Mitra 2007]. The first method brings great risk as to the amount and quality of the collected defective products, while the second one reduces this risk to a significant extent, but makes the collecting process much more strenuous, time-consuming and expensive. Therefore, the selection of the method for the gathering process depends on the cost structure and the budget devoted to actions related to reverse flows management [Atasu, Toktay, van Wassenhove 2013], as well as on the decisions made in the scope of returns management - in this case from the decision determining the quantitative volume of returned defective products what will allow to achieve the assumed results [Pochampally, Gupta 2004].

Another crucial reverse logistics process is the sorting and controlling process composed of two coordinated actions. While assuming that is common in the literature of the subject, to state that the consumers return the products out of known and unknown reasons [Rogers, Tibben-Lembke 1999], it is also assumed that the condition of returned products is highly differentiated. Therefore, the control carried out separately for each product that supplies the flows is so significant and required, and therefore this control is an action that precedes the sorting of gathered defective products. During the control, evaluation is carried out on both the appearance and condition of the returned product and its components. The products and components may be adequately sorted only after the evaluation is completed [de Brito, Dekker 2002].

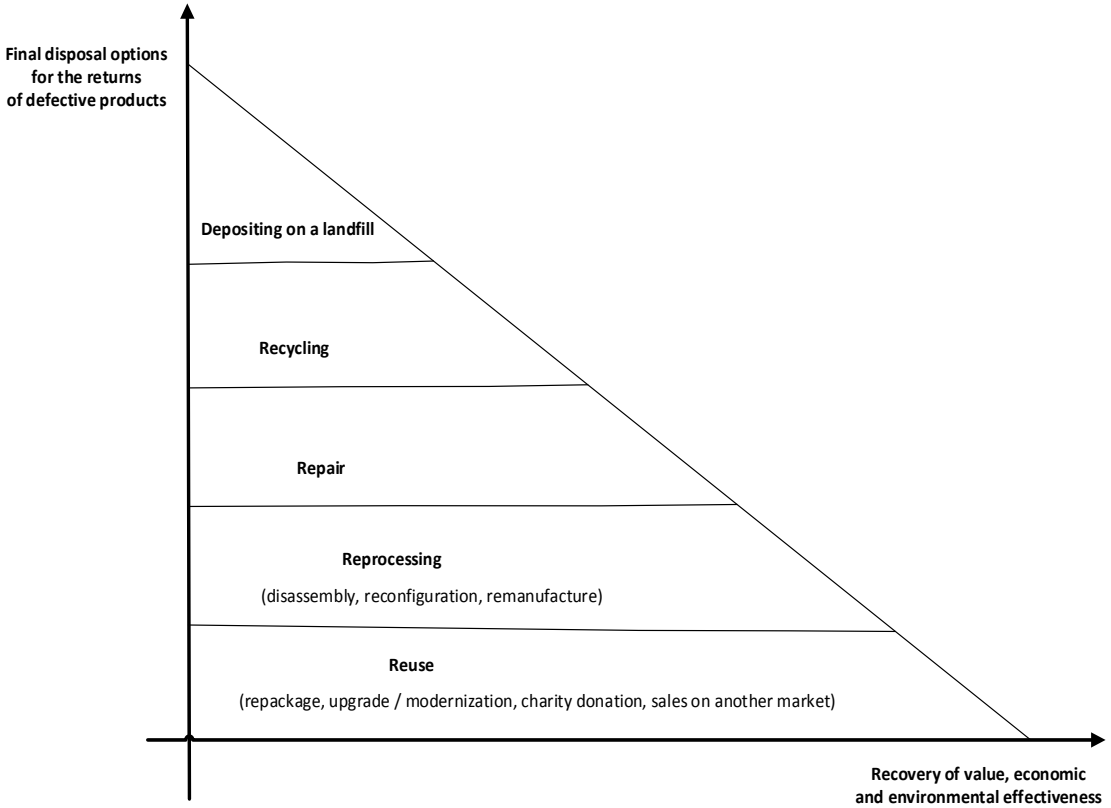
The last crucial process in the reverse logistics is the decision-making process regarding further management of the returned defective products, i.e. their final disposal according to actions (options) intended to recover the value from those products. On the initial stages of development of science regarding reverse logistics, the decision-making process related to the returns management was based on three main possibilities, i.e. reuse of product, recovery of materials or inclusion of the product into the waste management processes [Thierry et al. 1995]. The fourth possibility appeared at the beginning of the 21st century, namely the possibility to upgrade the product [Krikke, Bloemhof-Ruwaard, van Wassenhove 2003; Tibben-Lembke, Rogers 2002], and a moment later, based on the market research, there was a hierarchy for five disposal actions agreed on: sales of products as new, repair or repackage and sales of products as new, repair or repackage and sales of products as used, sales of products as outdated, sales of products as outdated at a lower price, sales of products as outdated at a price equal to the manufacturing costs [Norek 2003; Lambert, Riopel, Abdul-Kader 2011; Ait-Kadi et al. 2012].

In subsequent years, there were numerous propositions emerging in the literature of the subject, in varied combinations, related to the possibilities of further disposal of defective products' returns. However, the economic practice implements five most popular and common groups of alternative final disposal actions for returned defective products, along with the options implemented in their field [Thierry et al. 1995; de Brito, Dekker 2002; Fleischmann et al. 1997; Mutha, Pokharel 2009]:

- reuse - repackage, upgrade/modernization, charity donation, sales on another market,
- reprocessing - disassembly, reconfiguration, regeneration,
- repair,
- recycling,
- final disposal in waste management.

A decision on the manner of further disposal is a key process directly embedded in the reverse logistics [Sangwan 2017].

Figure 2.11. A pyramid with hierarchy of actions within the final disposal of defective products



Source: Own work based on: [van Wassenhove, Zikopoulos 2011; Nikolaidis 2013].

This decision is related to determination of an action (option), during which the products or value it holds will be recovered. Generally, the value recovery is carried out, first of all, because of applicable legal and environmental regulations, and second of all, regarding the market requirements, and third of all, bearing in mind the economic value included in the returned defective products (Fig. 2.11).

While making a decision on reusing the products, we may choose the option of repackage, upgrade/modernization, charity donation and sales on the market other than the primary one. Only few returned defective products are suitable for these options, as in the general characteristics, they consist in lack of interference with the returns (or the interference is slight), and then such products are reuse in their standard applications. More specifically, the repackage option includes the products returned in their original quality conditions, but with a damaged packaging that must

be replaced with a new one, and afterwards the product may supply the forward logistics flows. When it comes to the upgrade or modernization option, the returned products are also in a very good quality condition, but they require a slight modification, which will make them look more modern or improve their functionality so they correspond to the current market trends (e.g. seasonal or electronic products) [Mitra 2007]. This option is related to the moral aging of the products, which means that the products of full value, as a result of rapid technological, technical or other changes (e.g. fashion trends), become defective products as they fail to meet the ongoing standards of use. Charity donation from the defective products is related to their good quality, but it also means that the enterprise regards them as unwanted. Therefore, the company willing to improve its image may decide to hand donate those products to charity. In turn, sales of products on another market means that the products do not match the primary market out of numerous reasons, but regarding their good quality, there is a need to change e.g. the language of the manual or packaging - in other words, adjust the products to requirements of another market, and afterwards sell them on that market [Krumwiede, Sheu 2002]. Most frequently, in the literature, the actions of reuse cover the returns of packaging products. An example here may be posed by bottles [Gonzales-Torre, Adenso-Diaz, Artiba 2004], palettes or containers [Kroon, Vrijens 1995; Kelle, Silver 1989]. Furthermore, reuse is related to products that the users did not use, so their quality condition corresponds to their initial version. Other products are usually unsuitable for reuse within final disposal because of their frequently not the best quality condition [Zikopoulos, Tagaras 2007].

The recovery of value from the returns may also take place through reprocessing, i.e. the options of disassembly, reconfiguration and regeneration. The returned products are disassembled, and afterwards their parts are used in manufacturing of the same or different products. The case is similar with reconfiguration and regeneration, which adopt minor repairs, renovations, replacement of parts, refurbishment or cleaning to reinstate the returned products to their original form what is the goal of reprocessing. This option is usually adopted in the automotive, electronic industry – cell phones [Mitra 2007; Guide, Teunter, van Wassenhove 2003], copying machines [Wendy, Chris 2001], computers [Ferrer 1997], and at production of tires [Ślusarczyk, Kot 2017; Lebreton, Tuma 2007]. This option may be integrated with recycling [Hoshino, Yura, Hitomi 1995]. Having been reprocessed, the products may be sold as first-quality goods [Thierry et al. 1995].

Repair is another action allowing to recover value from the returned products. Its objective is to reinstate functionalities to the damaged/faulty products what at the same time is related to a loss in quality, thus it does not mean reinstatement of the primary quality [Amini, Retzlaff-Roberts, Bienstock 2005]. This action can also mean renovation of products, namely their reinstatement to a certain quality condition, which however is not equal the primary quality. The repair/renovation often accompanies the reprocessing actions in relation to the component that are employed there [Ferrer 2001].

The last action that serves recovery of value from the returns through their final disposal is recycling. The objective of recycling is to acquire secondary materials, thus it is performed in a manner not maintaining the primary structures of the product [Fagundes, Amorim, da Silva Lima 2017]. It consists of processing of returned products in such a manner that the acquired materials are characterized with desired quality that depends on the manufacturing process, where they are employed as raw materials. Examples for that may be posed by recycling of plastic [Pohlen, Farris 1992], paper [Pati, Vrat, Kumar 2008], glass [Gonzalez-Torre, Adenso-Diaz 2006], metals [Logozar, Radonjic, Bastic 2006], automotive parts [Bellmann, Khare 2000], electronic products [Nagurney, Toyasaki 2005], carpets [Biehl, Prater, Realff 2007].

Decision on depositing the returned products on a landfill is not an action of value recovery. This is the least desirable solution in the reverse logistics as apart from the potential incineration of the waste in order to generate energy for manufacturing processes, it represents no value recovery [Walther, Spengler 2005]. The enterprises try to avoid it as far as possible, and instead make use of other final disposal options. This is also related to their environmental policy, which imposes an obligation to limit the generation of industrial and hazardous waste to a necessary minimum [Li, Olorunniwo 2008].

Management of reverse flows requires a highly precise planning of actions and their effective control in order to ensure correct operation of manufacturing companies. The most significant actions, from the perspective of the manufacturing enterprises' strategies, are those related to implementation of gatekeeping processes and avoidance of returns, as they are directly reflected in effective management of defective products' flows. This implementation must be preceded with the analysis and evaluation of influence exerted by the returns on the enterprises' finances so it can have a correct course.

At the same time, all of the above-mentioned processes, regarding the fact that they are integrated elements of the reverse flows management in an enterprise, are based on a strategic and operational management formula. Basically, the effectiveness of reverse flows management is related to actions on the strategic and operational level, as the purpose of management is not only the value recovery [Wood 2001], but also generation of value [Autry 2005]. Therefore, all actions in the scope of defective products' flows management must be permanently embedded into strategic and operational actions undertaken by enterprises, through implementation of the reverse logistics processes [Mollenkopf, Russo, Frankel 2007].

There are developmental and implementation procedures arranged at the strategic level, while the coordination of the reverse logistics processes takes place on the operational level. The analyzed defective products' flows management is based in its strategic part on the structure related to implementation of the reverse logistics processes in the enterprises. In turn, the operation part of management consists in implementation of those processes in a form, in which they were implemented on the strategic level.

Therefore, Table 2.2 presents the sequence of management processes of reverse flows in an enterprise, divided into the strategic and operational level processes, along with interactions between those processes on both levels. All of those interactions are related to multi-dimensional functions, including marketing, finances, manufacturing or logistics in an enterprise (Table 2.2).

When considering the specificity of the defective products' flows, it is necessary to pay attention to the fact that these flows have a highly significant function in operations of enterprises that follow the sustainable development concept [Grabara 2013]. Actions related to defective products' flows management are currently increasingly more popular in operation of business activity related to manufacturing of physical goods, first of all because of the intensively diminishing accessibility to raw materials and the progressing degradation of the natural environment [Rogers, Tibben-Lembke 2001].

Majority of states require the manufacturers to observe the applicable law in the scope of environmental protection and preservation of raw resources, by introducing among others the extended producer responsibility (EPR) [Lifset, Atasu, Tojo 2013]. The manufacturers are imposed with liability for products that came to an end of life (EoL) [Hanafi, Kara, Kaebernick 2008] of an end of use (EoU) [Mutha, Pokharel 2009; Dehghanian, Mansour 2009] and are or may become products that are toxic, hazardous, polluting and degrading the environment and natural resources [Guide, van Wassenhove 2009]. The extended producer responsibility is the most important basis for development of policy related to natural environment protection and preservation of natural resources [Adamczyk 2009], related to avoidance of environmental impact exerted by the manufactured products what means collection of those products when they become the returns of defective products [Forslind 2005]. The authors raising this theme in the literature suggest that EPR is a factor that stimulates the manufacturing enterprises to create products based on ecological designing, as such products exert small impact on the environment, and at the same time less often adopt a form of a return of a defective product [Brouillat, Oltra 2012; Zailani et al. 2012; Fleckinger, Glachant 2010].

The EPR concept adopts two main forms [Xiang, Ming 2011; Forslind 2005]: 1) the customers' obligations to return the products that are used or that fail to meet their expectation, 2) the manufacturers' liability for management of returns flows that come from the customers.

Essentially, the extended producer responsibility is enforced in well-developed countries such as Germany, Sweden, Switzerland, the USA or Canada, but its premises can be also noticed in developing countries that introduce this concept with increased intensity year by year [Manomaivibool 2009].

Hence, the enterprises noticed that the defective products' flows management may bring an opportunity for not only improving the attractiveness of their business by developing the competitive advantage [Jack, Powers, Skinner 2010], but also for general acceleration of development of the sustainable concept [Pabian 2013].

This is first of all referred to the manufacturing enterprises that must accept returns of their products and manage them in the defective products' flows [Srivastava 2007; Toffel 2004]. What is more, such actions are motivated, apart from legal and economic conditions, by the customers themselves, who require that their expectations are respected, who exert pressure on the manufacturers to create efficiently operating programs for management of the returns of defective products [Srivastava, Srivastava 2006].

Table 2.2. The processes of management of reverse flows in an enterprise in the strategic and operational perspective

PROCESSES OF REVERSE FLOWS MANAGEMENT				
STRATEGIC			**OPERATIONAL**	
Characteristics	**Subprocess**		**Subprocess**	**Characteristics**
• Determination of the role of returns in the enterprise's strategy; • Determination of the most advantageous ways for value recovery; • Determination of environmental and legal requirements in the enterprise's surrounding; • Determination of limitations and possibilities of the supply chain in the scope of returns management.	**Determination of objectives and strategies of returns management**	**1**	**Receipt of a return request**	• Receipt of a return request; • Implementation of guidelines for gatekeeping.
• Determination of the type of returns in the enterprise; • Determination of structure regarding the possibilities for avoidance of returns; • Development of a returns policy and the gatekeeping mechanisms; • Determination of the final disposal option.	**Development of guidelines for the returns avoidance, gatekeeping and final disposal processes**	**2**	**Determination of routing**	• Review of the guidelines of routing; • Specification of the routing plan; • Generalization of authorization for the returned products.

• Determination of a network of the reverse logistics; • Selection of transport methods and means; • Development of a planning structure for the undertaken returns	**Establishment of a network of returns and a scheme of flows**	**3**	**Receipt of returns**	• Acceptance of the returned goods; • Verification of the returns in the gatekeeping process; • Determination of the causes for the returns.
• Establishment of the determination manner for the returns value; • Establishment of guidelines for the authorization of crediting; • Determination of the crediting policy.	**Establishment of the crediting principles**	**4**	**Selection of final disposal**	• Application of the guidelines for final disposal; • Transport of returns to the final disposal spot.
• Identification and examination of potential secondary market; • Determination of principles for using the secondary markets; • Determination of the returns processing strategy.	**Determination of secondary markets**	**5**	**Crediting a customer/supplier**	• Coordination of the crediting process in the whole supply chain; • Arrangements from negotiations.
• Combination of the returns management process with the economic balance of the enterprise; • Determination of the structure of measurements and strategic objectives in the scope of returns management.	**Establishment of the structure of measurements**	**6**	**Analysis of returns and measurements of efficiency**	• Analysis of returns and determination of possibilities to avoid them; • Estimating processual measurements and connecting them to the enterprise's economic balance; • Determination of objectives for improvement of operations in the scope of returns.

Processes: 1) Management of customer relationships, 2) Management of customer service, 3) Management of demand, 4) Implementation of orders, 5) Manufacturing flows management, 6) Management of relations with suppliers

Source: Own work based on: [Croxton et al. 2001].

The theoretical grasp of the logistics flows problem in enterprises, with special emphasis on the reverse flows, their scope and specificity, and the processual perspective of the reverse logistics, explaining its role in the defective products' flows management allowed exploring the new areas for implementation of the reverse logistics processes in enterprises, which are related to management of the defective products' flows. It also allowed to identify the reverse logistics processes and factors that influence them what is reflected in the level of implementation of actions in the scope of management of the defective products' flows in the manufacturing enterprises.

EMPIRICAL PART – IN THE LIGHT OF RESEARCH PRACTICE OF MANUFACTURING ENTERPRISES

The contents presented in the theoretical part constituted the substantive basis and research background for the implemented studies, presented in the empirical part.

The studies on reverse logistics both in the theoretical and practical field have been performed and explored in the literature of the subject for about 20 years. However, the scientific papers related to those issues, recorded in various databases, published in books or post-conference materials reveal that the approaches to the research carried out in the scope of reverse logistics are characterized with great differentiation and variety. It can be observed especially by analyzing literature reviews, which meticulously explore all English publications on reverse logistics published in a specific time interval. At this point it is worth mentioning the results from literature studies performed by C.R. Carter and L.M. Ellram [1998], S. Pokharel and A. Mutha [2009], P. Chanintrakul, A.E.C. Mondragon, C. Lalwani and C.Y. Wong [2009], K. Govindan, H. Soleimani and D. Kannan [2015], S. Agrawal, R.K. Singh and Q. Murtaza [2015], or J.J. Wang et al. [2017]. The published literature reviews suggest differentiated directions of reverse logistics studies in their various aspects. The reverse logistics is explored, among others, from the objective and subjective, processual, decision-making, organizational and implementation perspectives. All of those angles are demonstrated both theoretically and practically, and the studies are performed in selected countries, sectors of industry or particular enterprises.

In the group of significant publications describing various aspects of reverse logistics, special attentions should be drawn to the book by D.S. Rogers and R.S. Tibben-Tembke [1999]. It is one of the first works on reverse logistics, presenting the studies related to implementation and adoption of reverse logistics in American enterprises.

Special attention should be also paid to the doctoral dissertation by M. de Brito [2004], which combines the concept of reverse logistics with management sciences in a comprehensive manner.

The studies on reverse logistics of defective products in Polish manufacturing enterprises were inspired by multi-annual and deep analysis of publications related to reverse logistics, mainly the English ones. This allowed to find a research gap regarding the deficit in connecting the reverse logistics concept with logistics management in the practice of manufacturing enterprises in Polish economic realities, especially in the field of defective products.

Identification of this research gap and proving a possibility to fill it allowed the author of this monograph to acquire financial resources from the National Science Center[19] for broad studies over this topic, as the NSC considered the proposed form of studies as original and innovative, and their implementation as valuable and

[19] Project entitled "*Logistics management of defective products in Polish manufacturing enterprises*" financed by National Science Centre with the decision No. DEC-2012/07/D/HS4/02071.

necessary for development of Polish Science and support for the Polish industry with new solutions.

Realization of the empirical studies related to the reverse logistics of defective products in Polish manufacturing enterprises justified their implementation. Presentation of the studies results in a form of a monograph created the first comprehensive study related to reverse logistics in the Polish industrial sector.

3. Reverse logistics practice of defective products

3.1. Research objectives and sampling criteria

A basis for the empirical part is posed by the research over the reverse logistics processes in management of defective products' flows in Polish manufacturing enterprises. The research is intended to determine the place and significance of the reverse logistics processes in the field of management of the defective products' flows in the mentioned enterprises.

Characteristics and evaluation of practices adopted by the Polish manufacturing enterprises as regards the use of the reverse logistics processes in management of the defective products' flows are based on an analysis of primary data acquired from the performed survey research and on own observations and direct interviews carried out with representatives of the manufacturing enterprises.

Following comprehensive literature studies performed in the first place, there was the quantitative research drafted. It was developed as a survey, a questionnaire of which was composed of 15 substantive questions, particulars and a final confidential part that was to be filled in voluntarily[20].

There was a pilot study on the first stage, carried out on a sample consisting in 10 Polish manufacturing enterprises, intended to eliminate any possible ambiguities so the respondents had no doubts about the questions' essence. Afterwards the main research was performed on a representative sample of 302 Polish manufacturing enterprises.

While designing the research that would adopt the representative method, the goal was the maximum possible reduction in the sample size, but at the same time to maintain the required certainty and accuracy of conclusions. Classic sampling schemes offer some formulas that allow to calculate an approximate size of such a sample.

In case of fraction estimation (structure ration, percentage) in the simple random sampling scheme, the minimum sample size can be identified from the following formula [Steczkowski 1995]:

$$n = \frac{u_a^2 \, p(1- \ p)N}{u_a^2 \, p(1- \ p) + \ (N - \ 1)d^2}$$

where:

α — statistical significance (0.1–0.01);

u_α — value from normal distribution tables for the assumed level of significance;

[20] The survey questionnaire is provided in Attachment 1 of this monograph.

p — structure ratio (fraction) based on the pilot study; where the fraction value cannot be determined even as an approximate value, the least advantageous situation is assumed $p = (1 - p) = 0.5$;

d — maximum estimation error determined on the level of 1-5%.

The assumed significance level for the performed research was 0.1, and the maximum estimation error was 5%, thus the sample size was identified as follows:

$$n=\frac{u_{\alpha}^{2}\, p(1-p)N}{u_{\alpha}^{2}\, p(1-p)+(N-1)d^{2}} = \frac{1{,}64^{2}\cdot 0{,}5\cdot 0{,}5\cdot 41680}{1{,}64^{2}\cdot 0{,}5\cdot 0{,}5+41680\cdot (0{,}05)^{2}} \approx 267$$

Hence, the minimum sample size is 267 enterprises. The sample of 302 enterprises identified for the research is the representative sample.

Furthermore, the next stage was where the researched population was stratified according to operational activities undertaken the enterprises, based on the Polish Classification of Activity [pl. Polska Klasyfikacja Działalności, PKD), into 13 strata [Steczkowski 1995]:

$$n_h = \frac{N_h}{N} n$$

where:

n_h — estimated size of the sampling units in subsequent strata,

h — number of strata,

N_h — size of subsequent strata,

N — size of the researched population (41,680),

n — sample size (302).

In case of stratified sampling, there is a specific number of units sampled from each strata is searched for, so the average error of the parameter evaluation was as low as possible. Proportional allocation was selected in case of the researched sample out of four sample distribution methods (even, proportional, Neyman, optimum). It consists in sampling of subsamples from particular strata in such a way that the relation between each subsample's size to the general sample's size was equal to fraction of particular strata, expressed in relation to the size of the whole general population. This results in a self-weighting sample that meets the requirement stating that probability of getting into the sample should be identical for all units that compose the general population.

Identification and surveying of the representative sample of 302 Polish manufacturing enterprises allowed for the analyzis of the collected results with

interference extended to the general group of the enterprises. The sampling process consisted in selecting a certain number of Polish manufacturing enterprises, as this was the population of theirs that was the base for the research. Thanks to randomness of the sampling process, the sample is a mini picture of the whole population, reflecting the research features and variables [Zawada 2004].

Table 3.1. Research sample's structure

Type of Major Activity according to PKD	Description	Size in the sample
14.13	Manufacture of other outerware	87 (28.8%)
14.19	Manufacture of other wearing apparel and accessories	11 (3.6%)
26.3 and 26.4	Manufacture of [tele)communication equipment Manufacture of consumer electronics	6 (2.0%)
26.7 and 26.8	Manufacture of optical instruments and photographic equipment Manufacture of unrecorded magnetic and optical media	4 (1.3%)
27.2	Manufacture of batteries and accumulators	1 (0.3%)
27.5 and 27.9	Manufacture of domestic appliances Manufacture of other electrical equipment	5 (1.7%)
28.0	Manufacture of machinery and devices, not elsewhere classified	45 (14.9%)
29.3	Manufacture of spare parts and accessories for motor vehicles	10 (3.3%)
30.9	Manufacture of transport equipment, not elsewhere classified	3 (1.0%)
31.0	Manufacture of furniture	120 (39.7%)
32.2	Manufacture of musical instruments	2 (0.7%)
32.3	Manufacture of sports goods	3 (1.0%)
32.4	Manufacture of games and toys	5 (1.7%)

Source: Own work.

The survey questionnaire was carried out on the manufacturing companies from sectors characterized with some high potential for occurrence of defective products, i.e. mainly furniture, clothing, automotive, household appliances and electronic equipment. The sample structure is presented in detail in Table 3.1 providing general characteristics of its operations and its size (with percentage share).

The main survey questionnaire was performed in the first quarter of 2014. It was carried out as an interview via a telephone, with the CATI method. The group

of respondents covered representatives of the enterprises working on managerial positions on the level of whole companies or persons that they designate as responsible for management of the defective products' flows, i.e. among other receiving returns of products and developing the company's strategy and policy in that field.

The survey questionnaire comprised of notions related to defective products and management of their flows through the reverse logistics processes. There were mostly closed and multiple-choice questions, and such that allowed scores to be ascribed to particular items. Other questions were also of a closed character, but with a single answer, considering the percentage values provided as estimations.

While beginning the phone interview, each respondent needed to specify whether there are any defective products in the represented enterprises, revealed via returns. Only a positive answer for this question allowed further participation in the research. Therefore, it was possible to examine the whole group of companies, which the representative sample's size was specified for, and it was not necessary to eliminate the surveys out of formal reasons.

In its main part, covering the substantial questions, the survey questionnaire's structure allowed acquisition of information about the reverse logistics processes related to management of defective product's flows in the Polish manufacturing companies. The raised notions were focused on the following thematic areas:

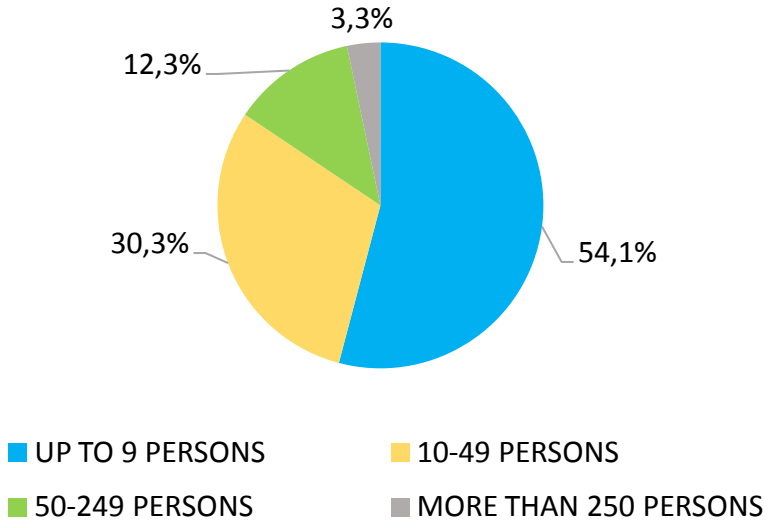
- defective products (returns) categories, places of their emergence, their quantitative condition and occurrence intensity;
- return period, duration of the returns processing cycle;
- politics and motives for returns acceptance, influence of the return on the company's profitability and development of the competitive position;
- problems related to processing of defective products - implementation of actions in reverse flows management, an analysis of barriers for effective management of returns, systems supporting the reverse logistics processes.

The survey questionnaire's results were adopted to illustrate the scale and scope of the reverse logistics processes in management of defective products' flows in the Polish manufacturing enterprises, the premises and motives as well as their manifestations and results.

The research results analysis begun with characteristics of the research sample based on its structure, considering sizes of the respondents' enterprises determined against the rate of employment, as well as the structure of answers distribution according to the type of logistics activities undertaken by a given enterprise.

Participants of the research were mainly the representatives of manufacturing enterprises employing up to 9 persons - they were more than a half of the respondents (Fig. 3.1). The next group in terms of its size was composed of small (30.3%) and medium-sized (12.3%) enterprises, while the lowest percentage share was taken by companies that employ more than 250 persons - 3.3% of the general group of respondents.

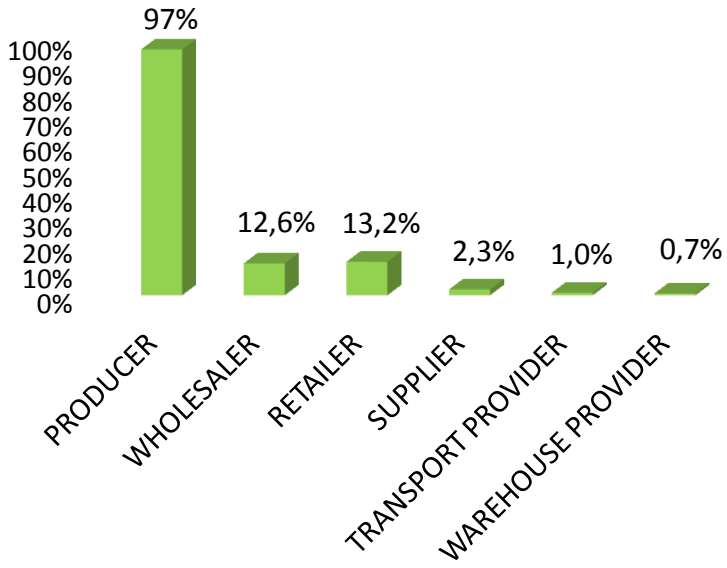
Figure 3.1. Sample's structure according to the size of enterprises



Source: Own work based on results from the survey questionnaire.

At the same time, in order to characterize the sample, the respondents were asked to specify the type of logistics operations carried out by their enterprise, with a possibility to make multiple choices. According to the assumption that the target is posed by the manufacturing enterprises, as much as 97% of the respondents pointed to operations as a producer or manufacturer. Furthermore, about 13% of enterprises determined to be retailers and wholesalers. The remaining options were barely selected (Fig. 3.2).

Figure 3.2. Sample's structure according to the type of logistics activities



Source: Own work based on results from the survey questionnaire.

The analysis of results from the survey questionnaire allowed implementation of the empirical part regarding the reverse logistics processes in management of defective products' flows, presented both in this and in three subsequent chapters of this monograph, and the results interpretation is based on own observations and direct interviews performed with representatives of the manufacturing companies.

3.2. Interpretation of the survey questionnaire results

3.2.1. Characteristics of the defective products' flows

Thanks to the results acquired from the survey questionnaire carried out on the representative sample of Polish manufacturing enterprises, it is possible to diagnose and identify some business practices employed in management of defective products' flows.

Based on the in-depth literature studies in the field of the notion in question, there were nine main categories of defective products identified for the research, which supply the reverse flows in the manufacturing enterprises[21].

During the survey questionnaire, the respondents' task was to determine the categories of returns that appear in the defective products' flows in their enterprises along with intensity of those flows (Fig. 3.3).

Intensity of the returns' occurrence was classified according to three categories in the survey: (1) numerous - more than 50% of the total annual production, (2) moderate - between 10 and 50% of the total annual production, (3) - marginal - up to 10% of the total annual production.

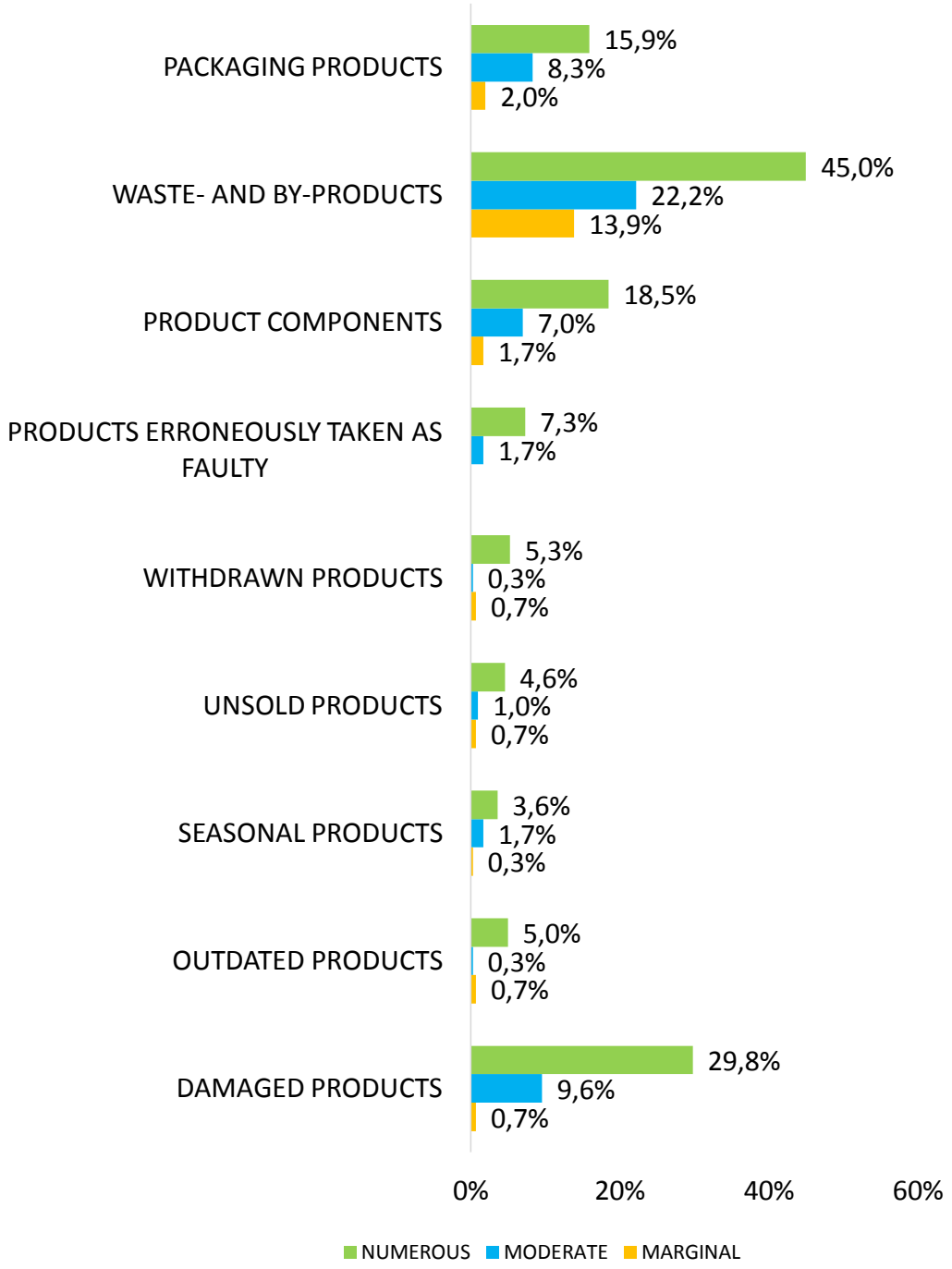
The research results prove that the waste- and by-products occur in the Polish enterprises with greater intensity. When this indication is considered in case of defective products, it can be seen that the reverse flows are composed in a greater part from waste- and by-products than from the defective products. However, this results from the fact that the waste- and by-products are a natural consequence of manufacturing processes. While a high number of defective products in reverse flows could indicate inefficiency of manufacturing processes or other actions undertaken by a given enterprise what would be disadvantageous for its image and operations within increasingly more competitive markets.

Analysis of the remaining answers provided by the respondents suggests that defective products are mostly present in the returns of packaging products and product components.

Average occurrence of returns is related mainly to the same categories of products as those specified above, but there are also some damaged products pointed out.

[21] Even though waste- and by-products are not defective products (according to a theoretical interpretation of the defective products and classification of returns presented in sub-chapter 2.2), they are included in the performed research and its results analysis. Inclusion of those products into the empirical research is an intended action, motivated by the willingness to show that the waste- and by-products are first of all the part of reverse flows in manufacturing enterprises, and second of all the background for comparisons and references for defective products.

Figure 3.3. Categories of returns in defective products' flows and intensity of their occurrence



Source: Own work based on results from the survey questionnaire.

While analyzing the marginal intensity, the emergence of all listed products categories can be observed, while most often the answers are related to waste-products, by-products, damaged products, components of products and packagings.

Outdated, seasonal, unsold products and products withdrawn from sales are characterized with marginal or moderate occurrence intensity, while numerous occurrence is almost not applicable in their case at all.

Products erroneously taken as faulty present a small share for the marginal intensity group and almost no share for the moderate intensity, and no share at all for the numerous intensity.

Analysis of the respondents' answers for this question suggests that the defective products are indeed present in the reverse flows of Polish manufacturing enterprises, thus it is justified and necessary to undertake actions intended to implement the reverse logistics processes in the field of those flows' management.

Another analysis regards the qualitative condition of defective products in reverse flows of the Polish manufacturing enterprises. A starting point for determination of the defective product's qualitative condition is to refer to the original quality of that product. While considering the issue of returns quality, the respondent could evaluate it on the 6-grade scale, which was as follows: (1) terrible, (2) poor, (3) sufficient, (4) good, (5) very good, (6) perfect (Fig. 3.4).

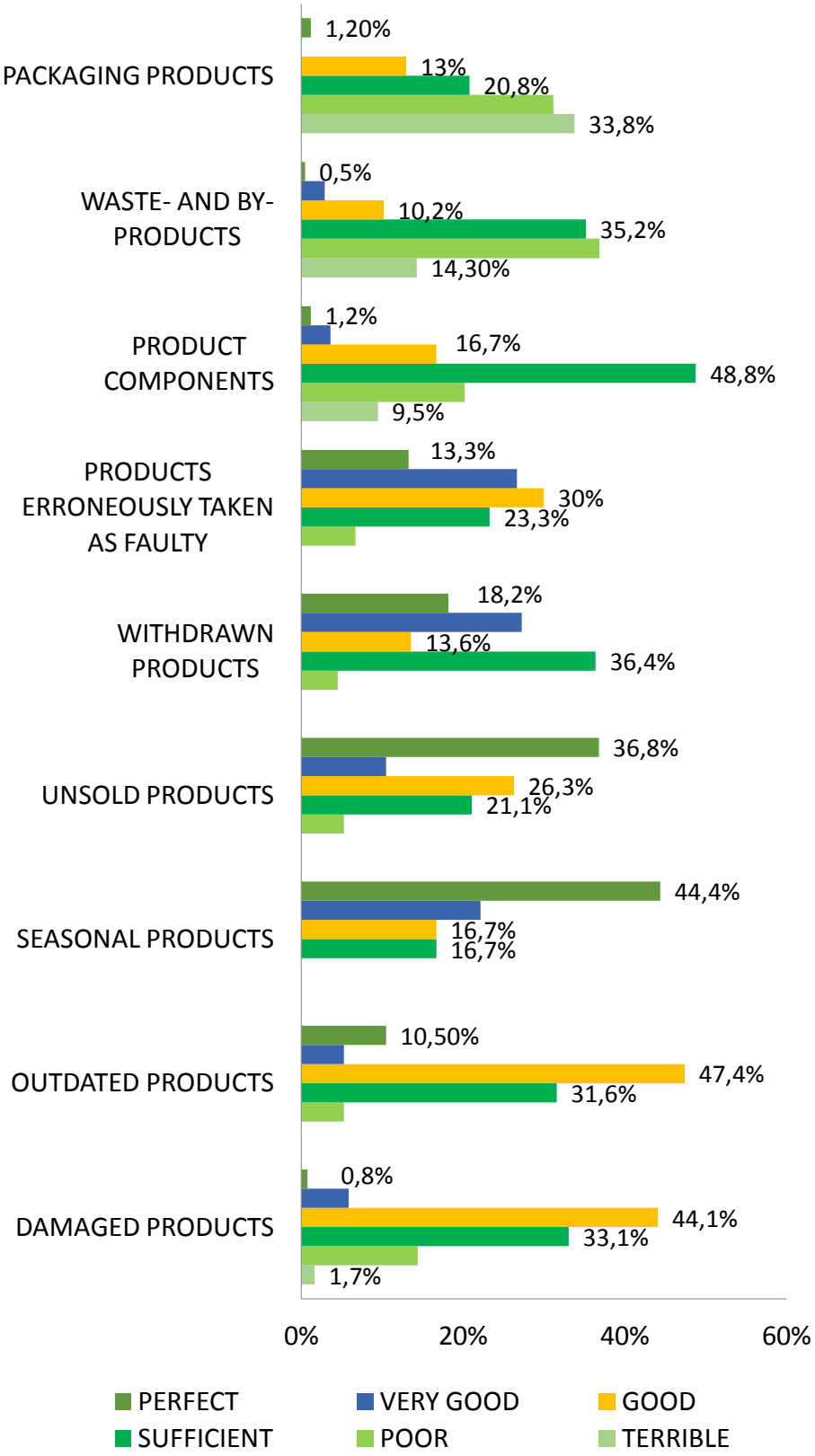
According to the respondents, the damaged products are most numerous in a form of good (almost 45%) or sufficient quality (almost 35%), while they appear in the reverse flows in perfect and very good conditions only to a marginal degree.

A similar distribution of respondents' answers occurs in case of outdated products in a good (almost 50%) and sufficient condition (more than 30%) - similar to damaged products, they are most numerous in this condition. At the same time, 5% of respondent pointed that they occur in the flows both in poor and very good conditions, and as much as 10% in a perfect condition.

In case of seasonal returns, the most frequent qualitative conditions of the returns were the perfect (almost 45%) and very good (more than 20%) conditions. Such a condition of those return may undoubtedly result from the character of products, the production and sales of which are based on seasonality. Concurrently, more that 15% of respondents suggested that the seasonal products appear in their reverse flows in good and sufficient conditions. There are no poor and terrible quality products in this category of returns.

The defective products that were returned as unsold in retail are most often characterized with perfect (more than 35%) and then good quality condition (more than 25%). About 10% of those products are returned in a very good condition, and a little more than 20% in a poor condition. The products in a sufficient condition are 5% and the terrible-condition returns do not occur.

Figure 3.4. Quality condition of the defective products in reverse flows



Source: Own work based on results from the survey questionnaire.

The defective products withdrawn from sales and returned are most often in the sufficient quality condition (more than 35%) according to the respondents. More than 20% of the respondents specified their quality condition as very good, and more than 15% as perfect. For more than 10% the products' quality was good and it was poor for 5%. The terrible-quality products do not occur also in this category.

Another category of the defective products' returns is comprised of products erroneously taken as faulty. Their quality condition was mostly determined as good, and less frequently as very good and sufficient. More than 10% of the respondents regarded condition of those returns as perfect in terms of quality, and 5% as poor. Also these products were not claimed to remain in a terrible quality condition.

Almost 50% of respondent determined the product components that supply the reverse flows of the Polish manufacturing companies as sufficient in terms of their quality condition, 20% as poor and 10% as terrible. Only a little more than 15% of respondents believed that the product components were returned in a good quality condition, less than 5% said they were in a very good and 1% that in a perfect condition.

In case of waste- and by-products, their quality condition, similarly as in case of the product components is not satisfactory. More than 35% of respondent specified this condition as bad and sufficient. For almost 15% of respondents, quality of this category of defective products was terrible, only 10% stated it was good, and 5% claimed it was very good. These returns do not occur in a perfect condition.

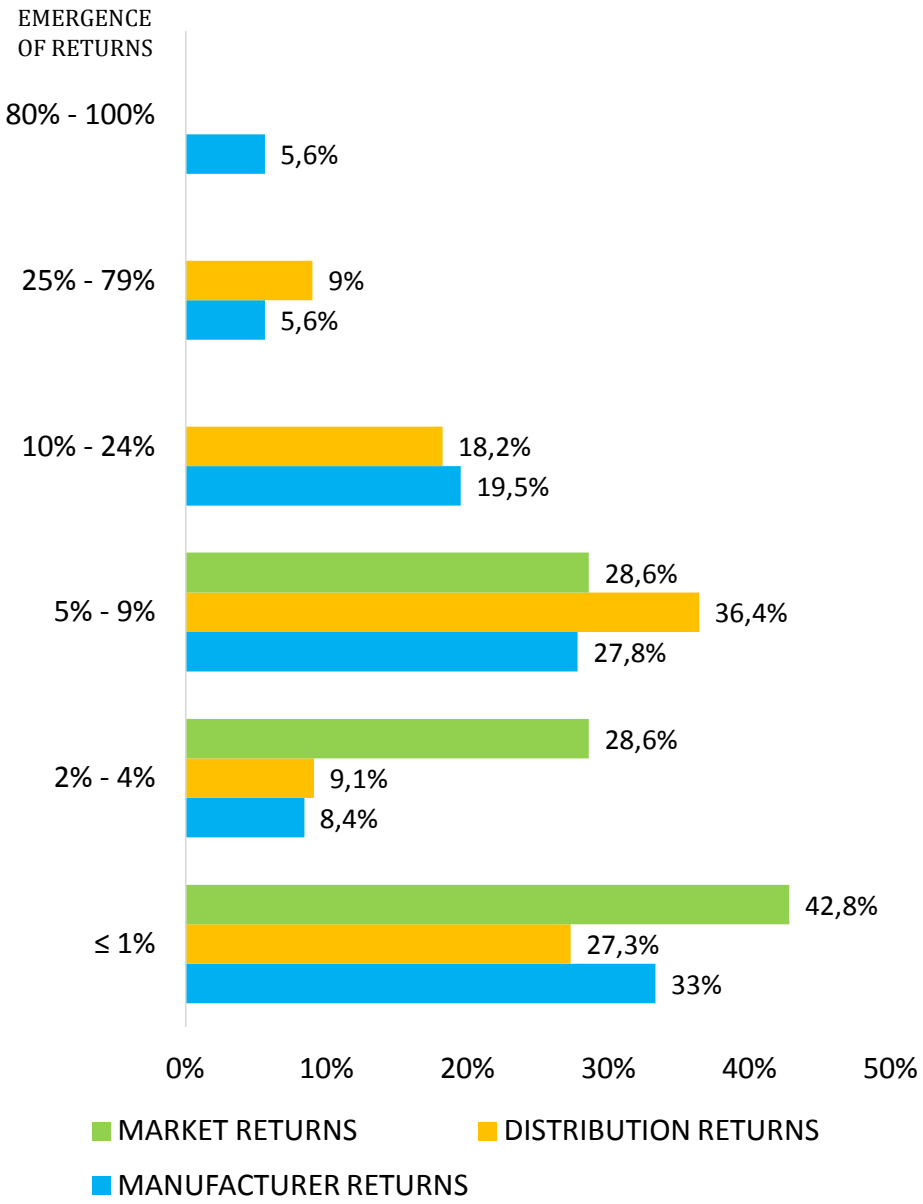
The last category of returns of defective products, i.e. packagings, is dominated by the terrible (almost 35%) and poor (slightly more than 30%) quality condition. The sufficient quality of packagings was claimed by 20% of respondents, while good by 15%. The packaging products remaining in a very good condition are completely absent, and those in a perfect condition appear in answers from 1% of the respondents.

Furthermore, apart from the nine categories of returns, the defective products may be also classified elsewhere - in three main categories regarding their place in the flow, where they emerge as a return. These are:

1) manufacturer returns - surpluses of raw materials, returns after quality control, manufacturing remains, etc.;
2) distribution returns - trade returns, surpluses in stock, etc.;
3) marketing returns - guarantee and post-guarantee products, products that came to an end of life, etc.

Within the survey, the respondents were intended to estimate the percentage share of defective products' returns based on the total annual production rate in the enterprises, and allocate such returns to one of the three aforementioned categories (Fig. 3.5).

Figure 3.5. Categories of returns according to the place of their emergence



Source: Own work based on results from the survey questionnaire.

The analysis of the respondents' answers pictures the general trend stating that the higher the estimated percentage of defective products the lower the number of enterprises that select it.

The manufacturer returns category occurs in all estimated ranges, while the greatest number of respondents point them in reverse flows on the level lower or equal 1%, and then 5%-9% and 10-24%. The next range is 2%-4%, and the lowest number of responses suggesting manufacturer returns can be identified in ranges of 25%-79% and 80%-100%.

At the same time, the 80%-100% range suggests that the manufacturer returns category is the only one in some enterprises.

The distribution returns are most numerous in the range of 5%-9%, and then not more than 1%, 10%-24% and 2%-4%. When it comes to the 80%-100% estimation range, the distribution returns were not pointed at all what means that they do not occur in such quantities.

The last category of return - marketing returns are most numerous in the lowest estimation range, i.e. up to 1%. Then, they were pointed are the most in the same quantities by the respondents within the ranges of 2%-4% and 5%-9%. The marketing returns category does not occur in higher ranges what means that in the Polish enterprises the marketing returns are maximum 10% of the total annual production size in the enterprise.

General interpretation allows of conclusion that the most numerous type of defective products' returns in the Polish manufacturing enterprises is the manufacturing returns. The distribution returns also occur, while they pose maximum 80% of the total annual production rate in the enterprise. When it comes to marketing returns, they are numerous but their percentage does not exceed 10% of the total annual production rate in the enterprise.

3.2.2. Parameters of actions related to management of defective products' flows

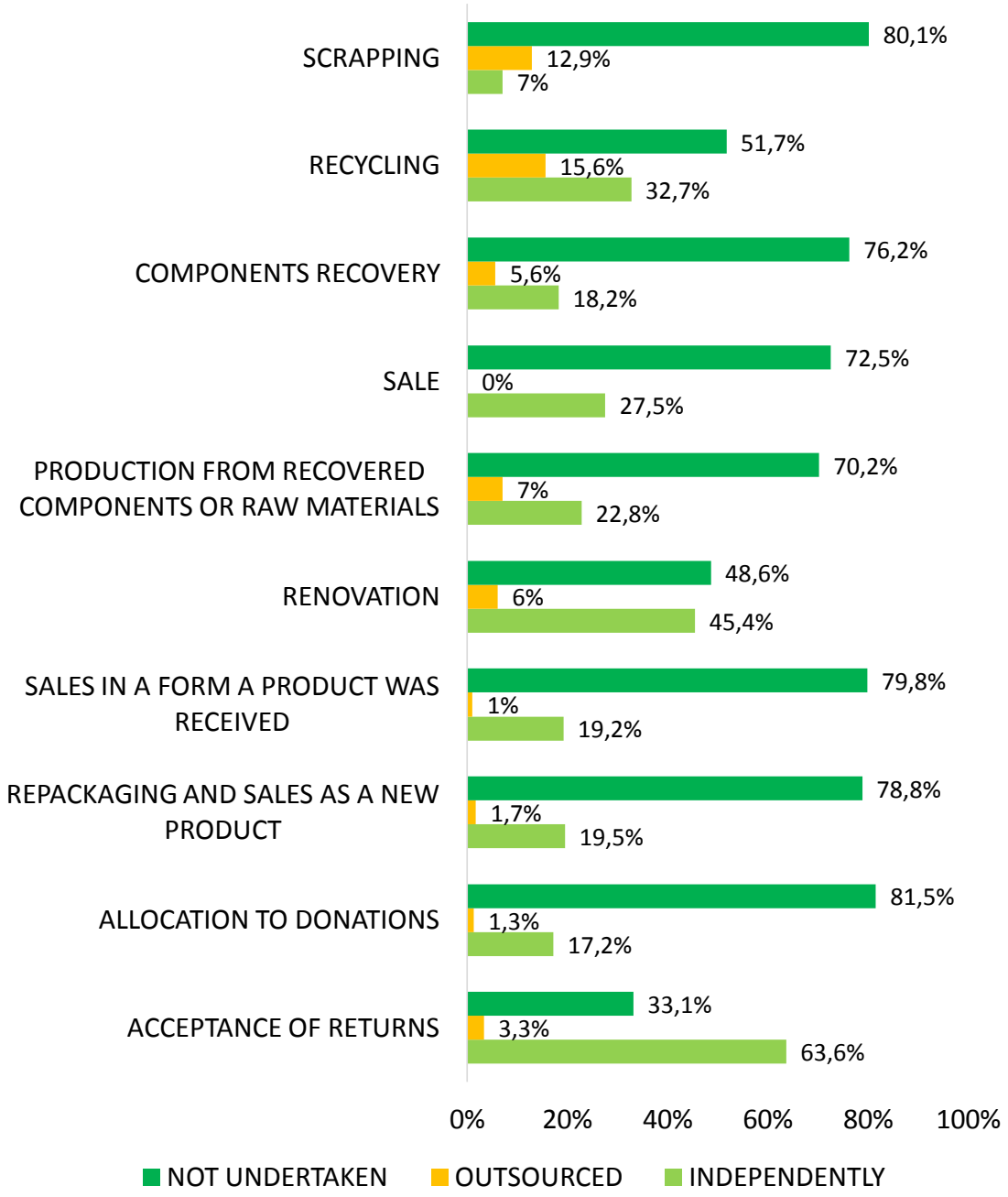
After characterization of the defective products' returns, subsequent stages of the research were intended to determine the parameters of actions undertaken in an enterprise in relation to flows management.

At first, the analysis was employed in case of the actions by the manufacturing enterprises in the scope of defective products' flows management. In this question, the respondents had a chance to specify the listed actions that they carry out on their own, which they commission to third parties (3PL) and which they do not carry out at all when it comes to the reverse flows management (Fig. 3.6).

Actions related to management of the defective products' flows were determined based on the previously performed literature studies, and the following processes were considered here: returns acceptance, allocation for donations, charitable purposes, repackage and sales of products as new, sales in such a form as the product was accepted, renovation, production from recovered components or raw materials, sale, recovery of components, recycling, scraping.

Analysis of acquired data allows for observation that a great number of respondents stressed that certain actions are not implemented. However, regarding the fact that it was a multiple-choice question, it cannot be assumed that the companies do not undertake actions related to the reverse flows management, as the equally high number of respondents pointed to independent implementation of actions related to returns.

Figure 3.6. Actions undertaken within reverse flows management



Source: Own work based on results from the survey questionnaire.

More than 60% of respondents carry out the process of returns acceptance independently, and almost 50% perform the renovation procedures on their own. The manufacturing companies deal with scrapping of the defective products in the lowest number of cases.

At the same time, we can observe a scarce trend to outsource the actions related to management of the defective products' flows. It most often takes place in case of recycling and scrapping, on a smaller scale in case of production from recovered components of raw materials, renovation and recovery of components, and marginally

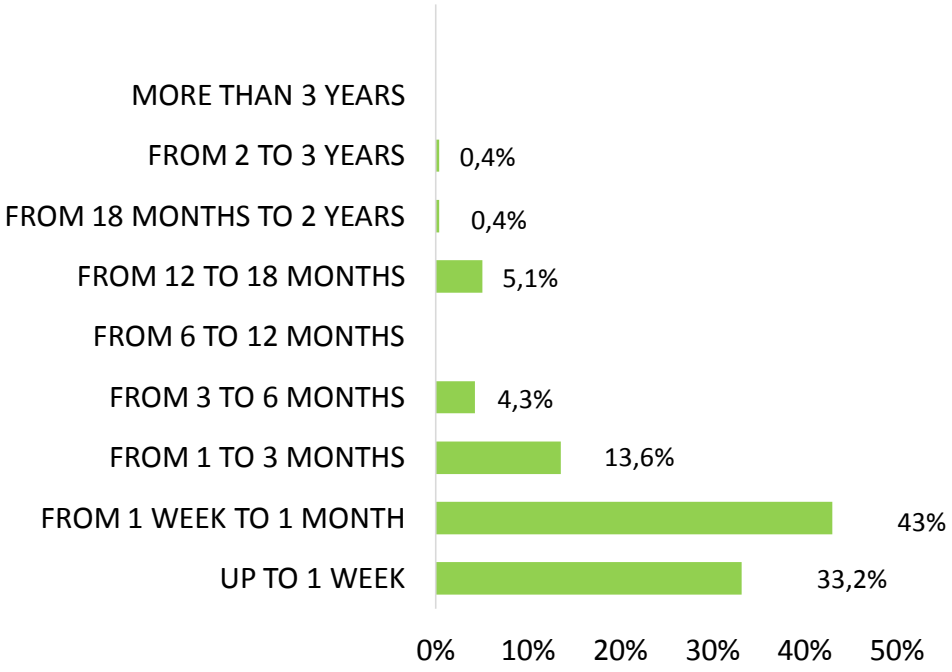
in case of returns acceptance, allocation for donations, repackage and sales of the products as new ones and sales in such a form in which the product was received. In case of sale, this action is not commissioned to third parties.

To sum up, it may be concluded that majority of the Polish manufacturing enterprises carried out the actions related to management the defective products' flows independently, while the companies implement them selectively and not comprehensively, meaning that they do not exercise all possibilities available in thescope of reverse flows management, only the options of their choice.

Furthermore, there is a tendency visible that the manufacturing companies are not willing to outsource actions related to the reverse flows management.

The survey questionnaire also researched the most frequent return period for the defective products. Bearing it in mind that the survey questionnaire was prepared for respondents representing manufacturing enterprises, the return period was determined as the time that passed from the moment of releasing the product from the manufacturing process for distribution, to the moment of its return to the manufacturer. The respondent could choose one out of ten time intervals (Fig. 3.7).

Figure 3.7. Average return period of defective products



Source: Own work based on results from the survey questionnaire.

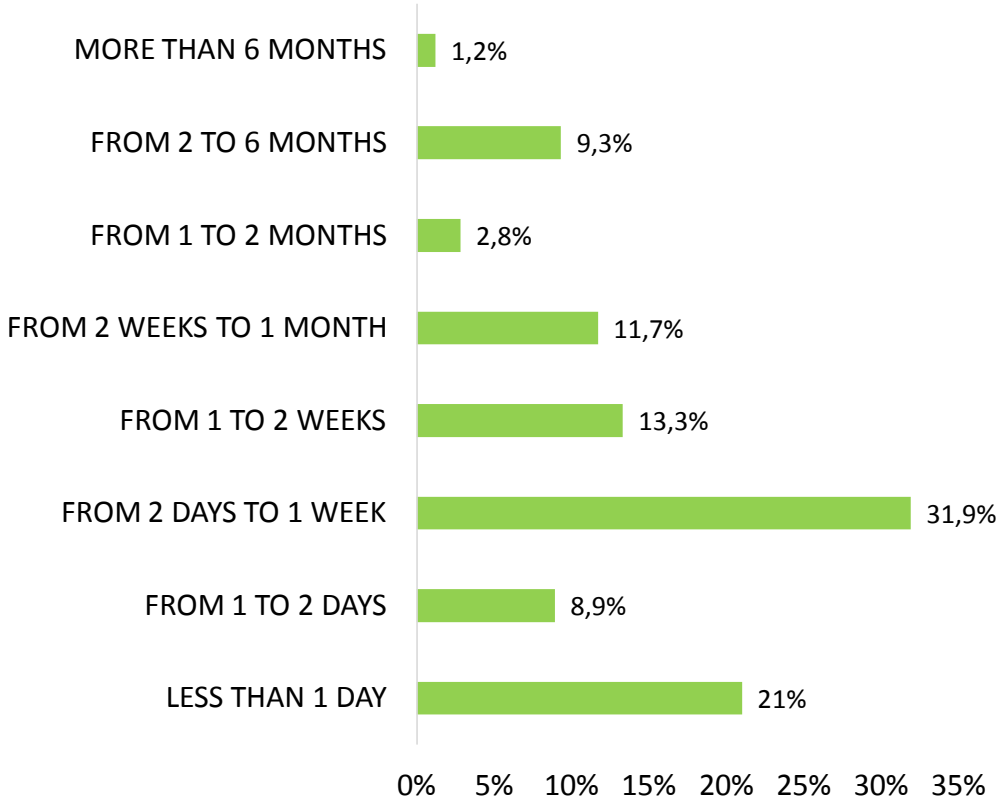
According to the respondents, the defective products most often occur in reverse flows of the manufacturing enterprises within a week to a month (more than 40%), and up to one week (more than 30%). Other three time intervals - 1 to 3 months, 3 to 6 months, and 12 to 18 months - are pointed less often. The return period of 1 to 3 months is recorded by about 15% of the respondents, while the intervals of 3 to 6 and 12 to 18 months by about 5%.

The return periods from 1 month to 2 years and from 2 to 3 years were claimed by under 0.5% of respondents. The returns were absent in the time intervals of 6 to 12 months and more than 3 years.

Summing up, it may be noticed that the return period of defective products in the Polish manufacturing enterprises is relatively short what proves the positive character of actions related to the reverse flows management of those products.

Thanks to the return period of the defective products in the researched enterprises being short, it is possible to quickly undertake actions related to the returns processing. The survey questionnaire's respondents were asked to specify duration of the returns processing period in their enterprises. Here, similarly to the previous question, the possible answers were included in eight time intervals (Fig. 3.8).

Figure 3.8. Average duration of the returns processing cycle



Source: Own work based on results from the survey questionnaire.

Similarly as in case of the product return period, the data analysis regarding the returns processing cycle proves that these actions take relatively little time. According to the most numerous group of respondents, the average returns processing period in a manufacturing enterprise last from 2 days to 1 week (more than 30%). Many responses - more than 20% - suggest that the processing cycle lasts less than 1 day, while the smallest group of respondents (little more than 1%) claimed that it takes more than 6 months.

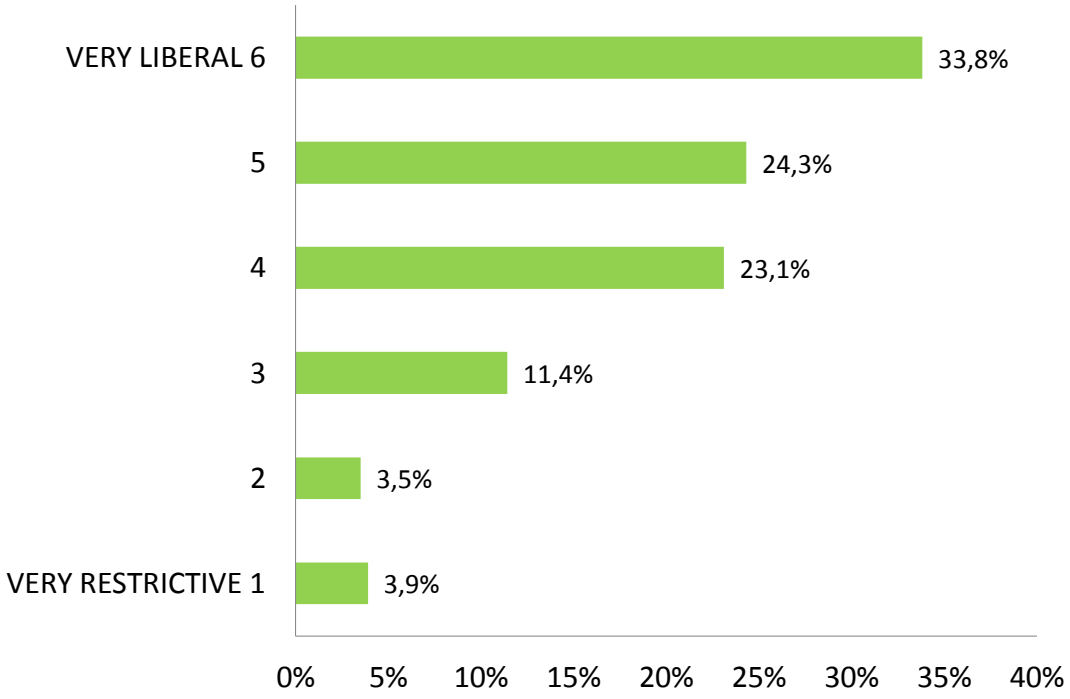
Generally, the data analysis allows to conclude that the average returns processing period is short in the Polish manufacturing enterprises - up to one month.

There are cases that it can be expanded and it may last even more than 6 months, but they are not frequent as they result from specificity of the product, branch or manufacturing process.

3.2.3. Objectives and motives of the policy of defective products returns

The performed survey questionnaire also considered the analysis of the manufacturing enterprises' policy as regards returns acceptance of the defective products. The respondents could assess it in the scale from 1 to 6 scores, where 1 meant a highly restrictive policy and 6 - a highly liberal one. The liberal policy means that in this case the rules assume openness towards customers, allowing them trouble-free complaints and returns of products in justified cases (Fig. 3.9).

Figure 3.9. Assessment of the returns policy



Source: Own work based on results from the survey questionnaire.

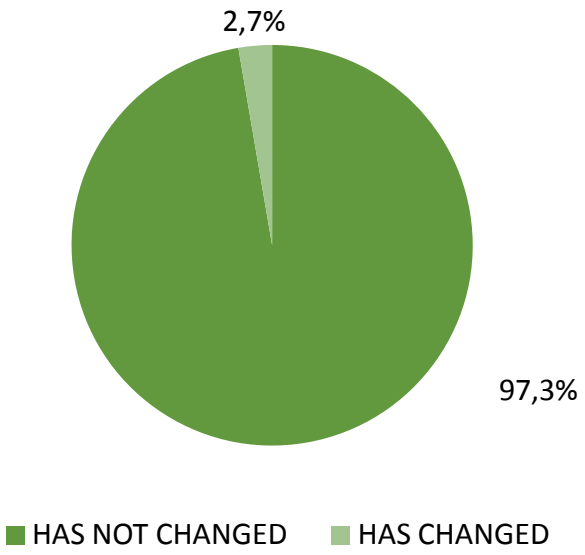
The analysis of the respondents' answers for this question shows that majority of them states to have a liberal returns acceptance policy in their enterprises what speaks in favor on a given company and its approach to customers. Just less than 5% of the respondents evaluated the policy of their company as very restrictive.

Generally, this might lead to conclusions that Polish manufacturing enterprises have appropriate priorities and one of their features is openness to customers what in case of management problems with defective products' flows is highly significant and helpful.

To carry on with the notion of the returns acceptance policy in case of defective products the research determined a change in this policy within last 5 years in the manufacturing enterprises (Fig. 3.10).

The results clearly indicate there are no changes what was claimed by more than 95% of the respondents. This means that the companies have been into the liberal approach to the returns policy for at least 5 years.

Figure 3.10. Evaluation of change in the returns policy within last 5 years



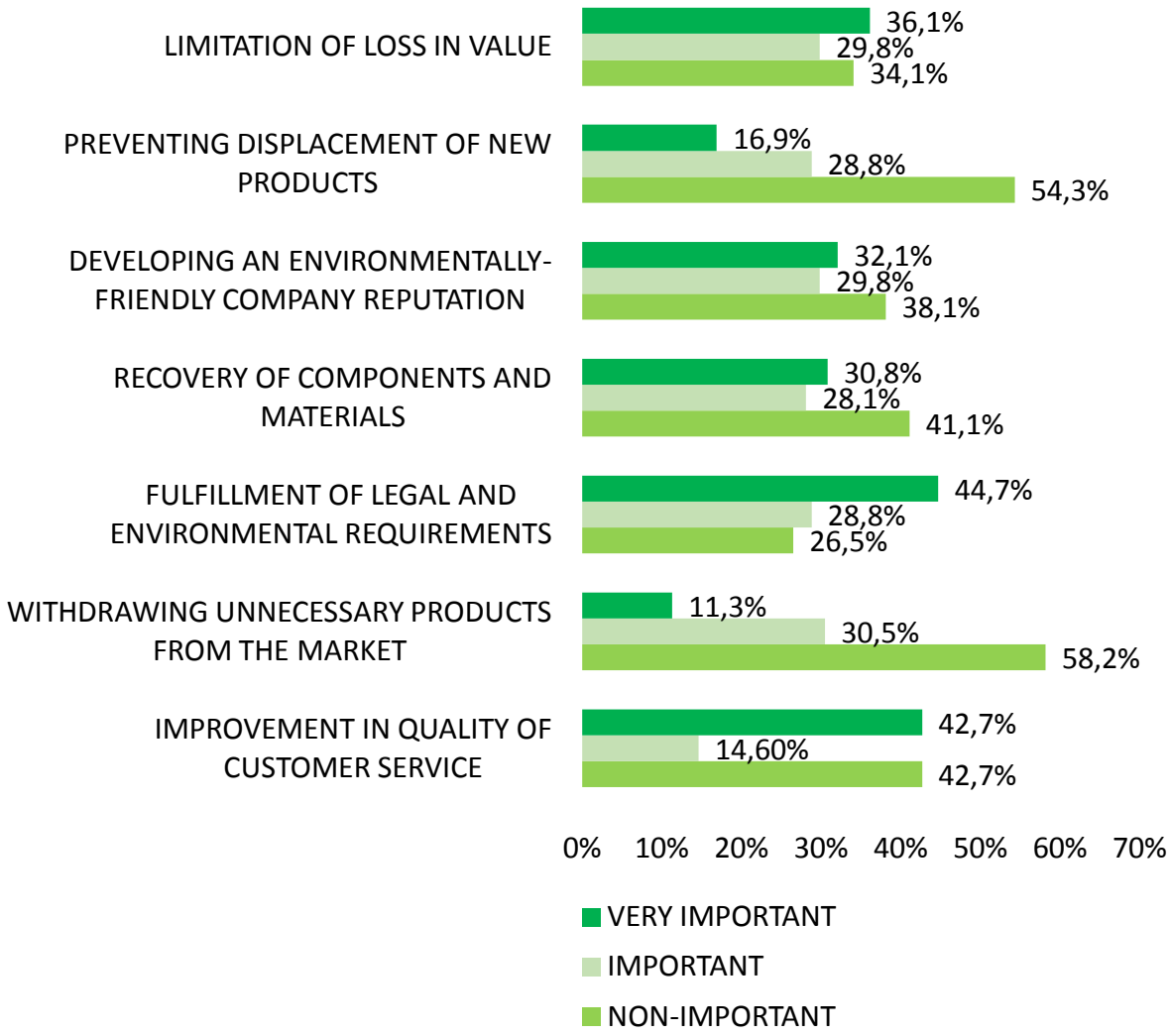
Source: Own work based on results from the survey questionnaire.

All of the respondents whole confirmed change in policy were asked to develop their response and specify the direction of changes. The here, the statements were related to transformation of the policy into a more liberal one, and only 1 out of 302 enterprises claimed to tighten up its returns acceptance policy within last 5 years.

The development of actions related to defective products flows management in an enterprise is time-consuming and labor-intensive. Not all companies are willing to get involved in solving the problems with returns, but at the same time they are often forced to seek good solutions regarding the pressures from the market. The respondents were asked about their motives for accepting the returns of defective products, and required to evaluate their significance in the following scale: (1) non-significant motive, (2) significant motive, (3) very important motive (Fig. 3.11).

Analysis of the results obtained from the research allows of conclusion that almost every motive for acceptance of the product returns out of the listed seven was treated as non-significant by at least 30% of respondents. However, as it was a multiple-choice question, such a response distribution must also be considered.

Figure 3.11. Motives for returns acceptance



Source: Own work based on results from the survey questionnaire.

Two the most important motives for acceptance of defective product returns by a manufacturing enterprises are the improvement in the customer service quality and fulfillment of legal and environmental requirements. Improvement in the customer service quality was a very important motive for more than 40% of respondents and at the same time non-significant for the same number of responding individuals. It was claimed to be significant by 15% of representatives of the enterprises. While fulfillment of the legal and environmental requirements was a very important motive for about 45% of the respondents, significant for almost 30% and non-significant for about 25%.

It turns out that getting rid of unnecessary products from the market does not pose a significant motive for returns acceptance, as only a little more than 10% of the respondents claimed it was very important, 30% stated the was significant and 60% non-significant.

Distribution of answers about significance of the following motives: recovery of components and materials, development of an environmentally-friendly company reputation and reduction in losses from unsold or defective products is similar in its structure. The greatest number of respondents, i.e. about 40% claims these motives are non-significant, while more than 30% states that they are very important and 30% that they are significant.

The last motive is prevention of displacement of new products by products from the secondary market. More than 50% of respondents believe that it is a non-significant motive and only 20% are think it is very important. This motive is significant for about 30% of the respondents.

Based on the distribution of answers for this question, it may be generally stated that the motives for accepting returns of defective products in the Polish manufacturing enterprises are varied. Each motive out of the seven listed is very important for a part of enterprises, while at the same time it is totally non-significant for others. The cause of this is specificity of products, manufacturing branches and other elements that vary the manufacturing enterprises. Nevertheless, it is a good signal that companies pay attention to such motives as improvement of customer service or fulfillment of legal and environmental requirements, as well as the other listed items, as it undoubtedly has some positive impact on their activities, and generally it poses some added value for the enterprises.

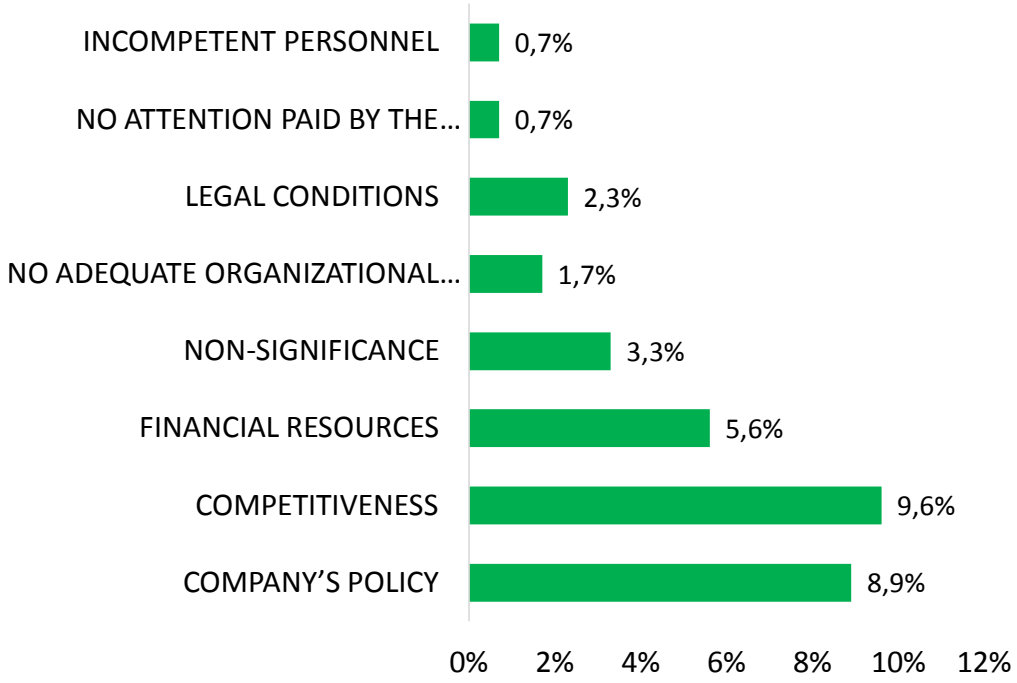
3.2.4. Barriers of effective management of defective products' flows and ways of overcoming them

The management of defective products' flows in manufacturing enterprises is often limited and/or hindered by existing barriers. Literature of the subject most often mentions such barriers as the company's policy, issues of competitiveness[22], financial resources, lack of significance, lack of adequate organizational solutions, legal conditions, no attention from the managerial staff, incompetent personnel.

Bearing in mind the aforementioned barriers, there was a question developed for the survey questionnaire, and respondents' answers in this scope are presented in Fig. 3.12.

[22] There is a series of factors causing the enterprise's worries of losing the competitive character. According to an enterprise they can reduce or even render it impossible to compete with other entities within a given market. In the reverse logistics processes and defective products' flows management these factors are, among others: lack of measurable effects from the reverse logistics processes regarding management of defective products' flows, and the measurable effects are present in a long time horizon, difficulties in implementation of innovative methods or modern technologies, no investment opportunities, customer's interest in the product return and at the same time no attention paid to further actions in that scope, a new product adopting materials and components utilized in other products, etc.

Figure 3.12. Barriers for effective management of defective products' flows



Source: Own work based on results from the survey questionnaire.

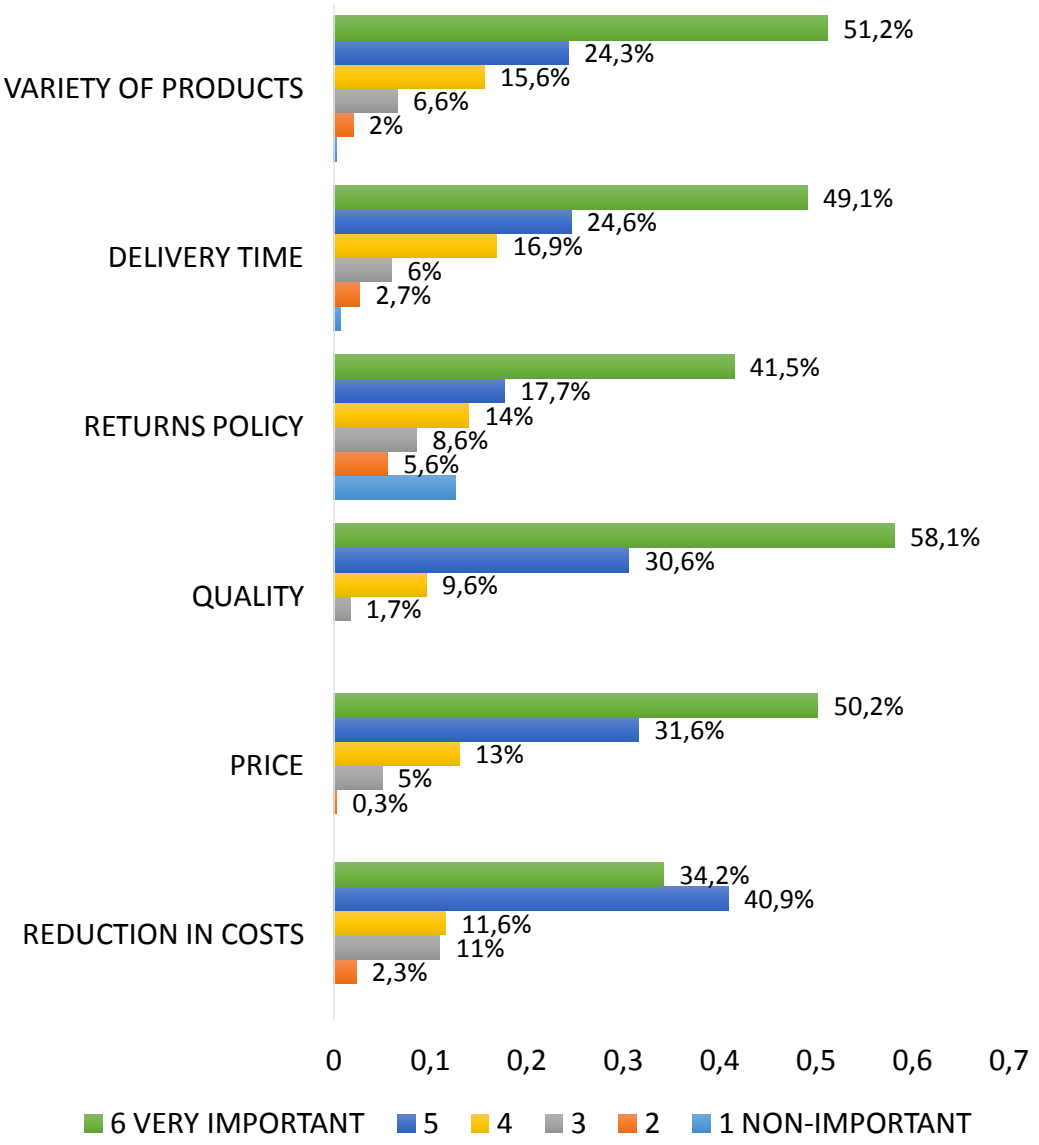
Plenty of respondents provided no answer for the question about the barriers that hinder effective management of the reverse flows in an enterprise. This might result from lack of knowledge about the difficulties and no practical reflection of theory in this field. It is true that correct determination of barriers for implementation and operation of the defective products' flows in an enterprise is not easy, and the enterprises - despite the fact that they have implemented such procedures - are not capable of identifying such problems.

The respondents who answered that question most frequently pointed the competitiveness features as the main barrier. The next listed were the company's policy, financial resources, non-significance, legal conditions, no adequate organizational solutions, and equally - no attention from the managerial staff and incompetent personnel.

Generally speaking, the analyzing of answers for this question allows of conslusion that there are some barriers for effective management of reverse flows in the Polish manufacturing companies but the problem is their identification.

The respondents' answers for subsequent questions allow to analyze the manner that the manufacturing enterprises see the elements of defective products' flows management in relation to development of the company's competitive position within the market. The following aspects have been listed below, which influence the competitiveness: reduction of costs, price, quality, returns policy, time of delivery, variety of products, and the respondents could assess them on the scale from 1 to 6, where 1 means a totally non-significant aspect and 6 - a very important aspect (Fig. 3.13).

Figure 3.13. Aspects of the reverse flows management in development of a competitive position



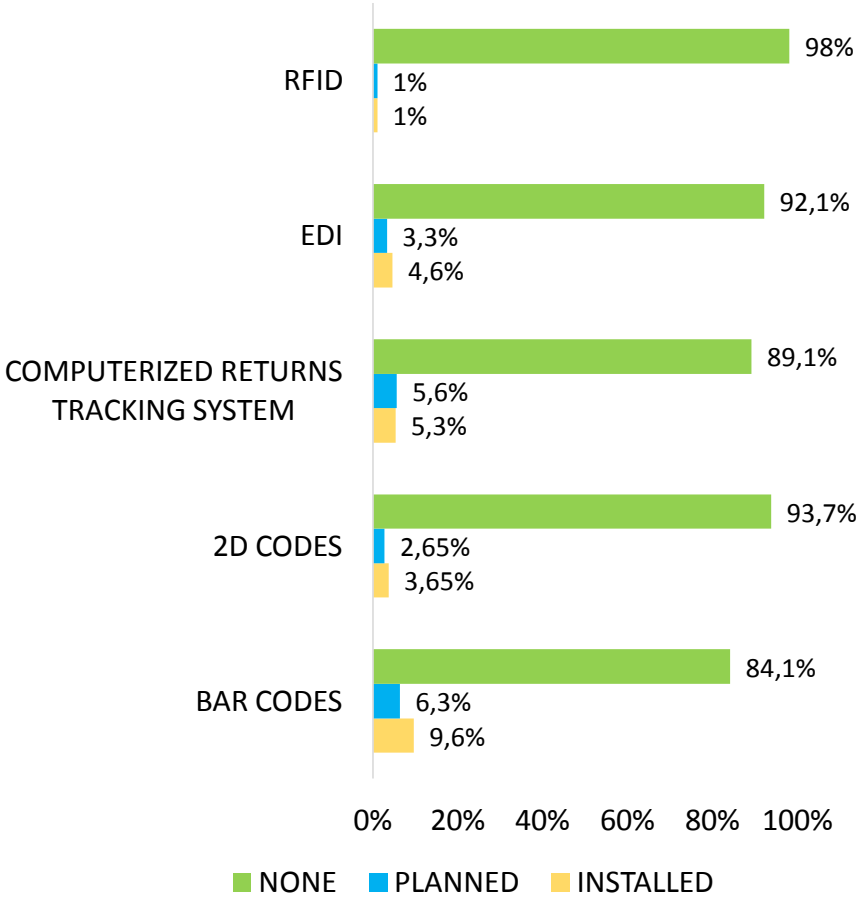
Source: Own work based on results from the survey questionnaire.

The respondents' answers clearly indicate that all elements are very important or significant for them when it comes to development of the enterprise's competitive position within the market. In the order of significance, the most important aspect is quality, then variety of products, price, delivery time, returns policy and reduction of costs. At the same time, the least important aspect turned out to be the element of return policy, where some answers claimed it was totally non-significant. Taking into account the current customers' requirements towards the possibility to return the defective products it is quite surprising.

Generally, when the competitive position development is being interpreted in terms of manufacturing enterprises within the market, their care of this strategic aspect is being noticed.

Furthermore, information and IT systems along with computer software may be employed to support the defective products' flows management. A diagnosis of implementations of such solutions in the manufacturing enterprises is presented in Fig. 3.14.

Figure 3.14. Solutions supporting the reverse flows management



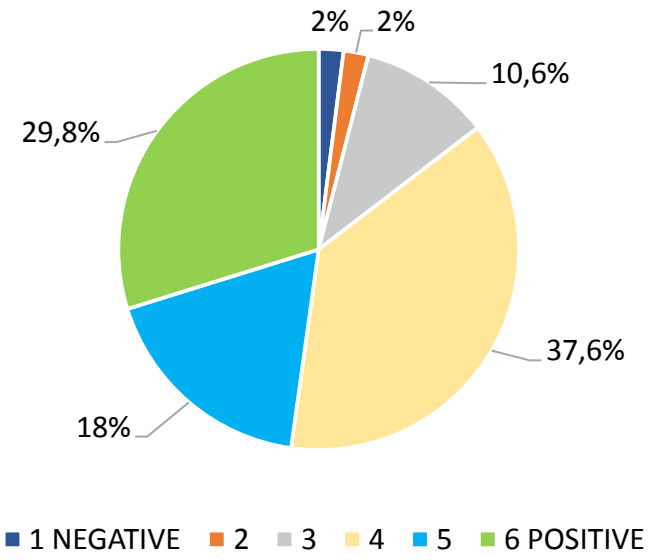
Source: Own work based on results from the survey questionnaire.

Unfortunately, as suggested from the above distribution of the respondents' answers, about 90% admit that there are no hardware or software solutions employed in their enterprises that would support management of reverse flows. What is more, only a small percentage (maximum up to 6%) claims that the company is planning to implement such a solution. Enterprises that make use of the support systems for management of reverse flows are scant - 1% has RFID (Radio-Frequency IDentification), 4.6% — EDI (Electronic Data Interchange), 5.3% — a computerized system for returns tracking, 3.6% — 2D codes, 9.6% — bar codes.

Such results are not impressive and they suggest that Polish manufacturing enterprises should try to make some investments in that scope.

Each manufacturing enterprise has certain objectives that it strives for through adequate control over the carried-out activities. Hence, it was necessary to verify the influence exerted by implementation of actions related to management of the defective products' flows on implementation of the company's objective (Fig. 3.15).

Figure 3.15. Impact of the reverse flows management on implementation of the enterprise's objectives



Source: Own work based on results from the survey questionnaire.

The respondents' task was to determine that influence on the scale from 1 to 6, where 1 means negative influence and 6 is positive influence. The Majority of the respondents pointed to positive influence - almost 30% gave it 6, 18% provided it with 5 and almost 40% with 4 scores. The influence of the reverse flows management had negative impact on implementation of the company's objectives for almost 15%.

This suggests that Polish enterprises have a positive view on the reverse flows management in terms of the company's objectives implementation.

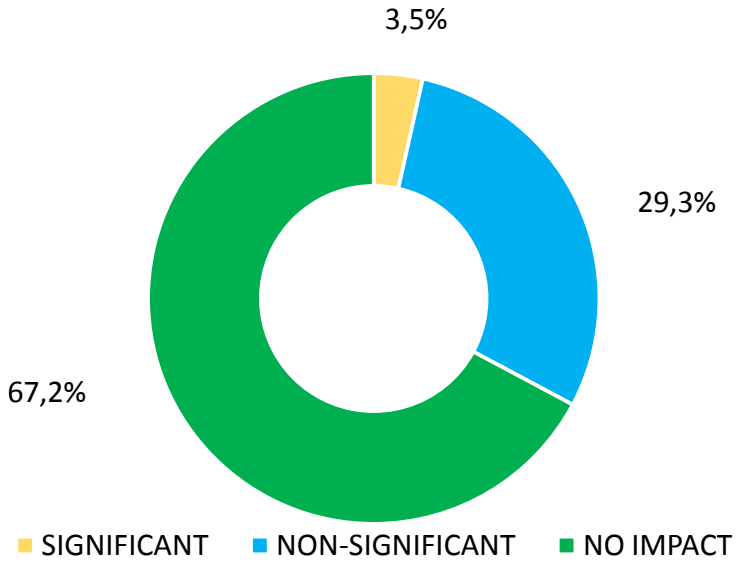
3.2.5. Effects of defective products' flows management

To determine the results from influence exerted by the defective products' flows management within an enterprise on its financial issues, the respondents were asked a question on the impact by the returns on the profitability of the enterprise (Fig. 3.16).

The majority of respondents (almost 70%) claimed that the defective products returns have no impact on the company's profitability. This means that the Polish manufacturing enterprises deal well with management of reverse flows and they are capable of using them adequately in such a scope that it has not impact on their financial results.

Almost 30% of respondents suggested that the returns reduce the profitability, but in a minor manner that has no greater impact on the above interpretation.

Figure 3.16. Impact of reverse flows management on the enterprise's profitability



Source: Own work based on results from the survey questionnaire.

Only 3.5% of the respondents state that returns of defective products reduce the company's profitability to a great extent. This means that management of defective products' flows in some enterprises does not function properly, as the returns should not reduce the company's profitability. An additional reason is the specificity of the companies' activities, unique qualities of products, and to a high extent complexity of the production process, which is why it is impossible to recover the value from the returns in whole or at least partially.

3.3. Identification of key premises for introduction and implementation of reverse logistics

The survey questionnaire carried out in the Polish manufacturing enterprises and its results on the reverse logistics processes in the defective products' flows management prompt to present some general conclusions on the problems in questions.

1. The Polish manufacturing enterprises carry out the processes in management of the defective products' flows in their activities.
2. The defective products occur in the Polish manufacturing enterprises in a form of returns creating reverse flows / flows of defective products.
3. The Polish manufacturing enterprises encounter defective products in a form of returns that may be divided into nine groups: damaged products, outdated products, seasonal products, unsold products, withdrawn products, products mistakenly taken as faulty, product components, waste- and by-products, packaging products.

4. All categories of defective products occur in the Polish manufacturing enterprises with different intensities, while most numerous are the waste- and by-products as well as packagings and product components, moderate intensity is ascribed to, apart from the previously mentioned, also the damaged products, and marginal intensity is most often related to waste- and by-products, damaged products, product components and packagings.
5. Major percentage share of the defective products is received by the Polish manufacturing enterprises in good, very god or perfect quality conditions. Less often their quality condition is determined as sufficient or poor, and it is barely stated to be terrible.
6. When we consider division of the defective products into three main categories of returns (manufacturer, distribution, market), it can be stated that in case of the flows in the Polish manufacturing companies the production returns are most frequent and numerous, the distribution returns pose maximum 80% of the whole annual production rate in the enterprises, and the marketing returns are numerous, but their percentage rate does not exceed 10% of the total annual production rate in the enterprises.
7. The return period of the defective products in the Polish manufacturing enterprises is relatively short (most often from 1 week to 1 month, up to 1 week and from 1 to 3 months). The return periods of more than 6 months are scarce.
8. The processing period for the defective products in the Polish manufacturing enterprises is also relatively short (from 2 days to one week and less than 1 day). The returns processing cycle taking more than 6 months is rather scarce.
9. The Polish manufacturing enterprises undertake the following actions as a part of the reverse logistics processes: returns acceptance, allocation for donations, charitable purposes, repackage and sales of products as new, sales in such a form as the product was accepted, renovation, production from recovered components or raw materials, sale, recovery of components, recycling, scraping.
10. The Majority of Polish manufacturing enterprises implement actions related to the defective products' flows management independently. Outsourcing of those actions is rather marginal.
11. The policy adopted by the Polish manufacturing enterprises as regards acceptance of the defective products' flows is liberal, meaning it is characterized with rules assuming openness towards the customers, allowing them to make complaints about the product without any problems, and to return them in justified cases. It was not amended within last 5 years.
12. The Polish manufacturing enterprises accept returns of the defective products because of at least one of the seven different motives: improvement in customer service quality, getting rid of unnecessary products from the market, fulfilling legal and environmental requirements, recovering the components and materials, developing reputation of an environmentally friendly company, preventing displacement of new products and limitation in the loss of quality.

13. The Polish manufacturing enterprises most often accept the returns while considering the improvement in customer service quality and fulfillment of legal and environmental requirements.
14. The elements of the defective products' flows management related to development of a competitive position of the Polish manufacturing enterprises are as follows: reduction of costs, price, quality, returns policy, delivery time and variety of products. All of those elements are of great significance for the companies, and they pose an important strategic element for the activities that are carried out.
15. The Polish manufacturing enterprises encounter the following barrier for effective management of the defective products' flows (listed in the order of significance): competitiveness issues, company's policy, financial resource, non-significance, legal conditions, lack of adequate organizational solutions, no attention paid by the managerial staff and incompetent personnel.
16. The Polish manufacturing enterprises scarcely use any hardware and software solutions that support management of reverse flows. Only a minor percentage plans implementation of such solutions in the near future.
17. Activities in the scope of defective products' flows management in the Polish manufacturing enterprises is reflected positively in implementation of those companies' objectives what means that they do not pose a barrier, or they even may turn out to be helpful in achievement of goals.
18. In majority of cases, the defective products in the reverse flows of Polish manufacturing enterprises do not contribute to reduction in the company's profitability.

The general summary of results from the survey questionnaire carried out in the Polish manufacturing enterprises suggests that those companies are active in implementation of the reverse logistics processes in management of the defective products' flows, despite the fact that the scope of those processes and that management is different in particular enterprises.

4. Organization and functioning of reverse logistics

4.1 Decisions in reverse logistics management processes

All reverse logistics processes are based on adequate decisions in the scope of their course and functioning, which may be made on various level of management in an enterprise. They should be strictly coordinated with defective products' flows management. Good practices in the area of the reverse flows management through implementation of the reverse logistics concept point to crucial significance of the decision-making processes for successful realization of those actions. Especially the manufacturing companies, struggling with problems related to the reverse flows, should make every effort so the decisions they make contribute to adequate organization of the reverse logistics processes in management of the defective products' flows.

Making decisions in the reverse flows management is of key importance for the manufacturing enterprises. The success of the whole undertaking related to functioning of the reverse logistics in the enterprise is in general based on accuracy of those decisions and their proper timing. While making decisions related to implementation of the reverse logistics in the scope of the reverse flows management the enterprises first of all need to focus on such optimization of the decision-making process that the decisions are most adequate for the scale of the flows emerging in the enterprise, and that it is possible to reuse the value they hold.

Making decisions related to the reverse flows management in manufacturing enterprises take place on three levels identified according to a time horizon: long-term, medium-term and short-term [Gupta 2013]:

- The main long-term decisions refer to the following problems:
    - Integration of the reverse flows with forward flows;
    - Appropriate distribution of financial sources;
    - Categorization and definition of the returns policy;
    - Determination of reasons, shareholders, etc. in reverse logistics;
    - Determination of actions in reverse logistics and the decision on whether outsource some or all of those actions;
    - Implementation of environmental management systems and knowledge acquisition about environmental directives, law and principles;
    - Selection of actions regarding final disposal and specification of their potential location;
    - Risk estimation (value of information and uncertainty).
- The main medium-term decisions cover the following areas:
    - Decisions about the means of transport and arrangement of transport routes;
    - Determination of the operational policy (production and stock);
    - Definition of returns policies for each product;
    - Definition of technical support for the offer;
    - Implementation of the reverse logistics actions;

- Development of a planning system for various reverse logistics actions and determination of their quality standards;
- Decision on location and allocation of the reverse logistics units' flow capacity;
- Definition of operational measures, optimization of policy.

- While the main short-term decisions refer to:
  - Development of logistics and process schedules;
  - Stressing the monitoring costs;
  - Actions in collecting and gathering of returns;
  - Considering the time value for returns;
  - Personnel training regarding the concept and practices of returns management;
  - Information management;
  - Specification of the disassembly level;
  - Returns analysis to improve the final disposal.

All of those decisions are more complex and extensive in practice because of additional and more detailed decisions made on the same three levels of the time horizon but regarding particular reverse logistics processes, which are also highly differentiated according to an individual character of each enterprise.

Based on the characteristics of the decisions in the scope of reverse logistics, its processes, specificity of defective products in enterprises, performed literature studies and business practices, it is possible to develop a general descriptive model of organization the reverse logistics processes related to defective products[23].

The foundation of the descriptive model of organization the reverse logistics processes related to defective products[24] are four main processes, implemented in the following order:

1) gatekeeping,
2) collecting and gathering,
3) control and sorting,
4) final disposal.

The model's structure is also based on decisions that are made within the aforementioned processes and connected with their implementation. The decisions, depending on their weight and the process they refer to, are made for a long, medium or short time (period), and their detailed characteristics are presented in Table 4.1.

[23] The descriptive model was drafted based on [Lambert, Riopel, Abdul-Kader 2011; Ait-Kadi et al. 2012].
[24] In the following part the model name is shortened to the synonymous name: the reverse logistics model of defective products.

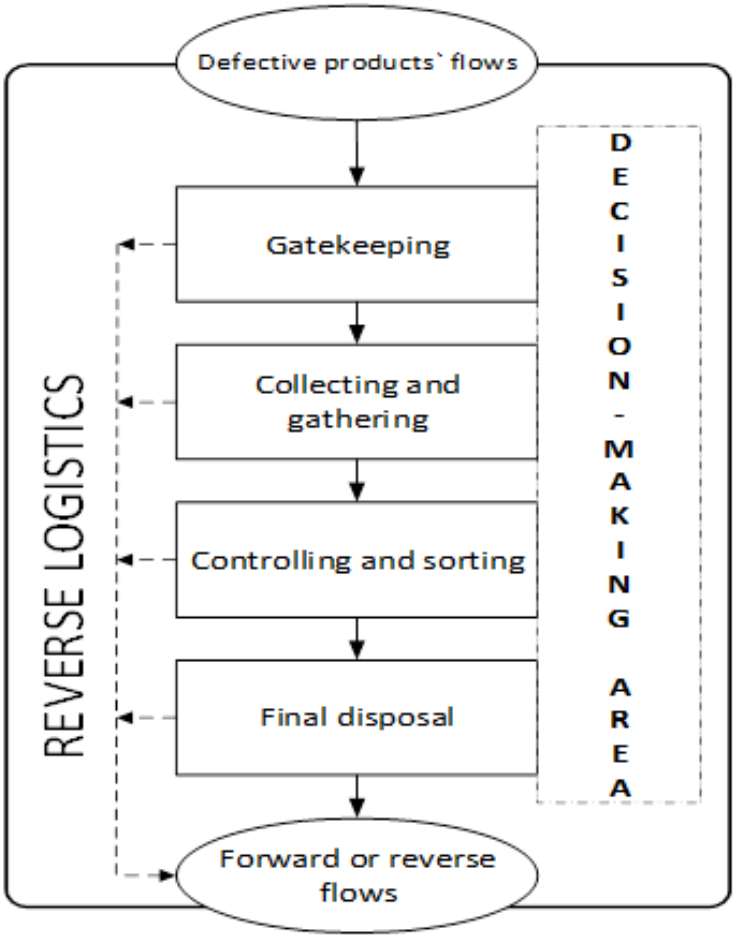
Table 4.1. Characteristics of the decisions in the scope of the reverse logistics processes management in the area of the defective products flows according to time periods

REVERSE LOGISTICS PROCESSES		
time hierarchy for decision-making		
Long-term decisions	**Medium-term decisions**	**Short-term decisions**
time		
2 – 5 years	**1 – 2 years**	**Day by day**
characteristics of decisions		
Most significant decisions; their results govern further operation of the enterprise and serve implementation of its primary objectives. Evaluation of the enterprise's activity in the scope of the reverse logistics processes. Determination of the products return policy. Determination of the reverse logistics' objectives and ways for their implementation, i.e. decisions on the policy of the reverse policy implementation and on the products return policy implementation. Determination of the scope of independent or outsourced implementation of the reverse logistics processes. Determination of procedures for handling hazardous materials. Adjusting the enterprise to the applicable environmental law and regulations.	***Decisions intended to implement the actions directed at and supporting the long-term decision-making.*** Organization of training programs in the scope of the reverse logistics processes. Development of cost estimates for the reverse logistics processes. Determination of functioning indicators of the reverse logistics processes. Determination of the supplies management system. Determination of the production planning system.	***Spontaneous decisions, undertaken as regards the current needs.*** Personnel training. Management of current problems. Control over costs. Development of reports from operations. Development of analyses related to the returns, based on which designs of new products are improved.

Source: Own work based on: [Guide, Jayaraman 2000; Schwartz 2000; Marcoux, Riopel, Langevin 2001].

Knowledge of the reverse logistics processes and decision made in the scope of their implementation allows graphical presentation of the general model of reverse logistics processes organization in the field of defective products, in the form presented in Fig. 4.1.

Figure 4.1. General descriptive model of the reverse logistics processes in the scope of defective products' flows



Source: Own work.

This model reflects only the generalized formula of processes and marks the decision-making area. In case of the reverse logistics processes regarding the defective products' flows, this generalization is crucial because each enterprise has a different way of the reverse flows organization and management. Furthermore, there are individualized decisions made in this scope. The difference occur even in the scope of manufacturers that produce within the same branch of industry. This is conditioned first of all by the contents of reverse flows, their uncertainty and no possibility to control them directly, as well as by specificity and individuality of the enterprises themselves.

What is more, a characteristic feature of the general model is that it does not explore the described processes and decisions precisely but it points to basic and feasible to use options related to the reverse logistics processes employed in management of the defective products' flows.

4.2.Model of reverse logistics of defective products

The presented reverse logistics model of defective products is a general view on the problems raised in this work. To present the processes in the reverse flows management carried out by manufacturing enterprises the model was extended in the scope of processes with their sequences and operations, unitary processes and elementary actions as well as relationships between them, from the "input" of the returns into the enterprise's flows, through implementation of the reverse logistics processes, to the "output" of the results from management of those returns.

The drafting procedure for that model was divided into three stages.

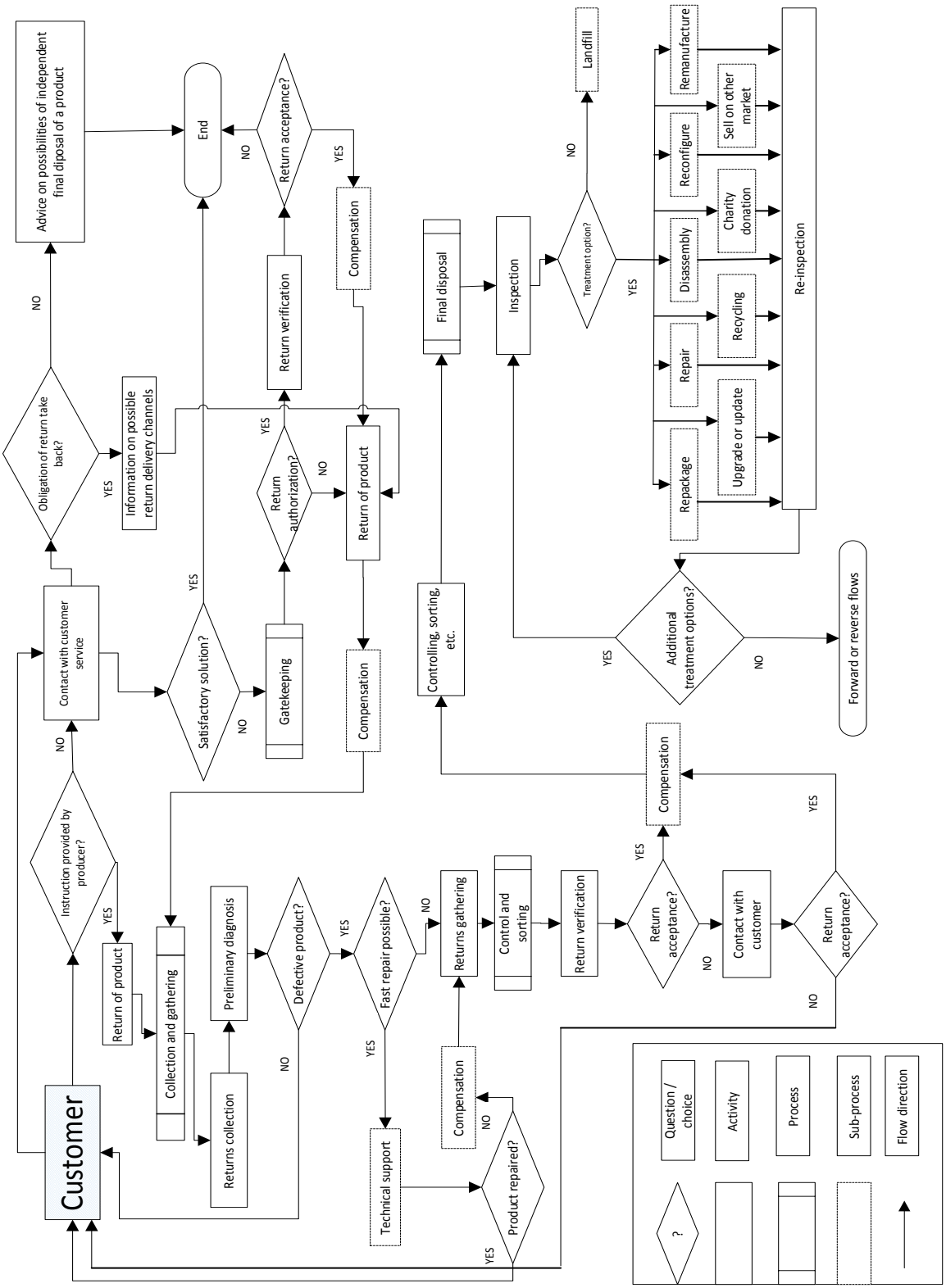
1. Development of the general reverse logistics model of defective products (Fig. 4.1).
2. Specification of the general reverse logistics model of defective products (Fig. 4.2):
   a) determination of boundaries for the defective products' flows [input/output),
   b) definition of the reverse logistics processes and particular operations carried out within the scope of those processes,
   c) development of a reverse logistics model of defective products,
   d) reviewing and improving the model on that basis.
3. Verification of the reverse logistics model of defective products compared to factual processes in manufacturing enterprises.

The defective products that supply the reverse flows come from final customers or from other participants of the enterprises' business environment (e.g. other enterprises, sub-contractors, logistics services providers). However, before the products become returns and supply the defective products' flows, there is a contact between the customer/ participant of the business environment with the manufacturer at the end of forward flows (usually with the customer service center) to request acceptance of the return, or the customer/participant of business environment returns the goods to the manufacturer following the operating manual.

The customer/participant of the business environment, holding the product/s with the attached manual describing the possibility to return the goods to the manufacturer should follow the served instructions. It usually means that the goods are delivered to the address pointed by the manufacturer. As such a return of the defective product[25] is a return authorized by the fact of having the operating manual, it is handed directly to the reverse flow.

[25] The presented model does not relate to returns of products of full value. The products of full value returned pursuant to the Act of 30 May 2014 on Consumer Rights, the Journal of Law Set of 2014, item 827 (e.g. Internet sales), or according to individual conditions arranged by a given manufacturer/seller (e.g. return of unwanted products in a retail shop), remain within the forward logistics flows.
The exception is posed by the products of full value, which were mistakenly classified as defective products by the customer/participant of the business environment or employees of the customer service center, and were returned as such. However, this mistake is eliminated in the gatekeeping process or at the latest during the collecting and gathering procedure.

Fig. 4.2. General reverse logistics model of defective products in manufacturing enterprises



Source: Own work.

It does not undergo the gatekeeping process and it is supplied directly to the first process of the reverse logistics implemented within the scope of the defective products' flows, i.e. the process of collecting and gathering the returns. While if there are no instruction as to the goods return, the customer/participant of the business environment must contact the manufacturer (customer service center).

The contact between the customer/participant of the business environment with the manufacturer is significant in two cases. First of all, it of elimination of the products lub eliminating the products the products that are potential returns already at the stage of their emergence within forward flows (preventing the returns), and second of all, it allows eliminating the gatekeeping process, directing the approved products in a form of a return directly to the reverse flow.

In the first situation the client/participant of the business environment contact the manufacturer (most often through the customer service center) by telephone, personally, via Intranet or e-mail, to solve the problem with the product. It is possible that having received appropriate support from the manufacturer, the person will decide not to submit the return. This is the most desired situation as it allows to preventy the returns. But it is probable that the proposed solution will not be satisfactory, and then the product will be directed to the gatekeeping process.

In the second situation, the customer/participant of the business environment contacts the manufacturer to return the product that has come to an end of life or end of use. Thus, there is no solvable problem with the product, as it can clearly be returned[26] as a defective product or based on the information provided by the returning party[27]. In such a situation, having identified correct qualification of the product for the reverse flow, the customer obtains information on how to hand the product to the manufacturer. Afterwards, the product is included into the reverse flow and it undergoes the collecting and gathering process. The product may sometimes not be eligible for the reverse flow (e.g. if it is produced by another manufacturer or if there is no law that would oblige the manufacturer to accept the return), but then the manufacturer may advise the customer to carry out the final disposal of the product independently.

In both presented situations, responsibility for the decisions made during the contact between the customer/participant of the business environment and the manufacturer is borne by the customer service center's employees. They are the ones that control the further course of a given situation. At the same time, in this moment these are the persons who decide on whether to change the flow from forward to reverse or not. These decisions are not always made correctly - even if the employees follow the guidelines regarding the returns acceptance policy strictly. Regarding erroneous interpretation of this polity or its over-interpretation, the justified returns may not be accepted, and the unjustified returns may be approved. However, such

[26] An example may be the applicable Polish Act of 11 September 2015 on used electrical and electronic equipment, the Journal of Law Set of 2015, item 1688, stipulating the principles of conduct with such equipment, and obliging its manufacturer to collect the used equipment from household free of charge.

[27] The customer/participant of the business environment reports such a failure of the product which clearly indicates its defective nature.

errors are successfully eliminated within the reverse logistics processes which cover the reverse flows.

The contact between the customer/participant of the business environment with the manufacturer may be established by an external company or by the functional unit of the enterprise. Usually, in the latter case, such a unit is also responsible for implementation of the gatekeeping process.

The gatekeeping process consists in identification of the returns, i.e. making an adequate decision as to determination of a suitability degree of the product or material for reverse flows. This process allows to determining not only the quality of returns included in the reverse flows but also the quantitative limit for those returns. Therefore, it is possible to keep the qualitative monitoring and reduce the number of returns what exerts advantageous influence on improvement of the customer service standards. What is more, the gatekeeping process protects the reverse flows from returns not intended for them (non-authorized, e.g. coming from another industry or manufacturer). It means minimization of costs related to returns of products which should not be returned, meaning qualified to the category of returns of defective products, and thus should not be included into reverse flows. This also reduces the costs related to the products returned in an incorrect manner or to an improper place (inclusion into the inadequate reverse flow). At the same time, as this process is a starting point for reverse flows, it is also the best point for elimination of all unnecessary costs and management of materials through filtration of goods to avoid unjustified returns.

The information obtained within this process are crucial and they pose a basis for implementation of the reverse logistics processes in management of the defective products' flows.

It is very important within the gatekeeping process that the decisions are made without any physical contact with the product intended to be returned. They are made solely based on information obtained by the manufacturer (customer service center) from the returning party. These decisions are very often of an indicative character, based on the returns acceptance policy. The decisions made within that process are of definitely more accurate and objective nature that during the first contact of the party reporting the product for a return, as here verification is applied to a whole set of factors that determine a given product and its suitability in reverse flows.

On the gatekeeping stage, there are long-term decisions made, related to such notions as: whether the process is to be implemented independently or via agents, whether the process is to be of a centralized or dispersed character, where the process implementation should be located. Apart from that there are also medium-term decisions which refer to possible technical support, language of communication, requirements towards authorization of the returns, elements and scale of evaluation necessary for acceptance of the returned defective products as well as decisions on whether the products are returned in whole or in parts.

Subsequent reverse logistics processes within the scope of the defective products' flows management are: collecting and gathering, control and sorting, and final disposal of the returns.

The collecting and gathering process is employed in case of defective products that have been verified positively and qualified for reverse processes during the gatekeeping, as well as the returned products, according to the instruction, directly by the customer/participants of the business environment. This process is implemented by a specific functional unit of the enterprises or specialist companies.

The collection is related to the products returned by the customers/participants of the business environment and their handing to the manufacturer. This action is intended to deliver the returns to the enterprise's location. This is the place where the first physical contact between the manufacturer and the returned products occurs.

While holding the returns and information about them that was collected during gatekeeping, it is possible to carry out the preliminary diagnosis of their condition. This action consists in first verification of the information about the product's defective nature[28]. Afterwards, based on this diagnosis, there is a decision made about the possibility of fast repair of the defective products. If this occurs impossible, then the products are directed to the subprocess of technical support.

There is a technical support subprocess within the collecting and gathering of returns, which is highly significant and characteristic for manufacturing enterprises. Bearing it in mind that the strategy of those enterprises is based on maximum possible reduction of returns, the technical support subprocess is highly developed there. Technical support has broad possibilities regarding elimination of the returned defective products. It is implemented into the manufacturing companies in order to limit the number of returns, also to improve the customer service. Having diagnosed the problem with a given defective product [independently by the returning party, during the first contact, during the gatekeeping or even within the returns collecting process) the technical support may have an opportunity to reinstate the original condition of the product so there is no need for its further presence in the reverse flow and involvement into other processes of the reverse logistics. The technical support is based in majority on possibilities of immediate repair of the defective products or quick reinstatement of their original quality by adopting spare parts. The technical subprocess is most often employed in case of products with valid guarantee. However, it also covers the products based on after-sales services. The repaired products that were not handed to the reverse flow are returned to the customer/participant of the business environment. In turn, the product the repair of which failed and other goods that had no chance for a quick repair undergo the gathering process.

Collecting, as regards the complexity level of the reverse flows in a given enterprises and its business surroundings, consists in or a more or less complex

[28] Regarding lack of previous physical contact with the products (customer service and gatekeeping are based solely on information and evaluations delivered by the customer; the customer may return the product independently, following the operating manual), it is possible that there will be some products of full value within the collecting and gathering process. The preliminary diagnosis allows to elimination them from the reverse processes.

sorting and consolidating of the defective products' returns to hand them to another process of control and sorting.

The process of collecting and gathering of the defective products' returns is based on long-term decisions in the following scope: whether the process should be implemented independently or via agents, determination of the desired service level for the returns, determination of the general need for collecting and gathering of the returns in a given quantity and quality, making decisions about financing of this process. It is also based on medium-term decisions regarding: selection of the way of transport, type and means of transport, determination of the possible course of the transport routes, deciding on whether it is necessary to ensure a temporary or a permanent replacement product for a given return, decide whether the return are to be accumulated and stored or rather handed further immediately, and short-term decisions related to planning of current transport routes.

The next reverse logistics process in management of defective flows is the controlling and sorting process. The returns collected and gathered in the reverse flows are directed to this process in order to validate information acquired during gatekeeping and authorization of their suitability in particular options of the next reverse logistics process - final disposal.

The controlling and sorting process is to ensure compliance of the returned defective products with information collected at the preliminary selection stage (or included in a card in the operating manual). The returns are subjected to verification in terms of product data correctness, quality, quantity, elements, visual condition, etc. If any significant discrepancies or problems are found out, it is necessary to contact the returning party again in order to obtain additional clarifications. If they are not satisfactory, the return may no longer be acceptable for a reverse flow, and it might be handed to the source (customer/participant of the business surroundings).

The defective products that have been verified positively undergo a series of actions that are intended for their most precise control and sorting so they comply with requirements of particular options in the final disposal. The course of the returns control and sorting process ends with consolidation for the need of handing the process for final disposal.

The long-term decisions, undertaken during the returns controlling and sorting process for defective products are related to specification of: location of the process implementation, its centralization or dispersion, independence of the process implementation or handing it to the agents, methods of service and manipulation. The medium-term decisions are related to: selection of the manner, type and means of transport, determination of possible transport routes, determination of the general need for controlling and sorting of the returns (in a given quantity and quality), determinations of controlling and sorting procedures, selecting of the returns intended for storage, determination of strict criteria for acceptance of the returns. While the short-term decisions are related to: planning of the vehicle routes.

At this point the attention should be paid to the subprocess of granting compensation for a defective process. The compensation consists in awarding the

customer/ participant of the business environment with temporary or permanent replacement products. They may also receive compensation in another satisfactory form. The compensation may be awarded, regarding the product's level of defectiveness and/or the enterprise's policy, at the gatekeeping, during return of the product, if it is impossible to implement technical support or at the stage of acceptance of the return in the controlling and sorting process. The decisions made in this subprocess are to a great extent financial decisions, they refer to methods and possibilities of granting compensation to customers/participants of the business environment.

The last process of the reverse logistics in management of the defective products' flows is the final disposal process. It is a complicated and comprehensive process as there are various options for recovering value from the returns, thus it is necessary to make numerous decisions in this field. The returns in the final disposal process undergo a thorough inspection at first. Its purpose is to ensure accuracy of undertaken decisions regarding their further direction to an appropriate final disposal option. Within the previous controlling and sorting process, the decision about the returns' final disposal option is also undertaken, but it is not a final decision. Some additional information about e.g. the condition of the returns may appear in the final disposal process, so the final decision is the one regarding the final disposal option made in this process.

The long-term decisions, made in the final disposal process, are related to: selection of whether the process should be implemented independently or through agents, choice of a location, disposal of actions among various units of the enterprise, estimation of the return volume that can be disposed by the enterprises, selection of the service method. The medium-term decisions in this process are related to: periodical review of the location needs, determination of quality standards for various disposal options, determination of feasible action for each return, the use of stock. In turn, the medium-term decisions are related to: determination of criteria for management of current actions and stock and arrangement of the actions schedule.

There are ten options that can be identified in the defective products' final disposal process. These are: repackage, repair, disassembly, reconfiguration, remanufacturing, upgrade/modernization, recycling, donation to charitable purposes, sales on another market, delivery to a landfill. Each option (except delivery to a landfill) ends with a repeated inspection of the products or material collected within the final disposal process. It is necessary as some defective products, after implementation of one final disposal option, may require other option to optimize the value recovery. Hence, the final disposal process is characterized with recirculation of reverse flows on this stage of the reverse logistics.

Medium- and short-term decisions are made within the determined final disposal options. Repackage is the simplest option for final disposal of returns. The product is repackaged into the same packaging, or if it causes any reservations as to the quality, then it is packed into a new packaging. The decisions made within the scope of this process are of a medium-term character and they are related

to determination of whether the cost of repackage will not be higher than the value obtained from sales of the product, and whether the repackage will improve the sales of products. The short-term decisions are related to the need of repackage and determination of the product's condition related to its suitability for repackage.

Repair consists in reinstatement of the damaged or non-operational products into service. In this scope, the medium-term decisions are related to: searching for a solution if the repair fails, repeated storage of the repaired products, determination of whether the repair is more advantageous in cost terms than replacement of the product with a new one or financial compensation. The short-term decisions are related to determination of whether the repair is feasible.

Disassembly consists in obtaining modules or components from the products and reuse them. When it comes to disassembly, the made environmental decisions are related to specification of whether the reuse is limited solely to the components that come from the returned defective products.

Reconfiguration consists in implementation of minor modifications in the product's configuration to prepare it for reuse in conditions similar to the original ones. It is mainly related to switching the language of the operating manual, so the product can be sold in another country, change of the label and replacement of some parts to adjust the products for requirements of consumers in a different state. The medium-term decisions made in the reconfiguration process are related to determination of whether reconfiguration cost is lower that the profit from sales of the products, while the short-term decisions are related to finding a different solution if the reconfiguration fails.

Remanufacturing is a process similar to the repair as it consists in reinstatement of modules, components or whole products to their original conditions, which may then be reused. Remanufacturing is different from repair as it allows regular modification on a greater number of used or damaged products, remaining a more specialized and deeper process. Within the remanufacturing process, the made medium-term decisions are related to finding an alternative solution if the remanufacturing fails, determination of whether the regenerated product will be stored or not and whether it is worth regenerating the product in cost terms, when compared to the profit from its sales. While the short-term decisions are related to determination of whether remanufacturing is possible in case of particular defective products.

Upgrade/modernization is intended to bring older types of the products to the latest version. This is related to adding new functionalities to products by replacing parts, components or modules. This process is very similar to the remanufacturing process, but it differs with the purpose - the remanufacturing is intended to prolong the product's life cycle, and this process is intended to improve functionality or appearance of the product. Upgrade/modernization is related to medium-term decisions made in the following scopes: identification of an alternative solution if the process fails, determination of whether the product will be stored and whether the costs exceed the future profit from sales of the product. The short-term decisions are

related to determination of whether the process is feasible in relation to particular defective products.

Recycling is based on extraction of raw materials from the returned defective products. Hence, the necessity to use primary materials for production is reduced, as they can be replaced with some recycled goods. The medium-term decisions made during the recycling process are related to determination of whether the costs of disassembly of the products to collect recycled materials are indeed lower than purchase of the original materials. In turn, the short-term decisions are related to determination of which defective products are eligible for that process and whether the returned products include any parts that could be recycled.

Donation for charitable purposes consists in handing the products to a *non-profit* organization. Generally, the only advantage for enterprises in this case is improvement of image. The decisions regarding this process are made only in a medium-term time horizon and they are related to determination of implications arising from donation of the products for charitable purposes (taxes and other), and verification of the demand for products that are planned for handing.

Sales on another market consists in directing the correctly functioning products to a different, alternative market, characterized with lower customer expectations regarding the fact that the returned defective products do not correspond to the requirements of the current market or fail to meet the quality criteria for this market. The medium-term decisions on this sales process on another market are related to determination of whether the costs of planning and implementation of sales on a different market are not higher that the profits from that operation, verification or existing secondary conditions and checking whether there is any risk for cannibalization of sales on the main sales market.

Delivery to a landfill is actually related only to a part of products that hold no value, and thus they become waste. This option also means that the waste is allocated for incineration. The waste must be free from hazardous qualities before implementation of the process, which is the least desired option, as despite the possibility to generate energy it brings no advantages for the enterprises. The medium-term decisions in the scope of this process cover determination of its costs, which should be lower than costs of other options, while the short-term decisions refer to verification of presence of the hazardous materials in waste.

Each final disposal process of the defective products, apart from the delivery to a landfill - what is an adverse but sometimes necessary action - leads to recovery of the value included in these products. Thanks to the final disposal options, the recovered secondary value in a form of whole products, parts and components or raw materials can supply the traditional or reverse flows in the enterprises again.

The presented general reverse logistics model of defective products can be verified in the Polish manufacturing enterprises to obtain information about adequacy of the described process in the economic practice.

4.3. Verification of procedures in reverse logistics of defective products

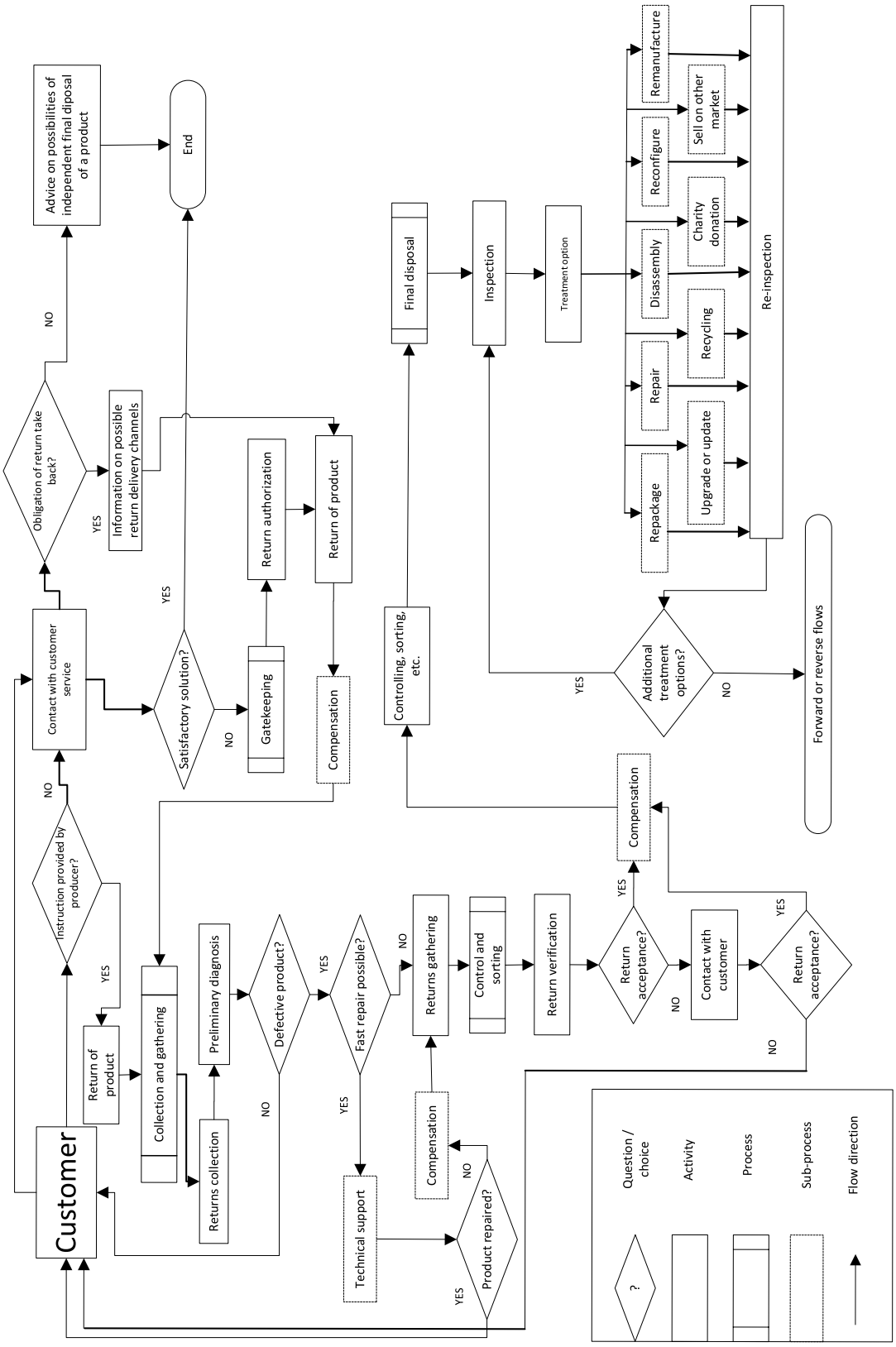
The concept of descriptive reverse logistics model of defective products developed within the performed research was verified in five selected manufacturing enterprises. They were selected with consideration of the research sample and parameters allowing general interference as to this type of economic entities. All of the five enterprise carry out the manufacturing activities in Poland, the type of their major activity complies with assumption of the performed research and there are defective products' flows in the area of their activities, as a result of which the enterprises have implemented certain procedures related to the reverse logistics in management of the defective products' flows.

The primary data on implementation of the reverse logistics data in management of the defective products' flows within the analyzed manufacturing enterprises were collected in the third quarter of 2015 with a method based on direct interviews with senior management staff, designated by authorities of the enterprises. During the interview, each designated employee was asked to present and describe the applicable procedures regarding acceptance of the defective products returns and further handling with such products, along with organization of such actions. Afterwards, the employee was presented with a concept of a general reverse logistics model of defective products. Then, the employee was asked to comment on the concept. Based on that interview, there was an individual reverse logistics model of defective products developed for each out of the five researched enterprises.

The Polish manufacturing companies selected for the research verifying the developed model, regarding recognizability of their brands and protection of confidential data related to their activities did not consent to have their names published, thus they are marked as X, Y, Z, Q and V.

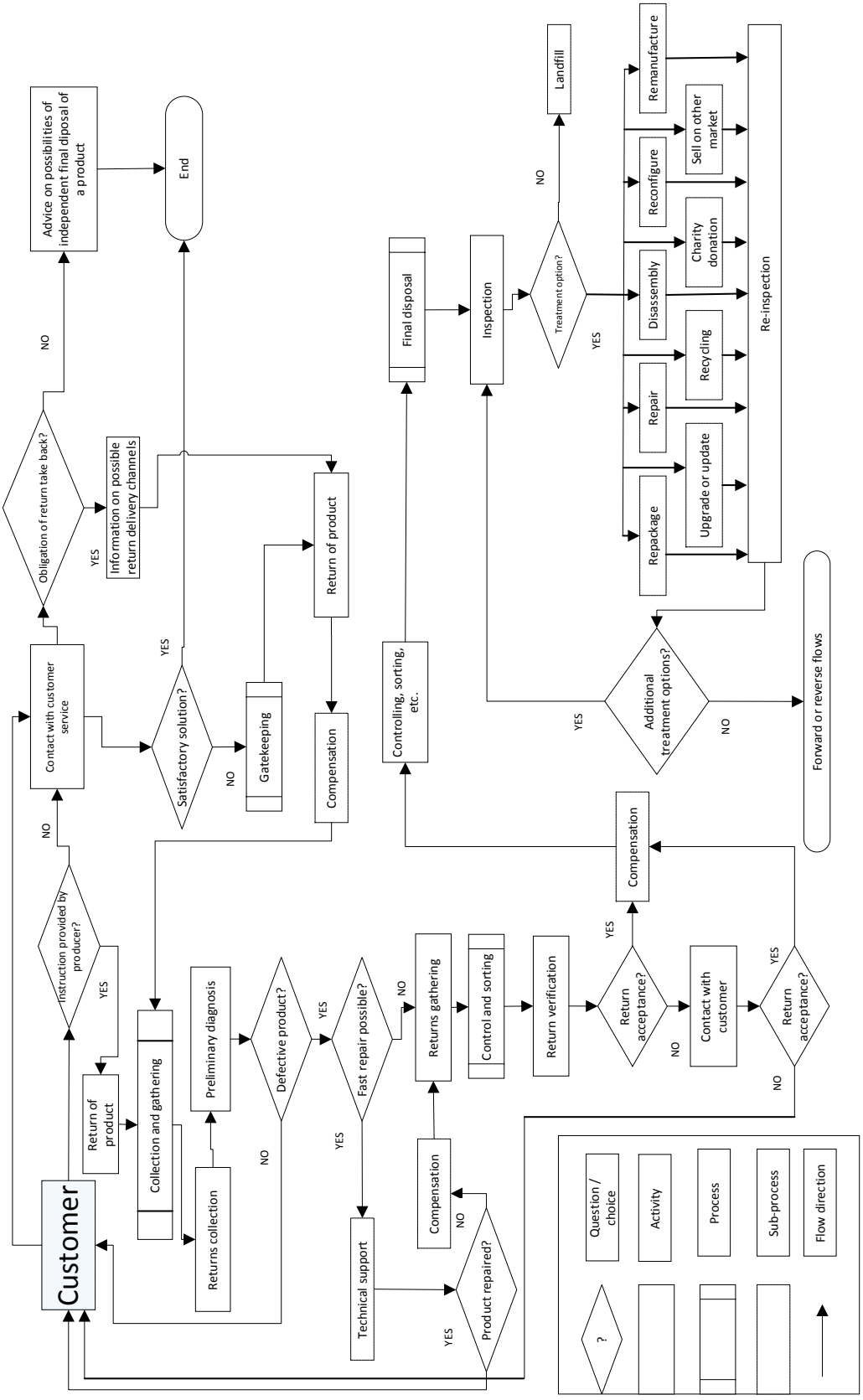
The X enterprise is a large entity manufacturing household appliances that are sold on domestic and foreign markets. It is one of the leading enterprises in that field on the Polish market. In Poland, the production focuses on large household appliances (washing machines, freezers, dishwashers, both stationary and built-in), while small household appliances are manufactured by this enterprises in its factories located in several other European states. Regarding the type of major activity and the international character of production and distribution, the X enterprises has highly developed procedures in the scope of reverse logistics in management of reverse flows (Fig. 4.3).

Fig. 4.3. Verification of reverse logistics model of defective products in the X enterprise manufacturing household appliances



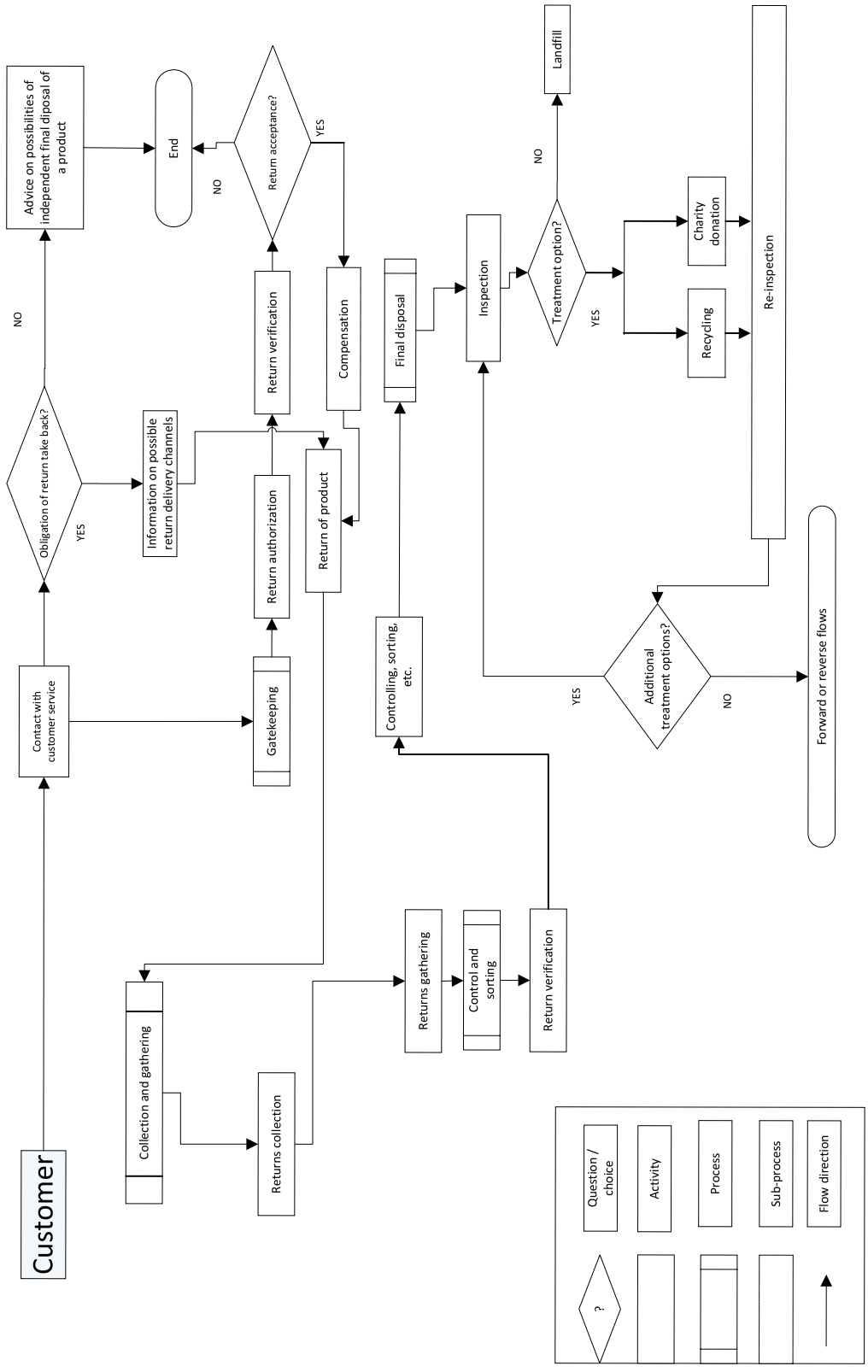
Source: Own work.

Fig. 4.4. Verification of reverse logistics model of defective products in the Y enterprise manufacturing baby strollers



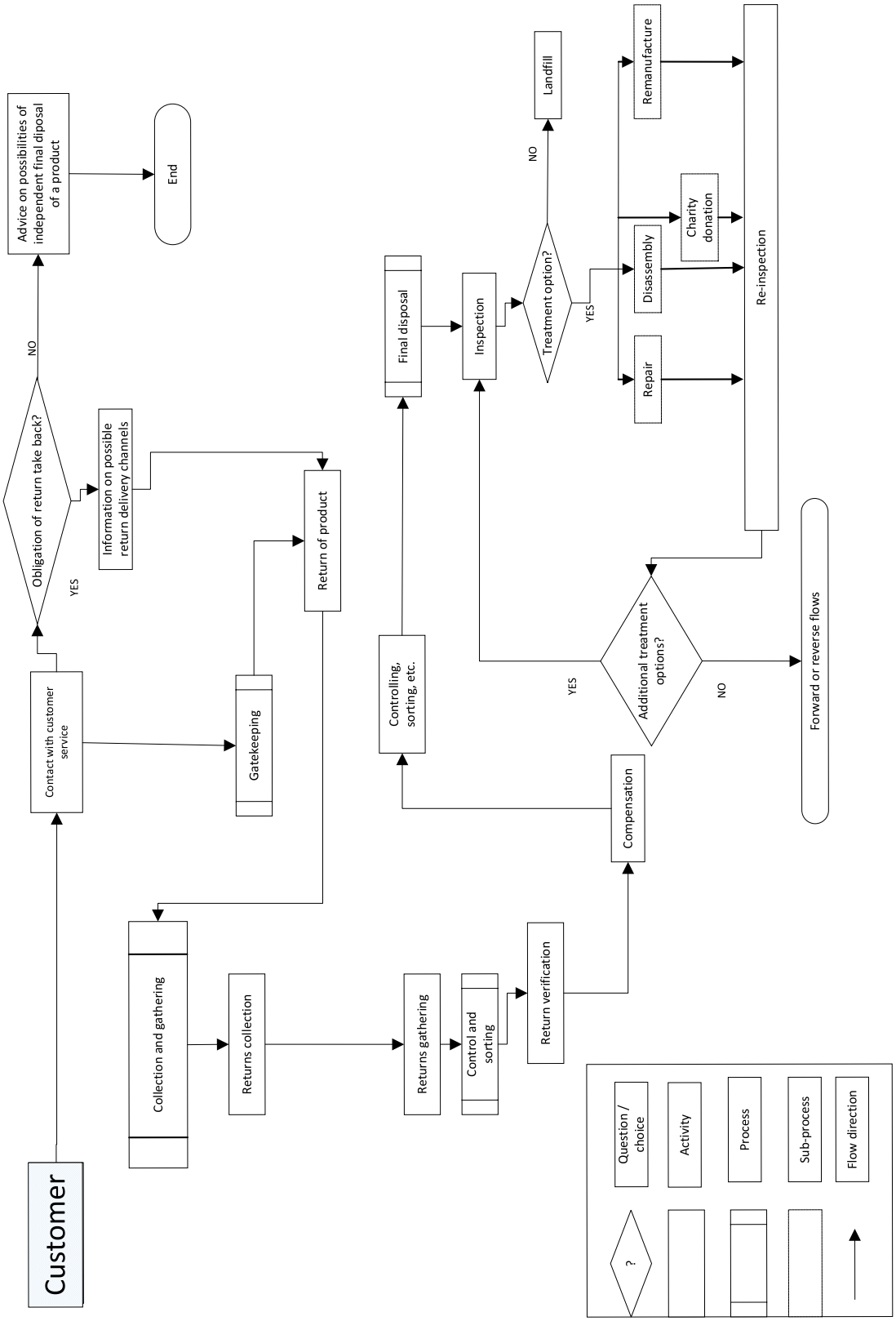
Source: Own work.

Fig. 4.5. Verification of reverse logistics model of defective products in the Z enterprise manufacturing furniture



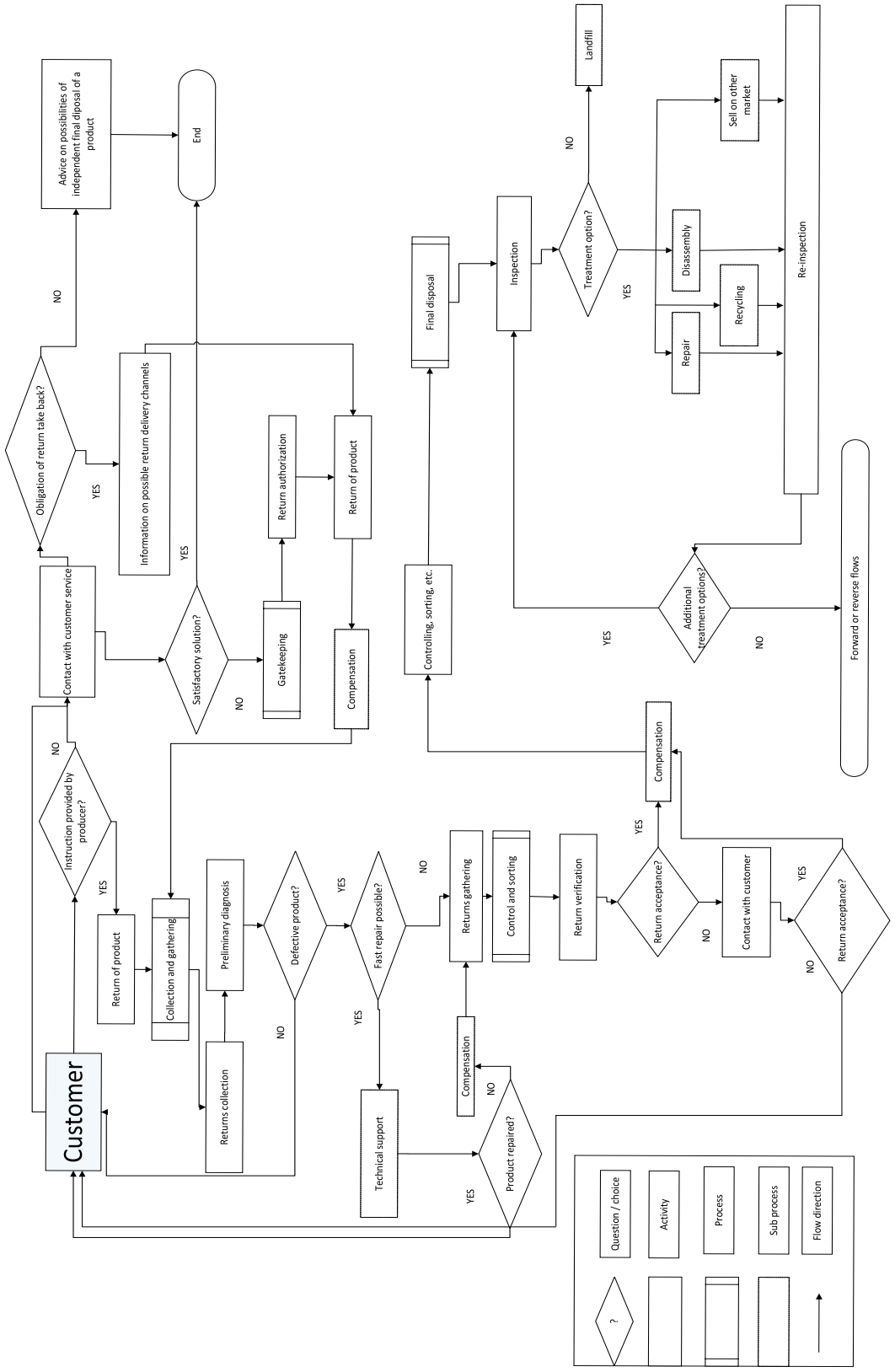
Source: Own work.

4.6. Verification of reverse logistics model of defective products in the Q enterprise manufacturing male clothing



Source: Own work.

4.7. Verification of reverse logistics model of defective products in the V enterprise manufacturing automotive parts



Source: Own work.

The Y enterprise is a medium-sized company that manufactures baby strollers that are sold mainly on the national market and in neighboring countries, but the company is gradually expanding to other European states. Production of this company is based on prams, buggies, multi-functional stroller and accessories. This enterprise has also implemented some reverse logistics processes in management of the reverse flows, first of all because of the security requirements for the products that they manufacture (Fig 4.4).

The Z enterprise is another a medium-sized unit, but from the furniture sector. The company manufactures furniture accessories and pieces of furniture based on systemic solutions. Its products are sold mainly in wholesale, but retail is also implemented, however at a smaller scale. The company operates on the domestic market, having its chain of wholesale stores first of all in the southern part of Poland. While planning the expansion to the European market, the Z enterprise has had some developed procedure standards for some years, regarding the reverse logistics processes implemented within management of the defective products' flows (Fig. 4.5).

The Q enterprise is a small company that manufactures medium- and high-quality male clothing, first of all for special occasions (weeding suits, first communion suits). Its operations are based mainly on the local and provincial market, in a form of retail. The enterprise is a family business, with a perspective for development within several upcoming years by extending its reach to the domestic market. Even though the Q enterprise's production scale is currently small when compared to other four researched enterprises, some reverse flows also emerge in this case, undergoing the reverse logistics processes, according to the standards adopted in this company (Fig 4.6).

The last researched V enterprises is a large manufacturing unit from the automotive industry. It manufactures automotive parts that are sold on the domestic, foreign and global market. Furthermore, it manufactures and sells (on a slightly smaller scale in Poland and Europe) components of motor vehicles, spare parts and special-purpose vehicles' equipment - mainly sport cars and motorcycles. The enterprise has implemented a high standard of procedure regarding the reverse logistics processes, first of all because of internationalization of production and the character of the manufactured products, covered with the highest quality standards in the scope of security (Fig 4.7).

Verification of the approved general descriptive reverse logistics model of defective products allows to showing the similarities and differences within the course of those processes. This analysis is solely of an illustrative and diagnostic character, as regarding the differences between the research entities, it cannot pose any comparative material. Thus, it is carried out in a form of case analysis.

The first information about the request made by the customer/participant of the business environment to be allowed to return the product is obtained by the research manufacturing X, Y, Z, and V enterprises via the customer service center. The contact is established by the customer/participant of the business environment via a telephone (or in rare cases via e-mail). In case of the Q enterprises, which das not

have customer service center differentiated within its structure, the first information on the return request are received personally, via a telephone to the owner.

In the X, Y and V enterprises, regarding specificity of products - household appliance, strollers and automotive parts - it is possible to solve the problems with the products during that contact. The customer service center's employee may propose solutions to the problems with faulty goods during their conversation with the customer, hence the return will not be implemented. In case of the X enterprise, the contact allows of prevention of about 40% of returns, in the Y enterprises it is about 25% of the returns and in the V enterprises it is less than 5%. Other return requests of the products are recorded (usually as a complaint if the product has valid warranty, or in other form if the product has no valid guarantee) by the customer service center's employees and subjected to the gatekeeping process. At the same time, the products returned to those enterprises based on the operating manual pose from 5 to 15%.

In turn, in both Z and Q enterprises the avoiding of returns can be a problem as there is no possibility - in case of furniture and furniture accessories and male clothing - to solve the problem with the product while contacting the customer. Thus, in case of the Z enterprise, all return requests of the products are recorded by the customer service center's employees and directed to the gatekeeping process, while in the Q enterprise, the return requests are registered by the owner. What is more, the returns are not submitted to both of those companies based on operating manuals as they are not attached to the products.

At the same time, the contact between the customer/participant of the business environment with the customer service center or the owner of the enterprise may be related to the willingness to return the defective product that has come to an end of life or end of use. This means that the customer must get rid of such a product.

This contact has special significance in the X enterprises as in case of the household appliances manufacturing the producers are legally bound to collect the products of that type from the market. Therefore, when the customer reports their willingness to get rid of the product, the manufacturer is legally bound to receive these goods. Hence, the manufacturers of household appliance attach an operating manual which informs the users on the conduct in case of fault or end of life or end of use. If the equipment is older and there is no such information in the manual, the manufacturer of the household appliances should provide information about the manner of handing the product in a form of a return.

Such a situation is non-existent in the Y, Z, Q and V enterprises, as the industries, which the companies operate in are not regulated by any laws that would oblige to collect the products from their users. In this case, the enterprises - while contacting the customer - may (but are not obliged to) instruct the customer on how to get rid of the used equipment on their own.

In the situation above, the decisions regarding qualification of a product as a return are made by employees of the X, Y, Z, V manufacturing companies working in the customer service center, or the owner in case of the Q manufacturing enterprise.

Employees of the X, Y, Z and V enterprises follow the conduct procedures stipulated in the internal policy of the enterprise, determining the principles for accepting the product returns. The customer service center's employee from those four research manufacturing enterprises also carry out the gatekeeping process for the products that they preliminarily qualified as returns of defective products. While the owner of the Q enterprises makes the decision on qualification of the returns on their own, more based on their own experience than the enterprise's return policy, as it is not formalized in this case. The owner is also competent in the scope of the gatekeeping process.

This process has a slightly different course in each of the researched enterprises. In case of the X manufacturing enterprise, the authorization of the return that checks if the returned product was manufactured by a given producer consists in verification of the product against the ascribed name code. Generally, this process is not intended to reject any products, it only serves to accept a product, and if necessary, to provide it with an appropriate complaint number. Afterwards, the returned defective products supply the reverse flows and undergo the reverse logistics processes.

The gatekeeping process looks similarly in the V enterprise, where the return authorization is intended to verify the product against the code that is unique for each item. This is necessary regarding specificity of products, as automotive parts are subjected to very high quality requirements in the scope of both security and production what is reflected in the need to verify and record all defects. These returns, marked as defective products, supply the reverse flows.

In the Y enterprise, the returns are not authorized, as there are no situations when the customers would like to return a baby strolled of another brand. Thus, the returns are accepted during the gatekeeping process and at once directed to the returns collecting and gathering process, or in case of complaints, a complaint number is ascribed to a given return. It is similar in case of the Q enterprise, where lack of authorization results from customers not attempting to return male clothing manufactured by another producer. This process is generally omitted in this enterprise because if the owner accepts the return, or the product is complained about, it is immediately directed to the collecting and gathering process, having an ascribed complaint number.

In case of the Z enterprise, authorization of a product is necessary, as it is crucial to ensure compliance of the returned product's brand with the manufacturer's brand because of the fact that in case of furniture and furniture accessories the products are not marked in such a clear and visible manner as e.g. household appliances, baby strollers or clothing elements. Hence, the gatekeeping process covers verification of a given return. If it is negative, meaning that the product is not compliant with product specification adopted in the Z manufacturer, the enterprise does not accept the return. In turn, if the verification is positive, the returned product is supplied to the reverse

flow and subjected to another reverse logistics process, i.e. collecting and gathering of returns.

The process of collecting and gathering the returns in the analyzed manufacturing enterprises begins from collecting the returns, where they undergo an initial diagnosis. Thanks to that, the X, Y and V enterprises can eliminate the products of full value that were mistakenly directed to the reverse flows. Afterwards, the enterprises, regarding their possibilities, attempt to use the technical support what gives them a chance to limit the quantity of returns that undergo further reverse logistics processes, and send the products of full value to the customers. The technical support implemented in the X enterprises directs about 30% of returned products to fast repair, in the Y enterprises it is about 5% of such products and in the V enterprise the value is 5%. In the latter case, the technical support is implemented only for selected categories of products, regarding the current needs, and it is usually employed for wholesale returns. Retail returns are not applicable in this case. If the technical support fails to repair the returns, they are directed to the gathering division.

The preliminary diagnosis is not implemented by the Z and Q enterprises, as the products specificity allows to elimination of the returns of the products of full value already at the initial stages. At the same time, the returns do not undergo the technical support subprocess in both enterprises regarding no possibility for a fast repair of this kind of goods.

The collected products are gathered afterwards. In the X enterprise, the gathering of the products is the responsibility of the agent. This results from broad distribution of the household appliances offered by the X enterprise. Customers/participants of the business environment who are willing to return a defective product, accepted for the procedure during gatekeeping hand it to the manufacturer via an intermediary company. Returns of the household appliances in the X enterprise are collected and gathered by the wholesalers and retailers and then delivered to its seat to carry out the controlling and sorting process.

In case of the Y, Q and V enterprises the customer returns a defective product - qualified as a return on previous stages - on their own, to the reverse flows. Baby strollers, male pieces of clothing and automotive parts are directly sent by the customers to the manufacturer, where they undergo the controlling and sorting process.

While the Z manufacturer collects and gathers the defective products' returns on its own. The reason for that is that it holds a well-developed chain of manufacturer stores, so the customers can hand the returned product in such a store, i.e. directly to the manufacturer.

In another process of the reverse logistics, the defective products' flows are controlled and sorted. This process starts with the return verification in all researched manufacturing enterprises. This verification is based on identification whether the previously acquired information is correct, and it allows to specifing an accurate qualitative and quantitative condition of the returned products.

The course of the controlling and sorting process looks very similar in the X, Y and V enterprises. This is the stage, where the return may still be rejected because of identified discrepancies or no suitability for final disposal. During verification, a final decision is made as regards acceptance of the return intended for further processing. In case of a positive decision, the return is subjected to the controlling and sorting actions. If the decision on acceptance of the return is negative, it is necessary to contact the customer again. This contact is intended to specify the defective nature of the product. Afterwards, when the acquired information is still not satisfactory for the manufacturer, they reject the return and send it back to the customer.

If the obtained information is satisfactory, the return is accepted for further processing, where all returns undergo the controlling and sorting procedure. This is intended to determine the manner, i.e. the option the returns should be processed further. This is the basis, on which the defective products are handed to the next and at the same last reverse logistics process, meaning the final disposal.

In case of the furniture and furniture accessories manufacturer Z and the male clothing manufacturer Q, the controlling and sorting process has simplified course, as verification of returns consists only in determination of qualitative and quantitative parameters of the returned defective products. What is more, in case of both of these enterprises, the specificity of product causes that the return acceptance and the repeated contact with the customer are unnecessary, as all required information was acquired on previous stages. Thus, after the verification process, the returns in Z and Q enterprises are subjected to controlling and sorting actions to determine the option for their further processing, and are afterwards handed to the final disposal process.

A significant issue from the perspective of reverse logistics in the scope of customer service is compensation of losses that the customer suffered because of the defective product. While analyzing the procedures in enterprises X, Y and V, the subprocess of awarding compensation looks similar. Regarding complexity of the reverse logistics process in those three enterprises as well as specificity of the products, the compensation may be implemented in three situations. The first possibility for awarding the compensation is upon the product return, the second one may be granted by the technical support when fast repair of the product is not possible, and the third one takes place within the controlling and sorting process - it might be awarded after verification and acceptance of the return. The moment when the customer receives compensation is strictly related and dependent on a particular returned defective product. In case of household appliances, baby stroller and automotive parts, the compensation is most often based on releasing the same product of the same or similar parameters to the one that was returned, or less often on a cash refund.

The compensation awarding procedure in the Z enterprise takes place in the gatekeeping process, after verification and acceptance of the return, as characteristics of the furniture products makes it impossible to restore them to their original condition during the final disposal option in the reverse logistics. This is usually the

customer who makes the decision on whether they are willing to get compensation as a refund or a returned product.

In turn, compensation in the Q enterprise is awarded in the sorting and controlling process, after the return is verified. The returned pieces of clothing are characterized with varied qualitative and quantitative conditions, which is why the owner can make a decision on compensation only after a given return is diagnosed. Compensation is usually a refund here, unless the customer decides otherwise.

The last process of the reverse logistics - final disposal - takes place in all analyzed production enterprises according to the same scheme. The difference is in the final disposal options adopted in those enterprises.

Returns of defective products in the final disposal process are inspected in the first place. First of all, the inspection is intended to eliminate any erroneous decisions made towards a given refund during previous processes, and second of all verification of the returned product in terms of the possibility to employ a selected option for final disposal, and to specify whether this selected option is most advantageous and allows maximization of the value restoration from this return.

When the final disposal options of the returned defective products are analyzed, it is visible that their full range is adopted by the Y manufacturing enterprise that employs all feasible options in case of baby stroller, i.e. repackage (about 2% per year), upgrade and modernization (about 3% per year), repair (about 45% per year), recycling (about 10% per year), disassembly (about 5% per year), reconfiguration (about 10% per year), remanufacturing (about 10% per year), sales on a different market (about 10% per year) or donation for charitable purposes (about 2% per year) and delivery to the landfill (about 3% per year).

Also the X enterprise adopts all above options in case of the household appliance, except the last one - delivery to the landfill - what is caused not only by legal and environmental regulations but also the products specificity itself, which as returns allow total recovery of value without being transformed into waste. This enterprise adopts the options at the following rates per year: repackage of about 5% of returns, upgrade and modernization - about 15%, repair - about 55%, recycling - about 5%, disassembly - about 3%, reconfiguration - about 5%, remanufacturing - about 5%, sales on a different market - about 5% and donation to charitable purposes - about 2%.

The option of recovering value from the returns in the final disposal process that is most frequently adopted in the V enterprise is recycling (about 65% per year). Other employed options are repair and disassembly (about 10% per year each), sales on other market (about 5% per year) and waste delivered to a landfill (about 10% per year).

The Z manufacturing enterprise, regarding characteristics of the returned defective products recovers the value from them through adopting the recycling process (about 85% per year), hence obtaining secondary raw materials. Minor percentage of the returns (about 5% per year) is suitable for charity donation. The remaining returns are ascribed with a waste status during the final disposal process and are delivered to the landfill (about 10% per year).

In turn, the Q enterprise, similarly to the Z enterprise, regarding the returns specificity, can recover the value from defective products by adopting: repair - about 40% of returns per year, remanufacturing and disassembly - about 15% per year for each process, charity donation - 10% per year. Returns of male clothing in this enterprises, which are delivered for storage on a landfill pose about 20% per year.

The possibility for returns recirculation is characteristic for the final disposal option. This happens when employment of a single value recovery option does not suffice so there is a need to adopt another option to optimize the advantage coming from the recovery.

In case of all analyzed enterprises, the returns that are subjected to the final disposal option undergo re-inspection when a decision is made on whether it is necessary to employ an additional value recovery option in their case. If the decision is positive, then the returns go back to the inspection point and then are transferred to another final disposal option. If the decision is negative, the reverse logistics processes are completed by supplying the forward or reverse flows with the value recovered during the final disposal process. Regarding specificity of the product and the performed value recovery from the product return, the manufacturing enterprises supply flows of their own or of other participants of the business environment.

The Z enterprise that acquires only the secondary raw materials, supplies its own production process with them. A similar situation takes place in the Q enterprise that includes the whole recovered value into its own production process. The Y enterprise keeps the recovered 90% of the value for itself in various forms. The X and V enterprises utilize about 50% of the recovered value, and they sell the second half on the secondary market, to supply the logistics flows of other participants of the business surroundings.

The performed verification of the reverse logistics model of defective products in five researched Polish manufacturing enterprises X, Y, Z Q and V suggests that they activities within the analyzed field match the concept developed during the literature studies[29]. In general, all analyzed processes are held in accordance with indications of the general model.

Verification of the model allowed practical presentation of the reverse logistics processes implementation in management of the defective products' flows, and rendered it possible to stress the basic differences in actions undertaken by enterprises in that scope. They result from both the differentiated parameters of the research enterprises and from the specificity of the defective products' flows, which is different in each of the pointed companies.

Development of the model and discussion about the research that verifies its correctness allowed conceptualization of the notions in the scope of the reverse logistics processes in manufacturing enterprises, which were explained at first in the

[29] It must be stressed here that the Polish manufacturing enterprises, while implementing the reverse logistics processes in the scope of defective products' flows management, do not use the terminology ascribed to these processes in the literature, but rather their own independent nomenclature. However, this has no impact on characteristics and qualities of both the process and studies.

theoretical and then practical perspective. At the same time, there were the scope and specificity of defective products' flows within manufacturing enterprises determined within the presented model. The descriptive characteristics of the general model, developed in detail at the verification stage in the manufacturing enterprises also allowed indicating the reverse logistics and its processes as implementation methods for defective products' flows management in those enterprises.

However, it is also significant that the concept of the general reverse logistics model of defective products in manufacturing enterprises is only a proposal for such companies, which may use it to improve their systems in this scope. As the model presents a general structure, each manufacturing enterprise must adapt this model preliminarily to their operational conditions, as its present form is of a universal nature. Nevertheless, the verification carried out in five manufacturing enterprises different in terms of parameters proved that the general form of the model allows any configuration of actions related to the reverse logistics processes, this it may pose the basis for manufacturing enterprises which do not implement management of the defective products' flows or are not highly advanced in that matter.

The general reverse logistics model of defective products should further undergo all adaptational extensions and a more detailed analysis of the decisions and actions undertaken in that scope, while striving for establishment of an individual reverse logistics system in management of defective products' flows that would be individual and unique for each manufacturing enterprise.

5. Interdependence of determinants in reverse logistics management of defective products

The survey performed in the Polish manufacturing enterprises and its results presented in the third chapter of this monograph allow carrying out certain analyze on a more methodologically advanced level. It allows among others to analyze the interdependencies between factors that determined defective products' flows management in Polish manufacturing enterprises, which was carried out based on the following indicators - x^2 and φ – Yule's coefficient.

The x^2 measure is adopted for examination of interdependencies of two features measured on rated scales. It is determined against a contingency table. The contingency table consists in empirical sizes n_{ij} of those sample elements, for which the X features adopts a x_i variant, and the Y feature adopts a y_j variant. The x^2 value suggests a stochastic dependence or independence between X and Y features in the general population that the studies sample comes from. But it does not indicate strength or direction of the dependences, and it practice its significance must be verified. The x^2 value is determined according to the following formula [Zeliaś, Pawełęk, Wanat 2002]: wyznaczana jest ze wzoru:

$$\chi^2 = \sum_{i=1}^{r}\sum_{j=1}^{s}\frac{(n_{ij}-\hat{n}_{ij})^2}{\hat{n}_{ij}}$$

Where $\hat{n}_{ij}$, posing a theoretical size, is obtained from the following formula:

$$\hat{n}_{ij} = \frac{n_{i.}\cdot n_{.j}}{n}$$

that is: $\hat{n}_{ij} = \frac{\text{total population in the i−th row x total population in the i−th column}}{\text{simple size}}$

The simples contingency table is the association table [Zeliaś, Pawełęk, Wanat 2002].

X / Y	+	–	Total
+	*a*	*b*	*a* + *b*
–	*c*	*d*	*c* + *d*
Total	*a* + *c*	*b* + *d*	*n*

Symbols adopted in the table are as follows:

a — the number of units holding the X feature and holding the Y features,

b — number of units holding the Y feature and not holding the X feature

c — the number of units holding the X feature and not holding the Y feature,

d — number of units holding none of the examined features.

There might be some simplified formulas adopted for data presented in the association table, the disadvantage of which is limitation in use and the benefit is the possibility to grasp the dependence direction, though this issue must be approach with great care.

The x^2 measure is directly proportional to the sample size - if with the same proportions of value in the contingency table the size in increased *n* times, the x^2 value will also grow by *n* times. To eliminate the impact exerted by the size on the x^2 value, there are standardized indicators calculated [Zeliaś, Pawełęk, Wanat 2002]:

$$\chi^2 = \frac{n(ad-bc)^2}{(a+b)(a+c)(b+d)(c+d)}$$

The Yule's coefficient - φ- is intended to examine the strength of relationship between two qualitative features with different numbers of variants. It is expressed with the following formula [Sobczyk 2000]:

$$\varphi = \sqrt{\frac{\chi^2}{n}}$$

For the number of rows not exceeding 2 the - φ Yule's value cannot be more than 1, and when the number of rows is higher than 2, that value can be greater than 1.

The x^2 value can be calculated only when the frequency of particular cells in a correlation table is not lower than five (excluding the possibility of the Yate's correction). For smaller cell frequencies in a table the calculations are much harder.

While interpreting the value of the φ– Yule's coefficient, we need to remember the close its value to 1, the clearer and stronger the dependence between examined variables.

The basic purpose of performed analyses, the results of which are presented in this chapter, is to evaluate the dependencies between characteristics of defective products' flows, their parameters and qualities, barriers for effective management of defective products' flows and manner of overcoming them, and the results of defective products' flows management in the Polish manufacturing enterprises.

To perform the interdependence analysis, there was a collection of variables assumed, divided into groups together with their characteristics:

1st group of characteristics for the defective products' flows:

1) Variables related to intensity and quality of the defective products' flows in the enterprises: damaged products, outdated products, seasonal products, products unsold in retail, withdrawn products, products mistakenly taken as faulty, product

components, waste- and by-products, packagings. These variables specify either intensity of reverse flows measured on a scale from 1 to 4, where 1 means that they are numerous and 4 that they are absent, or the medium qualitative conditions of the returns in relation to the primary product quality measured on the scale from 1 to 6, where 1 means a terrible condition and 6 is a perfect condition.

2) Variables related to the place where the defective products' flows appear in enterprises (as percentage): manufacturer returns, distribution returns, marketing returns.

2nd group of parameters of actions related to defective products' flows management:

1) Variables related to the most frequent return period for a defective product (calculating from the moment of handing it to distribution), where there are 10 variants of answers - the first one is the period from 1 week, and in the last one - the period of more than 5 years.
2) Variables related to duration of the average processing cycle for returns in the enterprises with 8 variants of answers - the first is the period shorter than 1 day and the last - the period longer than 6 months.
3) Variables related to determination of actions in the scope of the defective products' flows management, which are carried out independently or by the enterprises, are commissioned to third parties or not performed at all. These actions cover: returns acceptance, allocation for donations, charitable purposes, repackage and sales of products as new, sales in such a form as the product was accepted, renovation, production from recovered components or raw materials, sale, recovery of components, recycling, scraping.

3rd group of objectives and motives of the policy of defective products returns:

1) Variables related to evaluation of the enterprises' policy in the scope of accepting defective products, measured on the scale from 1 to 6 where 1 means a very restrictive policy and 6 is a very liberal policy, as well as variables related to the change in the enterprise's policy in the scope of accepting the defective products returns within last 5 years, also measured on the scale from 1 to 6, where 1 means a change into a more restrictive policy and 6 into a more liberal one.
2) Changes related to the motives of accepting the defective products returns by the enterprises: improvement in customer service quality, getting rid of unnecessary products from the market, fulfilling the legal and environmental requirements, recovering some components and materials, developing of an environmentally-friendly company reputation, preventing displacement of new products by the products from the secondary market, limiting the loss of value on unsold or defective products. These variables determine the motives that are considered by enterprises as non-significant, significant or very important.

4th group of barriers of effective management of defective products' flows and ways of overcoming them:

1) Variables related to barriers of effective management of defective products' flows, present or absent in the enterprise: company's policy, aspects of competitiveness,

financial outlays, non-significance, lack of adequate organizational solutions legal conditions, no attention from the managerial staff, incompetent personnel.

2) Variables related to evaluation of significance of particular aspects in an enterprise in development of its competitive position: reduction of costs, price, quality, returns policy, delivery time, variate of products. These variables were measured on the scale from 1 to 6, where 1 determined the aspects as completely non-significant and 6 as very important.
3) Variables related to installation of hardware and software that support management of the defective products' flows: bar codes, 2D codes, a computerized system for returns tracking, electronic data interchange (EDI), radio frequency identification (RFID). These variables determine whether the above solutions are installed, are planned to be installed or are not installed are there are no plans for their installation in the future.
4) Variables related to determination of influence exerted by the defective products' flow management in the enterprise on implementation of the enterprise's objectives, measured on the scale from 1 to 6 where 1 is negative influence and 6 - positive influence.

5th group of results from management of defective products' flows:

1) A variable related to the influence of the returns on reduction in the enterprise's profits, where this influence could be significant, non-significant or absent.

The interdependence analysis was employed in case of each variable (each pair of variables), but regarding the fact that the correlation was very weak in numerous cases or there were no causative relations that could be explained in a logical manner, this chapter presents only the most important and statistically significant interdependencies.

Interpretation of the interdependence results is based not only on the performed calculations but also on observations and performed direct interviews with representatives of the manufacturing enterprises mentioned in the previous chapters.

The first analyses covered interdependencies between emergence intensity of defective products in a form of returns in the examined enterprises, i.e.: damaged products, outdated products, seasonal products, products unsold in retail, products withdrawn from sales, products erroneously taken as faulty, product components, waste- and by-products, packagings and particular categories of variables from the assumed collection of variables divided into groups. Examination of those correlations proved that significant statistical interdependencies are present in case of emergence intensity of the defective products and particular categories of variables from the (2nd) group of parameters of actions in the scope of the defective products' flows management, i.e. the variables related to determination of actions in the scope of the defective products' flows management in the enterprises. Results of this study are presented in Table 5.1.

What is more, in case of emergence intensity of outdated and withdrawn products in the reverse flows of enterprises, no statistically significant correlations

with any of the researched variables category were confirmed, so they are not presented in the table.

Table 5.1. Values of the Yule's correlation coefficient φ and statistics x^2 for emergence intensity of defective products in reverse flows of enterprises and the accompanying variables category from the (2nd) group of action parameters in the scope of the defective products' flows management.

Variables \ Coefficient		x^2	φ
Damaged products			
Returns acceptance	(1)	**8.923***	**0.172**
Repackage and sales as new	(2)	**5.866***	**0.139**
Remanufacture	(3)	**9.477***	**0.177**
Production from recovered components or raw materials	(4)	**19.350***	**0.253**
Sales	(5)	**9.654***	**0.179**
Recovery of components	(6)	**3.876***	**0.113**
Seasonal products			
Repackage and sales as new	(7)	**12.308***	**0.202**
Sales in the same form as the product was accepted	(8)	**6.781***	**0.150**
Sales	(9)	**8.558***	**0.168**
Recovery of components	(10)	**5.209***	**0.131**
Products unsold in retail			
Charity donation	(11)	**4.424***	**0.121**
Repackage and sales as new	(12)	**8.838***	**0.171**
Sales in the same form as the product was accepted	(13)	**9.421***	**0.177**
Sales	(14)	**6.124***	**0.142**
Products erroneously taken as faulty			
Production from recovered components or raw materials	(15)	**5.414***	**0.134**
Product components			
Sales in the same form as the product was accepted	(16)	**11.086***	**0.192**
Production from recovered components or raw materials	(17)	**7.492***	**0.158**
Sales	(18)	**6.829***	**0.150**
Recycling	(19)	**4.987***	**0.129**
Waste- and by-products			
Remanufacture	(20)	**6.892***	**0.151**
Packagings			
Recycling	(21)	**5.218***	**0.131**

** - statistically significant values on the level of α= 0.05.*
Source: Own work based on results from the survey questionnaire.

The interdependencies presented in Table 5.1 confirm occurrence of correlations reverse flows significantly more often perform actions related to returns acceptance.

A between emergence intensity of some defective products in the reverse flows of some enterprises and independence of some actions undertaken in the scope of the defective products' flows management by the enterprises.

There is a statistically significant interdependence (1) between independence of returns acceptance and the damaged products' emergence intensity in flows of the returned defective products. Manufacturing enterprises that record damaged products in their similar situation refers to independence of enterprises in performance of actions that consist in: repackage and sales of the products as new (2), remanufacture (3), production from recovered components or raw materials (4), sales (5) and recovery of components (6).

When it comes to reverse flows management, occurrence of seasonal products is correlated with the following actions undertaken by the enterprises independently" repackage and sales of the products as new (7), sales of the products in the form as accepted (8), sales (9) and recovery of components (10). In this case, these interdependencies are clear in majority and they become stronger along the increase in emergence of seasonal products in the defective products' flows.

The emergence intensity of the products unsold in retail is correlated with frequency of independent actions carried out by the enterprises, covering: charity donation of defective products (11), repackage and sales as new products (12), sales of the products in the form as accepted (13) and sales (14). These interdependencies are in majority clear also in this case, and they become more intensive along with the increase in emergence intensity of the products unsold in retail in reverse flows.

The enterprises that employ production from recovered components or raw materials apart from traditional manufacturing processes more often notice significance of emergence of products erroneously taken as faulty in the reverse flows (15).

While emergence intensity of the returned products is correlated with the enterprises' undertaking actions related to management of reverse flows in a form of sales of products as accepted (16), production from recovered raw materials and components (17), sales (18) and recycling (19). Also these interdependencies are clear and they intensify along with growing emergence intensity of the product components among the returns in the defective products' flows of manufacturing enterprises.

When it comes to actions undertaken by enterprises in relation to the reverse flows management, the emergence intensity of waste- and by-products in those flows is correlated with remanufacture (20) as the enterprises that repair their products are rarer to generate waste- and by-products qualified to the category of returns in the defective products' flows.

While emergence intensity of packaging in the reverse flows is correlated (21) with implementation of recycling by those enterprises, allowing to recovering at least a part of the value included in this category of defective products.

The confirmed correlations suggest that even though Polish manufacturing enterprises do not have direct impact on the emergence intensity of the defective products in their reverse flows, they still, indirectly, through actions related to the defective products' flows management, influence this intensity. This is first of all related to situation when the enterprises collect the defective products returns on their own, seeing their potential to generate economic benefits, and adopting them in management operations of reverse flows.

What is more, during the examination of interdependence between the emergence intensity of the defective products in a form of returns in the researched enterprises and other categories of variables, there were statistically significant correlations found out with the variables from the (5th) group of management of defective products' flows regarding the impact of the returns on reduction in the enterprise's income, and from the (2nd) groups of action parameters in the scope of the defective products' flows management, related to the most frequent return period for a defective product return [calculating from the moment of handing it to distribution). Statistically significant results of this correlation study are presented in Table 5.2.

Table 5.2. Values of the Yule's correlation coefficient φ and statistics x^2 for emergence intensity of defective products in reverse flows of enterprises and the accompanying variables category from the (5th) group of the results of the defective products' flow management and (2nd) group of action parameters in the scope of the defective products' flows management

Coefficient / Variables	x^2	φ
Damaged products		
Reduction in the enterprise's profitability because of the returns (1)	**15.524***	**0.233**
Seasonal products		
Reduction in the enterprise's profitability because of the returns (2)	**6.536***	**0.151**
Products unsold in retail		
The most frequent return period (3)	**4.261***	**0.129**

** - statistically significant values on the level of α= 0.05.*
Source: Own work based on results from the survey questionnaire.

The interdependencies presented in Table 5.2 confirm occurrence of correlations between emergence intensity of some defective products in the reverse flows of some enterprises and reduction in the enterprise's profitability by returns and the most frequent return period.

The existing statistically significant interdependence between evaluation of the drop in the enterprise's profitability regarding emergence intensity of damaged products (1) and seasonal products (2) in the group of defective products returned to the reverse flows of those enterprises suggests that the products significantly contribute to the drop in the enterprises' profitability. While analyzing this interdependence there is a need to stress that both the damaged and seasonal products are indeed a category of defective products, which the enterprises would prefer to omit. However, on the other hand, while interpreting the obtained results with the data from Table 5.1, we need to notice that if the products undergo special operations in the enterprises within the scope of the defective products' flows management, they may pose a source of benefits consisting in recovery of the value they hold. Therefore, just the fact of confirming the above-mentioned interdependence does not need to prove its negative overtone.

While the statistically significant interdependence between the emergence intensity of the products unsold in retail in reverse flows of the enterprises and the most frequent return period (3) seems to result from the character of this kind of defective products. The products unsold in retail are most often returned directly or indirectly by retailers and/or whole sellers. As these entities usually cooperate with manufacturing enterprises, the return period for products unsold in retail in this case is identified and determined, thus - what was confirmed in the research - there is some interdependence between them.

Having performed the interdependence analysis between the emergence intensity of defective products in reverse flows of Polish manufacturing enterprises and particular variables categories from the (2^{nd}) group of action parameters in the scope of defective products' flows management, there was another interdependence analysis carried out between the qualitative condition of the defective products and particular categories of variables from the assumed collection of variables divided into groups. The examination of correlations covered the qualitative condition (in relation to the original product quality), returns of defective products in the enterprise's logistics flows for: damaged products, outdated products, seasonal products, products unsold in retail, products withdrawn from sales, products erroneously taken as faulty, product components, waste- and by-products and packagings correlated with particular categories of variables from the adopted collection of variables divided into groups. This research proved that there are some statistically significant interdependencies between the qualitative condition of defective products and variables categories from the (2^{nd}) group of action parameters in relation to the defective products' flows management, i.e. variables related to determination of actions from the scope of the defective products' flows in enterprises, and the (4^{th}) group of barriers for effective management of the defective products' flows and manner of overcoming them, meaning the variables related to evaluation of significance of particular aspects in an enterprise in development of its competitive position. Results of this research are presented in Table 5.3.

At the same time, when it comes to the qualitative condition of the outdated products, seasonal products, products unsold in retail, products withdrawn from sales, products erroneously taken as faulty and product components in reverse flows of enterprises, there were no statistically significant correlations confirmed with any of the researched variables categories, hence they are not covered by the table.

Table 5.3. Values of the Yule's correlation coefficient φ and statistics x^2 for qualitative conditions of defective products in reverse flows of enterprises and the accompanying variables category from the (2nd) group of action parameters in the scope of the defective products' flows management and from the (4th) group of barriers for effective management of defective products' flows and ways of overcoming them

Variables \ Coefficient		x^2	φ
Damaged products			
(2nd) Implementation of actions related to reverse flows management	Remanufacture (1)	**6.075***	**0.227**
	Sales (2)	**4.089***	**0.186**
Waste- and by-products			
(2nd) Implementation of actions related to reverse flows management	Recycling (3)	**15.835***	**0.255**
(4th) Significance of developmental aspects for the enterprise's competitive advantage	Costs reduction (4)	**6.190***	**0.159**
	Delivery time (5)	**8.287***	**0.184**
Packagings			
(4th) Significance of developmental aspects for the enterprise's competitive advantage	Costs reduction (6)	**6.005***	**0.279**

** - statistically significant values on the level of α= 0.05.*
Source: Own work based on results from the survey questionnaire.

Data presented in Table 5.3 confirm existence of statistical interdependencies between the qualitative condition of some defective products in the reverse flows of enterprises and implementation of selected actions related to the defective products' flows management and significance of chosen aspects of developing a competitive position of enterprises.

In the scope of the enterprises' actions related to management of reverse flows, the statistically significant correlations are observed for evaluation of the qualitative condition of the returned damaged products and independent implementation of remanufacture (1) and sales (2). There was the interdependence with independent implementation of recycling also in case of evaluation of the qualitative condition of waste- and by-products (3). In both cases, the enterprises that implement those actions on their own evaluated the quality of returned products as higher.

In turn, while analyzing the statistically significant interdependencies between the qualitative condition of the returned waste- and by-products and the variables

related to evaluation of significance of particular aspects of the enterprise in development of its competitive position, the stressed interdependencies were related to: costs reduction (4) and delivery time (5), and in case of researching the interdependence between the qualitative conditions of the returned packagings and evaluation of significance of particular aspects in the company regarding development of the competitive position, the stressed statistically significant interdependencies were related to costs reduction (6).

Other interdependencies analyses related to actions measured with their duration - between the most frequent period of the defective products return (calculating from the moment of handing the product to distribution) to the enterprise's reverse flow and duration of an average returns processing cycle in an enterprise and particular variables categories from the assumed collection of variables divided into groups.

This research proved that there are some statistically significant interdependencies between the most frequent return period of defective products to the enterprise's reverse flow and variables categories from the (2nd) group of action parameters in relation to the defective products' flows management, i.e. variables related to determination of actions from the scope of the defective products' flows in enterprises, and the (4th) group of barriers for effective management of the defective products' flows and manner of overcoming them, meaning the variables related to installation of hardware and software solutions that support the defective products' flows. Results of this research are presented in Table 5.4.

Table 5.4. Values of the Yule's correlation coefficient φ and statistics x^2 for the most frequent return period of defective products in reverse flows of enterprises and the accompanying variables category from the (2nd) group of action parameters in the scope of the defective products' flows management and from the (4th) group of barriers for effective management of defective products' flows and ways of overcoming them

Variables \ Coefficient		x^2	φ
Return period of defective products			
(2nd) Implementation of actions related to reverse flows management	Returns acceptance (1)	**6.852***	**0.164**
(4th) Hardware and software solutions that support the reverse flows management	Bar codes (2)	**4.411***	**0.131**

** - statistically significant values on the level of α= 0.05.*
Source: Own work based on results from the survey questionnaire.

Table 5.4 points to a statistically significant correlation between the most frequent return period of the defective products to the enterprise's reverse flows and actions undertaken in connection to the defective products' flows management, consisting in independent returns acceptance (1) - in some cases, the enterprises that accept the

returns on their own are capable of reducing or extending the products return times. This applies mainly to a situation when the returns come from partners of a given enterprise. Then, thanks to efficient exchange of information, the manufacturing enterprises have updated data on their products, and in case of returns they are capable of collecting them quicker or extend the time for their emergence in reverse flows.

A statistically significant correlation is also found out between the most frequent return period for defective products into the enterprise's reverse flows and the hardware and software solutions that support the reverse flows management in the form of employed bar codes (2). Thanks to such a solution, the manufacturing enterprises, while cooperating with other enterprises that use their product, are capable of - similarly as in the previous case - control the return periods via efficient exchange of data on the products.

While the research of interdependence between duration of the average processing cycle of returns in the defective products' flows of the enterprises and particular categories of variables from the assumed collection of variables divided into groups suggested emergence of statistically significant interdependencies for the variables category from the (2nd) group of actions related to the defective products' flows management, i.e. variables related to determination of actions in the scope of the defective products flows in enterprises, from the (3rd) group of objective and motives of the returns policy for defective products, meaning the variables related to the evaluation of the enterprise's policy regarding acceptance of defective products returns and motives for accepting the defective products returns by the enterprises, as well as the (4th) group of barriers for effective management of the defective products' flows and ways of overcoming them, i.e. variables related to evaluation of significance of particular aspects of an enterprise in development of its competitive positions, and the (5th) group of effects from the defective products' flows management, i.e. the variable related to the influence of returns on reduction in the enterprise's profits. The research results are presented in Table 5.5.

The analysis of correlations presented in Table 5.5 suggests that there is a statistically significant interdependence between duration of the average processing cycle of defective products in reverse flows of the enterprise and evaluation of the returns acceptance policy by the enterprise (1). This interdependence suggests that the more liberal the returns policy is, the longer the time for returns processing in the enterprise lasts. This might be related to the fact that in case of the liberal returns acceptance policy, more returns emerge in the defective products' flows, and this in turn expands the time for their processing.

There are some statistically significant interdependencies between the duration of the average processing of returns and motives of accepting the returns by the enterprise, which are as follows: improvement in the customer service quality (2), recovery of components and materials (3) and development of an environmentally-friendly company reputation (4). These interdependencies reflect a situation when the enterprises, while accepting the returns, are willing to improve the customer service

quality, develop some reputation as an environmentally-friendly enterprise, recover some components and materials from the returned products, as while striving for the objectives they shorten the returns processing duration what has positive impact on their implementation.

Table 5.5. Values of the Yule's correlation coefficient φ and statistics x^2 for duration of an average processing cycle of returns in the defective products' flows of an enterprise and the accompanying categories of variables from the (2nd) group of action parameters related to the defective products' flows management, from the (3rd) group of objective and motives of the defective products returns policy, from the (4th) group of barriers of effective management of the defective products' flows and ways of overcoming them, and from the (5th) group of effects of the defective products' flows management

Variables \ Coefficient			x^2	φ
DURATION OF THE AVERAGE PROCESSING OF RETURNS				
(3rd) Evaluation of the returns acceptance policy		(1)	**7.362***	**0.174**
(3rd) Motives for acceptance of the returns by an enterprise	Improvement in customer service quality	(2)	**19.995***	**0.284**
	Recovery of materials and components	(3)	**9.327***	**0.194**
	Development of an environmentally-friendly company reputation	(4)	**5.024***	**0.142**
(5th) Reduction in the enterprise's profitability because of the returns		(5)	**6.035***	**0.156**
(2nd) Implementation of actions related to reverse flows management	Remanufacture	(6)	**4.253***	**0.131**
	Sales	(7)	**12.308***	**0.223**
	Recycling	(8)	**5.703***	**0.152**
(4th) Significance of developmental aspects for the enterprise's competitive advantage	Costs reduction	(9)	**4.552***	**0.135**

** - statistically significant values on the level of α= 0.05.*
Source: Own work based on results from the survey questionnaire.

Within the course of research there was also a statistically significant interdependence confirmed between the average duration of processing of the defective products in the reverse flows of an enterprise and reduction in profitability of the enterprise because of the returns (5). This interdependence proves that the long processing time of the returns by the enterprise is not beneficial, and it contributes to a decrease in profitability because of excessive extension of the process.

When it comes to independence in performance of actions related to the reverse flows management by the enterprise and average duration of the returns processing cycle, there is a statistically significant interdependence regarding: remanufacture (6), sales (7) and recycling (8). The enterprises that implement those actions on their own intend to shorten the returns processing cycle as much as possible, because then they are capable of recovering the value included in those returns quickly.

The research also confirmed the statistically significant difference in time between the average duration of processing of the defective products in the reverse flows of an enterprise and cost reduction as a significant aspect of development of the enterprise's competitive advantage (9). Therefore, the enterprises that intend to reduce the costs strive for a maximum reduction in the returns processing cycle duration, as it allows them to recover the value from the returns and re-use it in their operations.

Other correlation analyses were carried out between the enterprise's policy in returns acceptance, influence of the returns on reduction of the enterprises' profitability and impact of the defective products' flows management on implementation of the enterprise's objective and particular variables categories from the assumed collection of variables divided into groups, and certain scores were granted.

The first interdependence analysis is related to the correlations between the enterprise's policy evaluation in the scope of returns acceptance and other categories of variables from the assumed groups.

Table 5.6. Values of the Yule's correlation coefficient φ and statistics x^2 for evaluation of the enterprise's policy regarding returns acceptance and the accompanying variables category from the (2nd) group of action parameters in the scope of the defective products' flows management, from the (3rd) group of objectives and motives of the policy of the defective products' returns, and from the (4th) group of barriers for effective management of defective products' flows and ways of overcoming them

Coefficient / Variables			x^2	φ
Evaluation of the returns acceptance policy				
(3rd) Motives for acceptance of the returns by an enterprise	Improvement in customer service quality	(1)	**16.084***	**0.251**
(2nd) Implementation of actions related to reverse flows management	Returns acceptance	(2)	**31.435***	**0.351**
(4th) Impact of the reverse flows management on implementation of the enterprise's objectives		(3)	**23.212***	**0.306**

** - statistically significant values on the level of α= 0.05.*
Source: Own work based on results from the survey questionnaire.

The research proved that the evaluation of the returns acceptance policy is correlated with the variables from the (2nd) group of actions in the scope of the defective products' flows management, meaning the variables related to determination of actions in the scope of the defective products' flows management, from the (3rd) group of objectives and motives of the policy of the defective products' returns, i.e. variables related to the motives for acceptance of the defective products' returns by an enterprise, and from the (4th) group of barriers for effective management of the

defective products' flows and ways of overcoming them, i.e. variables related to determination of influence exerted by the defective products' flows management in the enterprise on implementation of its objectives. Results of this study are presented in Table 5.6.

While analyzing the obtained results, there were some statistically significant correlations stressed between evaluation of the enterprise's policy regarding returns acceptance and the motive for returns acceptance that is improvement of the customer service quality (1), independence in realization of an action related to the reverse flows management, which consists in acceptance of the returns (2) and influence exerted by the reverse flows management on implementation of the enterprise's objectives (3). All of those correlations adopted not only significant but also high values. The enterprises that improve the customer service quality, accept the returns on their own and having positive views on the impact exerted by the reverse flows management on implementation of the company's objectives have a more liberal policy in the scope of accepting the defective products returns.

The second interdependence analysis is related to the correlation between the evaluation of the returns' impact on reduction in the enterprises' profitability and other categories of variables from the assumed groups. The research proved that the evaluation of impact from the returns on reduction in the enterprises' profitability is correlated with the variables from the (2nd) group of actions in the scope of the defective products' flows management, meaning the variables related to determination of actions in the scope of the defective products' flows management, from the (3rd) group of objectives and motives of the policy of the defective products' returns, i.e. variables related to the motives for acceptance of the defective products' returns by an enterprise, and from the (4th) group of barriers for effective management of the defective products' flows and ways of overcoming them, i.e. variables related to evaluation of significance of particular aspects of an enterprise in development of its competitive position. Results of this study are presented in Table 5.7.

There is a statistically significant interdependence between evaluation of the returns' impact on reduction of the enterprises' profitability and motives for acceptance of the returns by an enterprise, such as: improvement in the customer service quality (1), fulfillment of legal and environmental requirements (2), developing an environmentally-friendly company reputation (3) and preventing displacement of new products by the products from the secondary market (4). Enterprises that stress significance of those motives pointed to the returns' impact on reduction of the enterprise's profitability.

When it comes to evaluation of the returns' impact on the enterprise's profitability and operations related to the reverse flow management, carried out independently by the enterprises, there as a statistically significant correlation found out with: returns acceptance (5), charity donation (6), repackage and sales as new (7), sales in the form as accepted (8), remanufacture (9), production from recovered raw materials or components (10), sales (11), components recovery (12)

and scrapping (13). The enterprises stating the returns reduce the profitability made attempts to carry out the mentioned actions on their own - except the scrapping.

Table 5.7. Values of the Yule's correlation coefficient φ and statistics x^2 for evaluation of the returns' impact on reduction in the enterprise's profitability and the accompanying variables category from the (2nd) group of action parameters in the scope of the defective products' flows management, from the (3rd) group of objectives and motives of the policy of the defective products' returns, and from the (4th) group of barriers for effective management of defective products' flows and ways of overcoming them

Variables \ Coefficient		x^2	φ
Evaluation of the returns' impact on reduction of the enterprise's profitability			
(3rd) Motives for acceptance of the returns by an enterprise	Improvement in customer service quality (1)	**8.815***	**0.175**
	Meeting the legal and environmental requirements (2)	**8.819***	**0.175**
	Development of an environmentally-friendly company reputation (3)	**12.288***	**0.207**
	Prevention of displacement of new products by products from the secondary market. (4)	**4.167***	**0.120**
(2nd) Implementation of actions related to reverse flows management	Returns acceptance (5)	**9.052***	**0.178**
	Charity donation (6)	**18.528***	**0.254**
	Repackage and sales as new (7)	**9.048***	**0.178**
	Sales in the same form as the product was accepted (8)	**23.984***	**0.289**
	Remanufacture (9)	**34.435***	**0.346**
	Production from recovered components or raw materials (10)	**9.204***	**0.179**
	Sales (11)	**24.245***	**0.291**
	Recovery of components (12)	**5.864***	**0.143**
	Scrapping (13)	**4.384***	**0.124**
(4th) Significance of developmental aspects for the enterprise's competitive advantage	Returns policy (14)	**4.709***	**0.128**

** - statistically significant values on the level of α= 0.05.*
Source: Own work based on results from the survey questionnaire.

The course of research also proved that the enterprises that treat the returns policy significant regarding the competitive position development as non-significant, evaluated the returns' impact on the enterprise's profitability as faint (14).

The third interdependence analysis is related to determination of correlations between evaluation of impact of the defective products' flows management on implementation of the enterprise's objectives and the remaining categories of variables from the assumed groups. The research proved that the evaluation of impact from the reverse flow management on implementation of the enterprise's

objectives is correlated with variables from the (2nd) group of actions in the scope of the defective products' flows management, meaning the variables related to determination of actions in the scope of the defective products' flows management, and from the (3rd) group of objectives and motives of the policy of the defective products' returns, i.e. variables related to the motives for acceptance of the defective products' returns by an enterprise. Results of this research are presented in Table 5.8.

Table 5.8. Values of the Yule's correlation coefficient φ and statistics x^2 for evaluation of the impact from the reverse flows management on implementation of the enterprise's objectives and the accompanying variables categories from the (2nd) group of action parameters in the scope of the defective products' flows management, from the (3rd) group of objectives and motives of the policy of the defective products' returns

Coefficient / Variables		x^2	φ
Impact of the reverse flows management on implementation of the enterprise's objectives			
(3rd) Motives for acceptance of the returns by an enterprise	Meeting the legal and environmental requirements (1)	**6.032***	**0.154**
	Development of an environmentally-friendly company reputation (2)	**4.425***	**0.132**
(2nd) Implementation of actions related to reverse flows management	Returns acceptance (3)	**12.659***	**0.223**

** - statistically significant values on the level of α= 0.05.*
Source: Own work based on results from the survey questionnaire.

There is a statistically significant interdependence in the scope of following motives between evaluation of impact exerted by the reverse flows management on implementation of the enterprise's objectives and motives for returns acceptance: meeting the legal and environmental requirements (1) and development of an environmentally-friendly company reputation (2). The enterprises stressing the significance of those motives maintained that the reverse flows management is of negative impact on implementation of the company's objectives.

When it comes to evaluation of impact exerted by the reverse flows management on the enterprise's objectives implementation, there was also a statistically significant correlation observed with independent returns acceptance as an action related to the reverse flows management (3). The enterprises' negative evaluation of the impact exerted by the reverse flows management on the company's objectives implementation led to their dropping the independent acceptance of the defective products returns.

Further correlation analyses in the research was employed in case of interdependencies between the motives of accepting the defective products returns by the enterprises (improvement in customer service quality, getting rid of unnecessary products from the market, fulfilling the legal and environmental requirements, recovering some components and materials, developing of an environmentally-friendly company reputation, preventing displacement of new

products by the products from the secondary market, limiting the loss of value on unsold or defective products) and particular variables categories from the assumed collections of variables divided into groups. Examination of those interdependencies proved that significant statistical interdependencies are present in case of motives for acceptance of the defective products returns by the enterprises and particular variables categories from the (2nd) group of parameters of actions in the scope of the defective products' flows management, i.e. the variables related to determination of actions in the scope of the defective products' flows management in the enterprises. Results of this study are presented in Table 5.9.

Table 5.9. Values of the Yule's correlation coefficient φ and statistics x^2 for motives of acceptance of defective products returns by the enterprise and the accompanying variables category from the (2nd) group of action parameters in the scope of the defective products' flows management

Coefficient / Variables		x^2	φ
Improvement in customer service quality			
Returns acceptance	(1)	**7.063***	**0.153**
Charity donation	(2)	**9.042***	**0.173**
Repackage and sales as new	(3)	**15.052***	**0.223**
Sales in the same form as the product was accepted	(4)	**21.246***	**0.265**
Remanufacture	(5)	**54.767***	**0.426**
Sales	(6)	**25.871***	**0.293**
Recycling	(7)	**20.902***	**0.263**
Getting rid of unnecessary products from the market			
Repackage and sales as new	(8)	**4.187***	**0.118**
Sales in the same form as the product was accepted	(9)	**9.834***	**0.180**
Remanufacture	(10)	**5.742***	**0.138**
Scrapping	(11)	**5.221***	**0.131**
Meeting the legal and environmental requirements			
Returns acceptance	(12)	**9.801***	**0.180**
Charity donation	(13)	**14.857***	**0.222**
Sales in the same form as the product was accepted	(14)	**6.311***	**0.145**
Remanufacture	(15)	**11.621***	**0.196**
Scrapping	(16)	**18.584***	**0.248**
Recovery of materials and components			
Returns acceptance	(17)	**17.662***	**0.242**
Charity donation	(18)	**4.551***	**0.123**

Recovery of components	(19)	**6.538***	**0.147**
Scrapping	(20)	**7.229***	**0.155**
Development of an environmentally-friendly company reputation			
Charity donation	(21)	**4.812***	**0.126**
Repackage and sales as new	(22)	**7.956***	**0.162**
Sales in the same form as the product was accepted	(23)	**14.279***	**0.217**
Remanufacture	(24)	**18.042***	**0.244**
Sales	(25)	**6.554***	**0.147**
Recycling	(26)	**7.508***	**0.158**
Scrapping	(27)	**3.905***	**0.114**
Prevention of displacement of new products by products from the secondary market			
Remanufacture	(28)	**7.392***	**0.156**
Sales	(29)	**4.056***	**0.116**
Scrapping	(30)	**5.973***	**0.141**
Reduction in the loss of value on unsold or defective products			
Returns acceptance	(31)	**14.873***	**0.222**
Repackage and sales as new	(32)	**10.085***	**0.183**
Remanufacture	(33)	**11.374***	**0.194**
Scrapping	(34)	**12.449***	**0.203**

** - statistically significant values on the level of α= 0.05.*
Source: Own work based on results from the survey questionnaire.

The enterprises that accept the returns to improve the customer service quality most often undertake independent actions in the scope of returns acceptance (1), charity donation (2), repackage and sales of the returns as new (3), sales in the assumed form (4), remanufacture (5), sales (6) and recycling (7). These actions undertaken by the enterprise on its own contribute to improvement in the customer service quality.

The enterprises that accept returns because they are willing to discard unnecessary products from the market significantly more often undertake independent operations in the scope of repackage and sales of the returns as new (8), sales in an accepted form (9), remanufacture (10), and scrapping (11).

In turn, the enterprises where the motive for the returns acceptance is to meet the legal and environmental requirements, significantly more often undertake independent operations in the scope of returns acceptance (12), charity donation (13), sales in a form as the product was accepted (14), remanufacture (15) and scrapping (16).

The enterprises that accept returns because they are willing to recover some components and materials significantly more often undertake independent operations in the scope returns acceptance (17), charity donation (18), recycling (19) and scrapping (20).

If the motives for returns acceptance provided by the enterprises cover development of an environmentally-friendly company, they significantly more often undertake operation in the scope of charity donation (21), repackage and sales of the returns as new (22), sales in the form as the product was accepted (23), remanufacture (24), sales (25), recycling (26) and scrapping (27).

When the enterprise is motivated by prevention of displacement of new products by the secondary-market products, the enterprises significantly more often undertake independent actions in the scope of remanufacture (28), sales (29) and scrapping (30).

The enterprises that accept returns because they are willing to limit the loss of value on the unsold or defective products, they significantly more often undertake independent actions in the scope of returns acceptance (31), repackage and sales as new (32), remanufacture (33) and scrapping (34).

At the final, there were analyses over interdependencies between operations in the scope of the defective products' flows management, which are carried out independently by the enterprise, and the particular variables categories from the assumed collection of variables divided into groups. These actions cover: returns acceptance, allocation for donations, charitable purposes, repackage and sales of products as new, sales in such a form as the product was accepted, renovation, production from recovered components or raw materials, sale, recovery of components, recycling and scraping.

Examination of those correlations proved that the statistically significant interdependencies are related to actions from the scope of the defective products' flows management carried out independently by the enterprise, and particular variables categories from the (4^{th}) group of barriers for effective management of defective products' flows and ways of overcoming them, i.e. variables related to installation of hardware and software that supports the defective products' flows. Results of this correlation examination are presented in Table 5.10.

Table 5.10 Values of the Yule's correlation coefficient φ and statistics x^2 for actions in the scope of the defective products' flows management, which are carried out independently by the enterprise, and the accompanying variables categories from the (4th) group of barriers for effective management of the defective products flows and ways of overcoming them.

Coefficient / Variables		x^2	φ
Returns acceptance			
Bar codes	(1)	**11.231***	**0.193**
Charity donation			
Bar codes	(2)	**5.713***	**0.138**
Repackage and sales as new			
Bar codes	(3)	**23.695***	**0.280**
Computerized returns tracking system	(4)	**9.409***	**0.177**
EDI	(5)	**5.967***	**0.141**
Sales in the same form as the product was accepted			
Bar codes	(6)	**26.409***	**0.296**
2D codes	(7)	**5.368***	**0.133**
Computerized returns tracking system	(8)	**13.894***	**0.214**
EDI	(9)	**13.429***	**0.211**
Remanufacture			
Bar codes	(10)	**10.694***	**0.188**
Production from recovered components or raw materials			
Bar codes	(11)	**8.698***	**0.170**
Computerized returns tracking system	(12)	**10.464***	**0.186**
EDI	(13)	**9.696***	**0.179**
Sales			
Bar codes	(14)	**23.200***	**0.277**
Computerized returns tracking system	(15)	**16.280***	**0.232**
EDI	(16)	**11.870***	**0.198**
Recovery of components			
Bar codes	(17)	**3.975***	**0,115**
Computerized returns tracking system	(18)	**6.623***	**0,148**
Recycling			
Bar codes	(19)	**6.034***	**0.141**
2D codes	(20)	**10.456***	**0.186**
Computerized returns tracking system	(21)	**6.773***	**0.150**

** - statistically significant values on the level of α= 0.05.*
Source: Own work based on results from the survey questionnaire.

In case of scrapping, when it comes to actions from the scope of defective products` flows management, no statistically significant correlations were confirmed with any of the researched variables categories, therefore it was not covered in the table.

The enterprises that accept returns on their own (1), similarly to those employing charity donations (2) and remanufacturing (3), significantly more often make use of bar codes to support the defective products' flows management.

The enterprise that repackage and sell the returns on their own as new significantly more often use the bar codes (4), computerized return tracking system (5) and electronic data interchange (6) to support the reverse flows management.

The same solutions are significantly more often employed by enterprises that produce from recovered components or raw materials on their own: bar codes (7), computerized returns tracking system (8), electronic data interchange (9) and enterprises that organize sales on their own: (10), computerized returns tracking system (11) and electronic data interchange (12).

The enterprises that sell the returns in a form that the product was accepted significantly more often make use of the reverse flows management support, by employing bar codes (13), two-dimensional codes (14), computerized returns tracking systems (15) and electronic data interchange (16).

The enterprises that recover the components on their own significantly more often adopt the bar codes (17) and the computerized returns tracking system (18), while managing the defective products' flows.

While the companies that carry out the recycling operations significantly more often make use of the bar codes (19), two-dimensional codes (20) and the computerized returns tracking system (21).

The manufacturing enterprises that carry out actions in the scope of the defective products' flows management on their own, employ hardware and software solutions supporting management of the flows because they allow better supervision over the returns that emerge within the reverse flows of those enterprises.

Summing up, the empirical studies' results presented in this chapter allow of evaluation the interdependence between description of the defective products' flows in the Polish manufacturing enterprises and the results of those flows' management. It is possible among others thanks to development of a set of principles (variables) related to shaping of the defective products' flows in the researched enterprises what at the same time allows to improving effectiveness and efficiency of the flows.

6. Relationships of reverse logistics processes and differences in their management

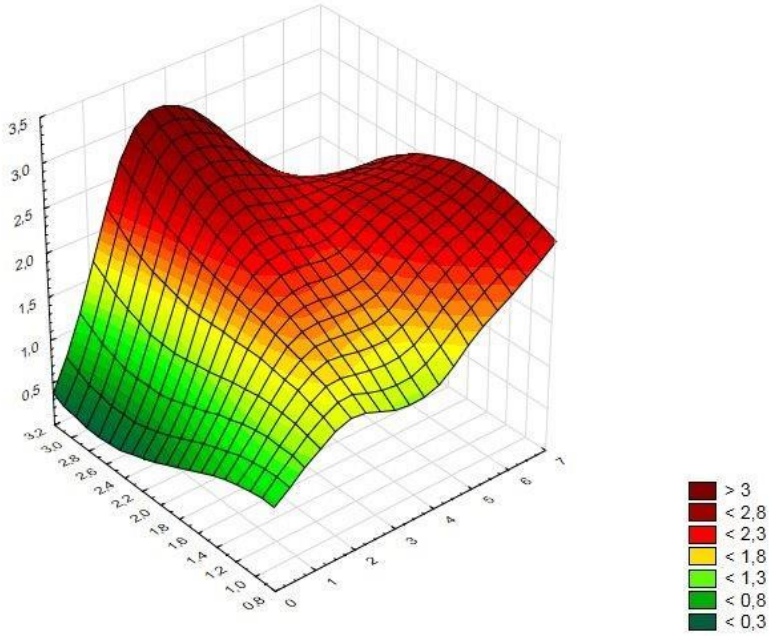
Thanks to the existing original data collected from the survey questionnaire performed in the Polish manufacturing enterprises and the results from descriptive and statistical research, it was possible to carry out some graphic simulations for selected relationships in management of defective products' flows.

The presented fields allow generalized interference, and all simulation were carried out to stress the relationships between shaping of particular variables in comparison to the changes of other variables.

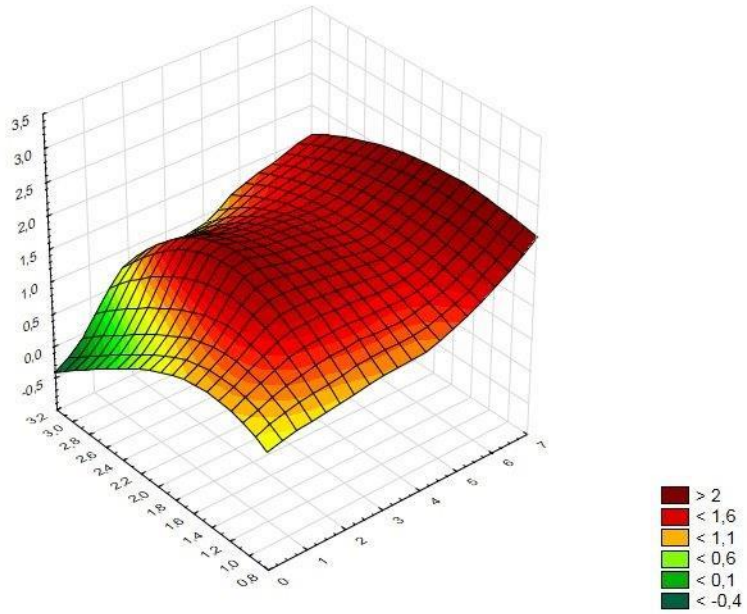
At first, within the research adopting the distance weighted least squares smoothing methods [Szajt 2014] there was a simulation carried out regarding relationships between the motives for accepting the returned defective products by the enterprises and evaluation of the returns policy and assessment of changes in profitability regarding returns acceptance in the Polish manufacturing enterprises (Fig. 6.1).

Figure 6.1. Simulations of relationships between the motives for accepting the returned defective products (0X axis) and evaluation of changes in profitability (0Y axis) in relation to returns acceptance in the Polish manufacturing enterprises

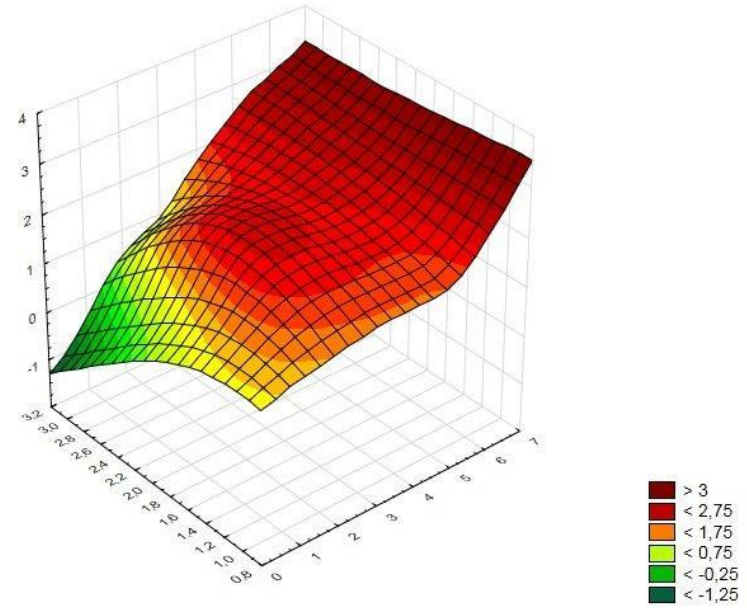
a) improvement in customer service quality



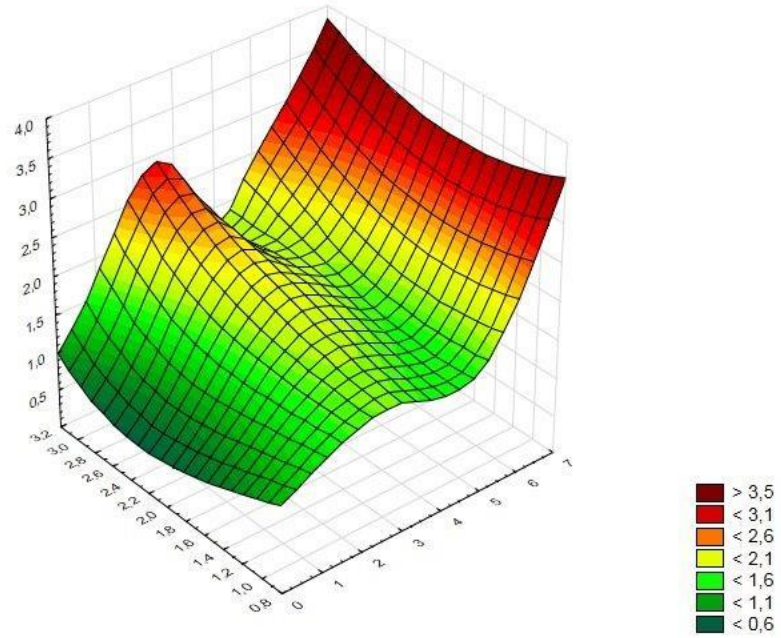
b) getting rid of unnecessary products from the market



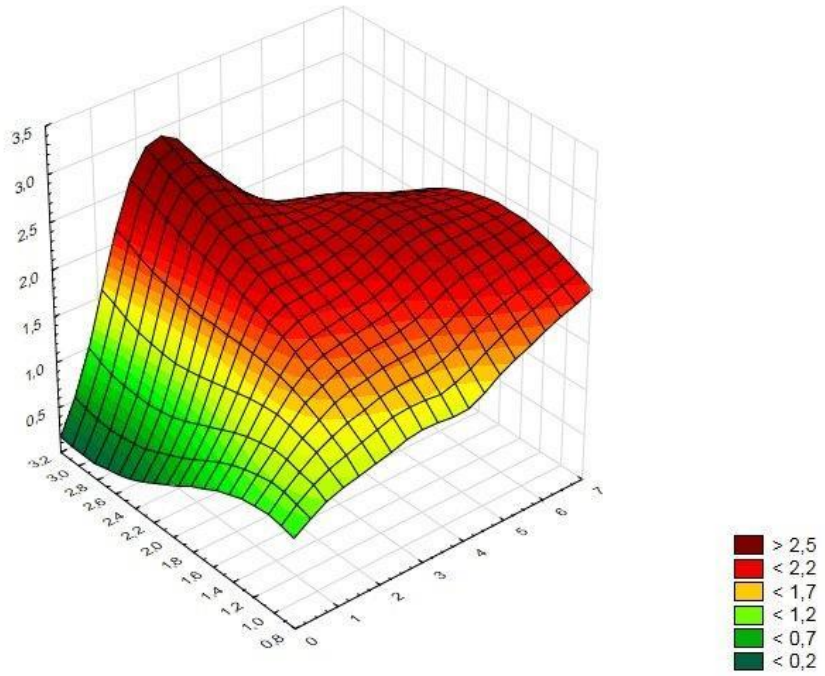
c) meeting the legal and environmental requirements



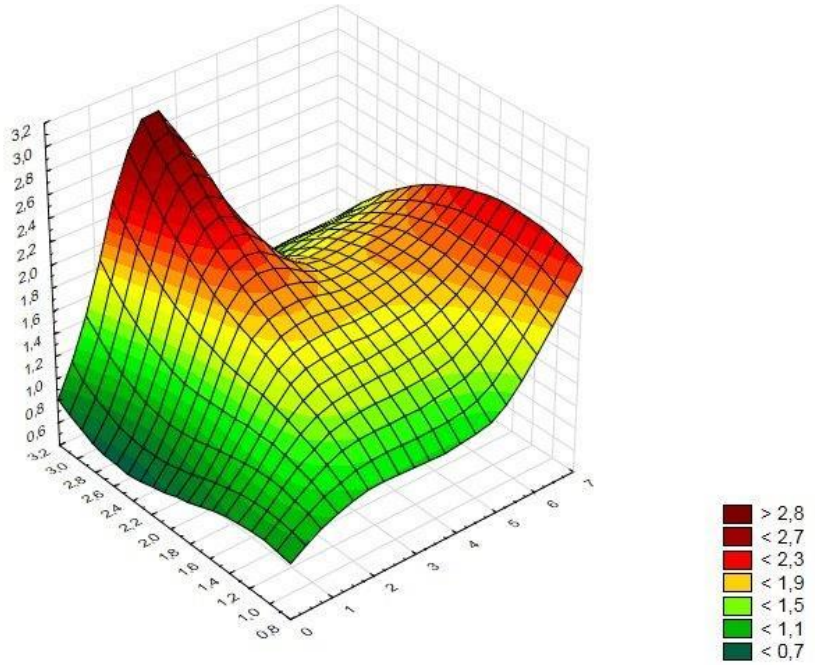
d) recovering components and materials



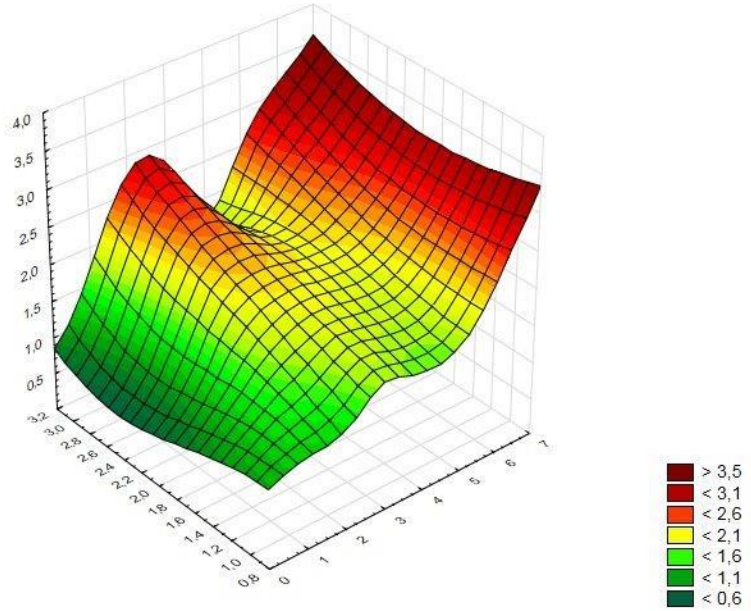
e) developing an environmentally-friendly company reputation



f) preventing displacement of new products



g) reduction in the loss on value on unsold or defective products



Source: Own work in the Statistica 12 package.

The performed research, the results of which are illustrated on the Figure 6.1 was related to simulations of relationships between the motives for accepting the returned defective products by the enterprises and evaluation of the returns policy and assessment of changes in profitability regarding returns acceptance in the enterprises. Motives for returns acceptance that were considered are as follows: improvement in customer service quality, getting rid of unnecessary products from the market, fulfilling the legal and environmental requirements, recovering some components

and materials, developing of an environmentally-friendly company reputation, preventing displacement of new products by the products from the secondary market, limiting the loss of value on unsold or defective products.

Results of the performed simulations of relationships between all seven motives for the returns acceptance and evaluation of the returns policy and assessment of the enterprises' profitability allow of the following conclusions.

Along with the increase in evaluation of the returns policy significance in operations of the enterprises and the increase in assessment of profitability related to acceptance of the returned products, there is certain growth in significance of the motive of returns acceptance by the enterprises, which is improvement in the customer service quality. This motive looks a little weaker for enterprises with a general high evaluation of the returns policy significance when it comes to the impact.

Along with the increase of the returns policy significance in operation of the Polish manufacturing enterprises, regardless of the assessment in the profitability changes related to the returns, the significance of the motive of returns acceptance by the enterprises - namely getting rid of the unnecessary products from the market - is increased. In this perspective, assessment of changes in profitability regarding the returns, if low, exerts some positive impact on significance of this motive, and when high, simultaneously with a low general evaluation of the returns policy's role, influences the significance of this motive in a negative manner, meaning it diminishes it. Along with the increase of the returns policy significance in operation of the Polish manufacturing enterprises, regardless of the assessment in the profitability changes related to the returns, the significance of the motive of returns acceptance by the enterprises - namely meeting the legal and environmental requirements - is increased, dynamically. In this perspective, assessment of changes in profitability regarding the returns, if low, exerts some positive impact on significance of this motive, and when high, simultaneously with a low general evaluation of the returns policy's role, influences the significance of this motive in a negative manner, meaning it diminishes it.

Along with the increase in evaluation of the returns policy significance in operation of the manufacturing enterprises, in terms of low evaluations of changes in profitability related to the returns, the significance of the motive, meaning recovery of components and materials, as a motive for returns acceptance by the enterprises, at first raises slowly, and after a certain express level is exceeded for the general evaluation of the returns policy - it raises very dynamically. For high evaluations of the roles of returns in diminishing of the company's profitability, the general evaluation of the returns policy on the low and high level leads to strengthening of the mentioned motive, and for the medium evaluation of the returns policy to a smaller role of the components and raw materials recovery as the motive for returns acceptance by the enterprises.

Along with the increase in evaluation of the returns policy significance and moderate or low evaluation of changes in profitability of enterprises through returns, the significance of the motive that is development of an environmentally-

friendly company reputation is increased as the motive for acceptance of defective products returns. In this context, assessment of changes in profitability regarding the returns, if low, exerts some positive impact on significance of this motive, and when high, simultaneously with a high general evaluation of the returns policy's role, influences the significance of this motive in a negative manner, meaning it diminishes it.

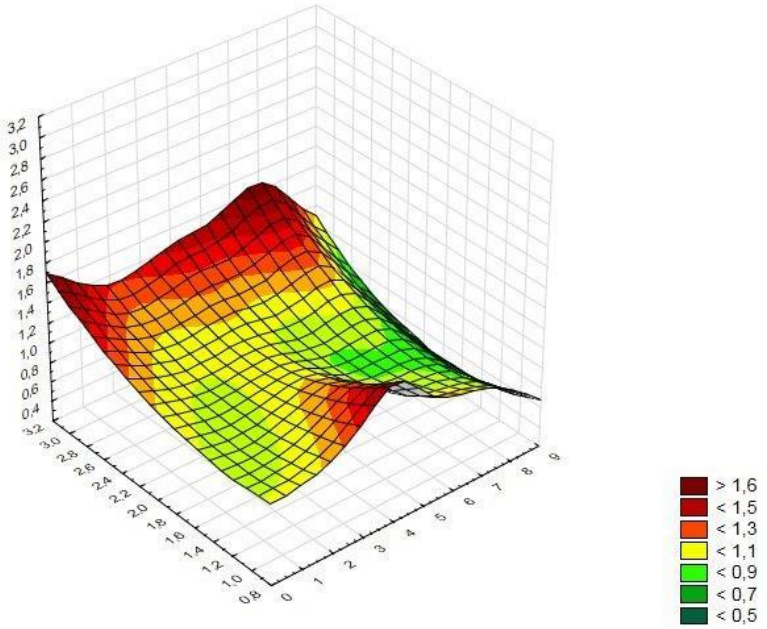
Along with the increase in evaluation of the returns policy significance in operation of the enterprises and moderate or low evaluation of changes in profitability because of the returns, the significance of the motive that is prevention of displacement of new products by the secondary-market products is increased as the motive for returns acceptance by the enterprises. Evaluation of returns in diminishing of profits, if low, exerts some positive impact on significance of this motive, and when high, simultaneously with a high general evaluation of the returns policy's role, influences the significance of this motive in a negative manner, i.e. it diminishes the motive. The highest evaluation of this motive regards a situation when the profit diminishing is evaluated high and at the same time justifiability of the returns policy is assessed moderately in general. Along with the increase in evaluation of the returns policy significance in operation of the enterprises, in terms of low evaluations of changes in profitability related to the returns, the significance of the motive, meaning reduction of loss on unsold or defective products, as a motive for returns acceptance by the enterprises, at first raises slowly, and after a certain express level is exceeded for the general evaluation of the returns policy - it raises very dynamically. For high evaluations of the roles of returns in diminishing of the company's profitability, the general evaluation of the returns policy on the low and high level leads to strengthening of the mentioned motive, and for the medium evaluation of the returns policy to a smaller role of the components and raw materials recovery as the motive for returns acceptance by the company.

Afterwards, there were some simulations of relationships between the emergence intensity of the returns accepted by the enterprises carried out and independence of their acceptance of the returns as an action related to management of reverse flows and duration of the average returns processing time in a manufacturing enterprise (Fig. 6.2).

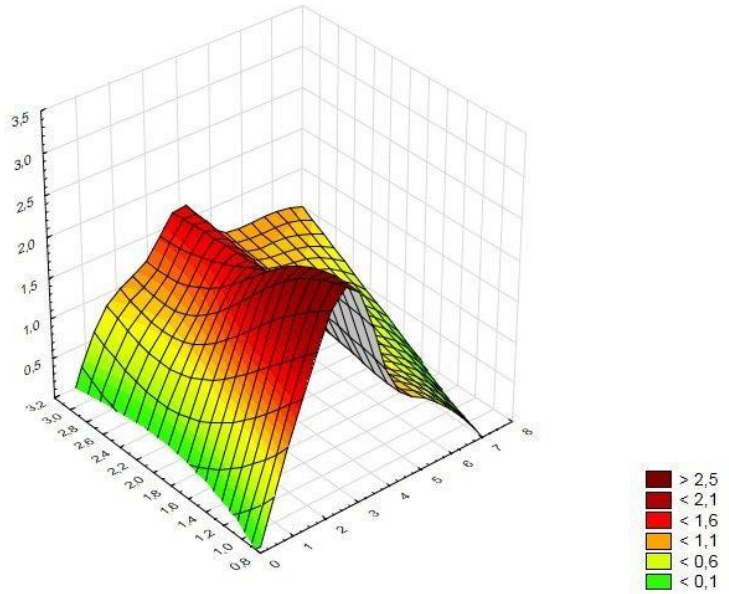
In the researched simulations of relationships between emergence intensity of the returns accepted by the enterprises and independence of their acceptance of the returns as an action related to management of reverse flows and duration of the average processing cycle of the returns in the manufacturing enterprise, the following returns categories were considered: damaged products, outdated products, products erroneously taken as faulty, product components and waste- and by-products. For the remaining categories of accepted returns, i.e.: seasonal products, products unsold in retail, products withdrawn from sales and packagings, the simulations of relationships between their emergence intensity were not presented because their interpretation was non-significant.

Figure 6.2. Simulations of relationships between the emergence intensity of the returns accepted by the enterprises carried out and independence of their acceptance of the returns (0X axis) as an action related to management of reverse flows and duration of the average returns processing time (0Y axis) in a manufacturing enterprise

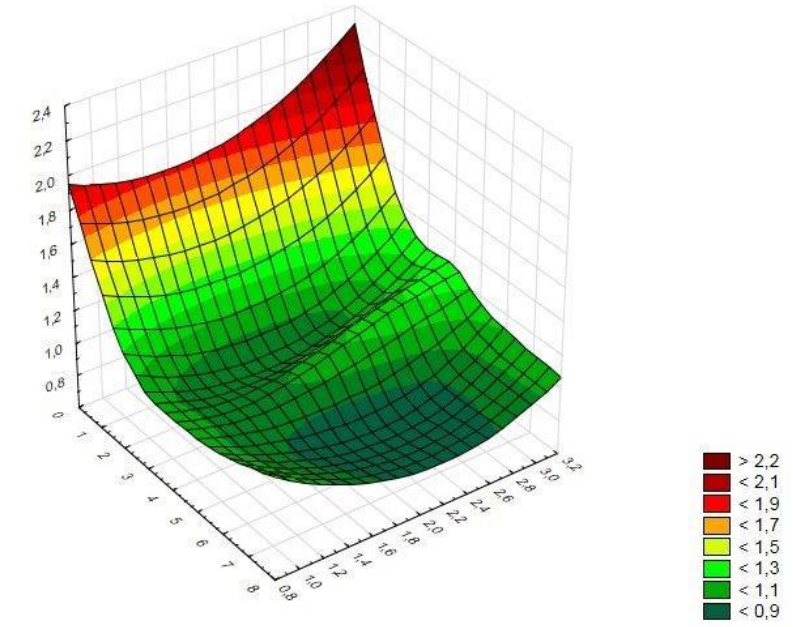
a) damaged products



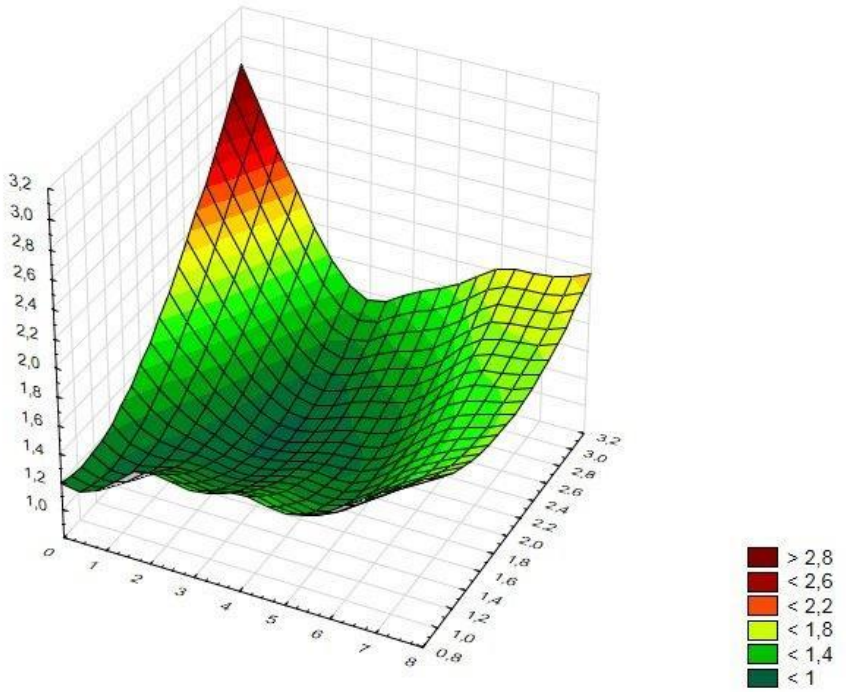
b) outdated products



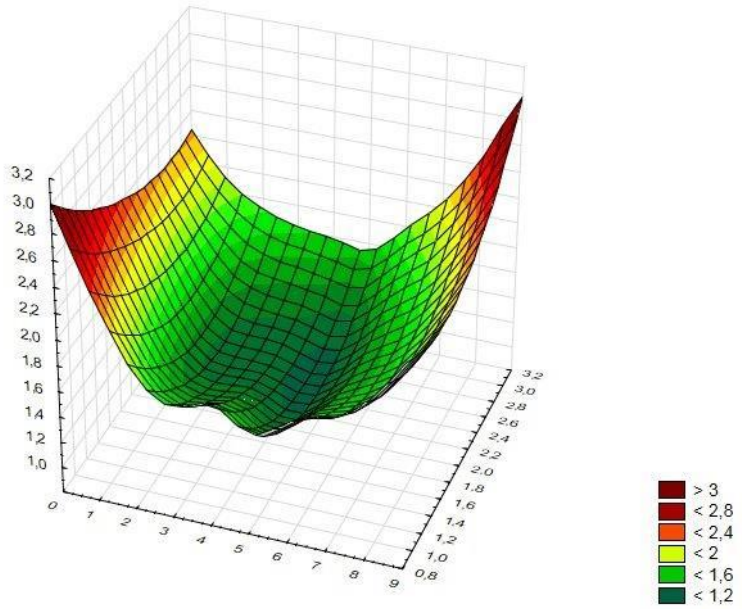
c) products erroneously taken as faulty



d) product components



e) waste- and by-products



Source: Own work in the Statistica 12 package.

Results of the performed simulations of the relationships between the emergence intensity of the mentioned categories of returns accepted by the enterprises and independence of their acceptance of the returns as an action related to management of reverse flows and duration of the average returns processing time in a manufacturing enterprise allow of the draw the following conclusions.

The damaged products emerge in high amounts in the enterprises that accept the returns independently only when the returns processing time reaches the period from two to four weeks. In the remaining cases, the emergence of those returns is marginal. In case of enterprises that commission actions related to the reverse flows management to third parties, this level is also not high, and it decreases along with extension of the service time. In turn, the enterprises that do not operate the defective products returns within their standard operations, encounter their noticeable emergence almost in every situation, especially in case of short and very long returns processing cycle. It may be assumed that this regards the possibility of exchange (very short period) and waiting for the complaint (repair) to be resolved by the manufacturer - the period is very long.

The noticeable level of the outdated returns refers to - regardless of the operation manner - the period from two weeks to one month. In practice, apart from those periods, such returns are not present at all.

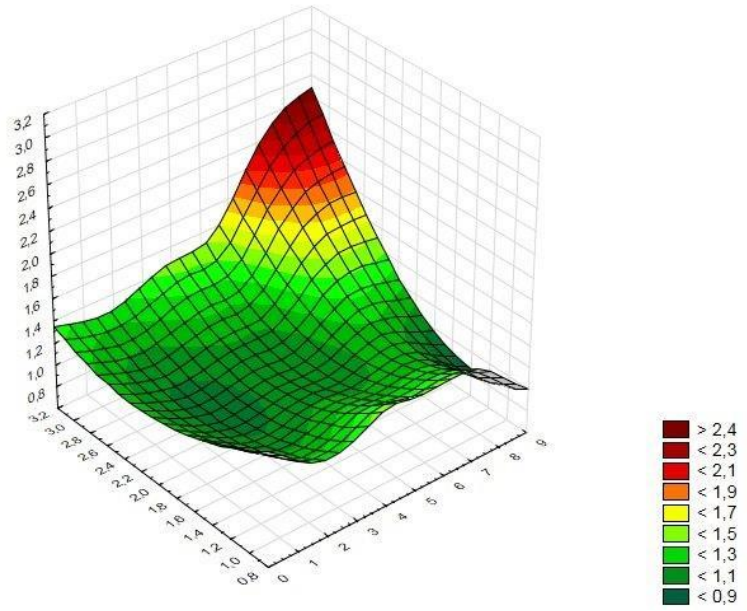
The products erroneously taken as faulty are present regardless of the manner of the defective products' flows management only in a very short returns processing cycles - up to 1 week. In the remaining situation, such returns are present in a marginal scope at the most.

Only the enterprises not implementing the processes of reverse flows management - with short-term implementation of actions in this scope, consisting in returns acceptance - encounter an increase in the returns rate in the field of the product components. Such returns are also recorded on a noticeable level in the same group of enterprises for long-term returns of defective products. In the remaining cases their significance is marginal at most. When the waste- and by-products are analyzed for the short-time returns processing cycle, their level is high only in the enterprises that deal with returns acceptance on their own, while in case of the long-term cycle the situation is opposite - this refers mainly to the enterprises that do not perform any formal actions in the reverse flows management.

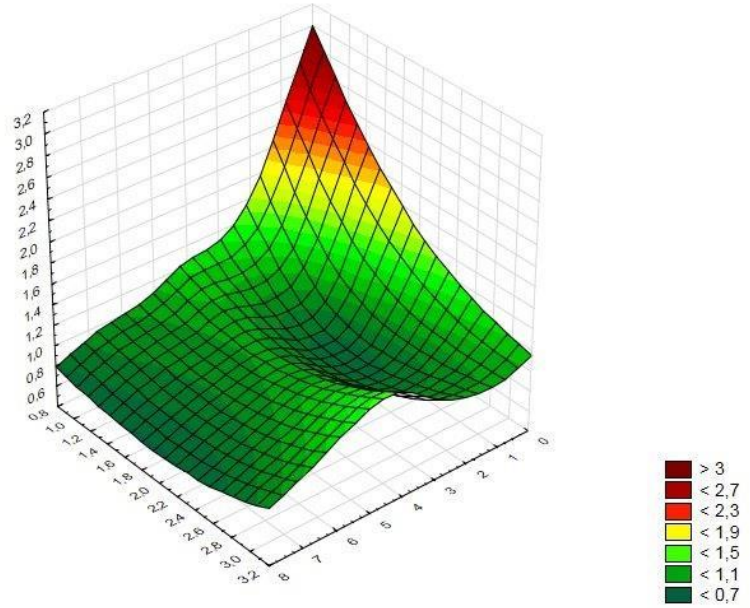
Next simulations of relationships were performed between the emergence intensity of the returns accepted by the enterprises and independence of the charity donation of the returns as an action related to management of reverse flows and duration of the average returns processing time in a manufacturing enterprise (Fig. 6.3).

Figure 6.3. Simulations of relationships between the emergence intensity of the returns accepted by the enterprises carried out and independence of charity donation of the returns (0X axis) as an action related to management of reverse flows and duration of the average returns processing time (0Y axis) in a manufacturing enterprise

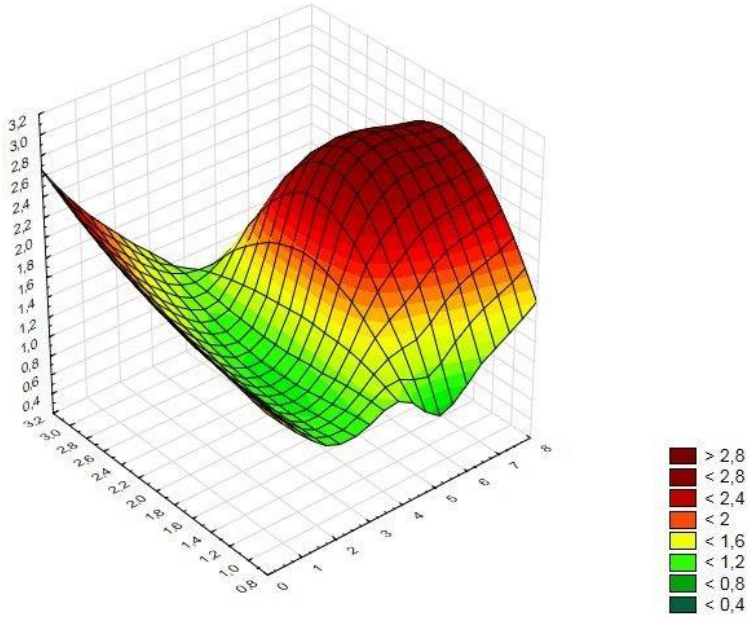
a) products erroneously taken as faulty {1}



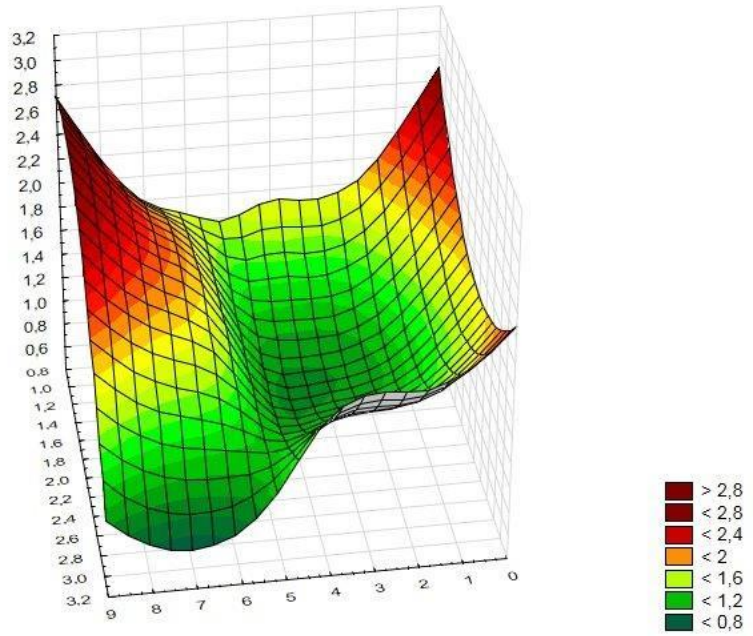
a) products erroneously taken as faulty {2}



b) product components



c) waste- and by-products



Source: Own work in the Statistica 12 package.

In the researched simulations of relationships between emergence intensity of the returns accepted by the enterprises and independence of charity donation of the products as an action related to management of reverse flows and duration of the average processing cycle of the returns in the manufacturing enterprise, the following returns categories were considered: products erroneously taken as faulty, product components and waste- and by-products. For the remaining categories of accepted returns, i.e.: damaged products, outdated products, seasonal products, products unsold in retail, products withdrawn from sales and packagings, the simulations of relationships between their emergence intensity were not presented because their interpretation was non-significant.

Results of the performed simulations of the relationships between the emergence intensity of the mentioned categories of returns accepted by the enterprises and independence of charity donation of the returns as an action related to management of reverse flows and duration of the average returns processing time in a manufacturing enterprise allow to draw the following conclusions.

The enterprises that carry out independent actions in the scope of reverse flows management, consisting in charity donations of the returns, record an express increase in the number of returned products in the category of products erroneously taken as faulty both justifiably (simulation variant {1}) and unjustifiably (simulation variant {2}) along with extension of the returns processing cycle to up to several months.

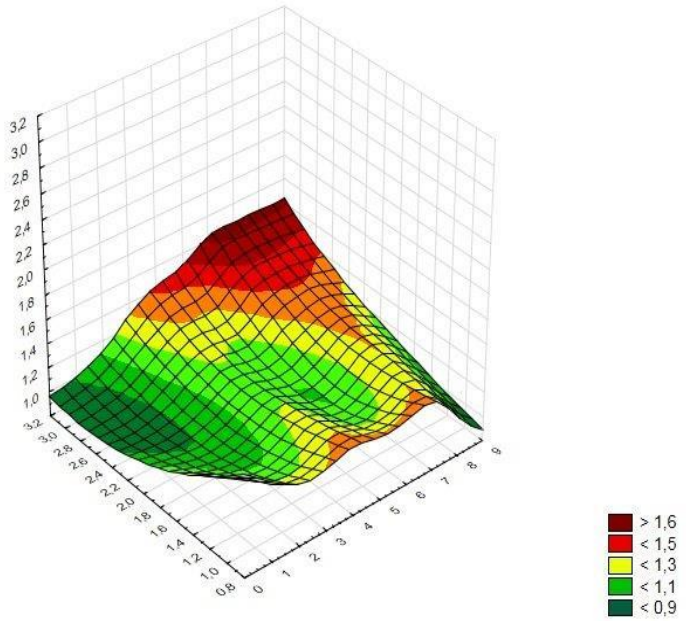
The enterprises that commission charity donations of the returns to third parties within the scope of reverse flows management record a very high level of returns of the product components in case of short- and long-term returns processing cycle. In turn, those that deal with returns acceptance on their own or do

not deal with it at all, register high returns level only in case of short-term returns processing cycle for defective products. Enterprises that carry out independent actions in the reverse flows management in the scope of charity donations of the returns record an express increase in the number of returns of waste- and by-products in case of very short-term returns processing cycle and its extension to more than several months. The enterprises that do not carry out the actions of reverse flows management in this scope observe a decrease from the high to a definitely low level of waste- and by-products returns along with extension of the returns processing cycle to more than several months.

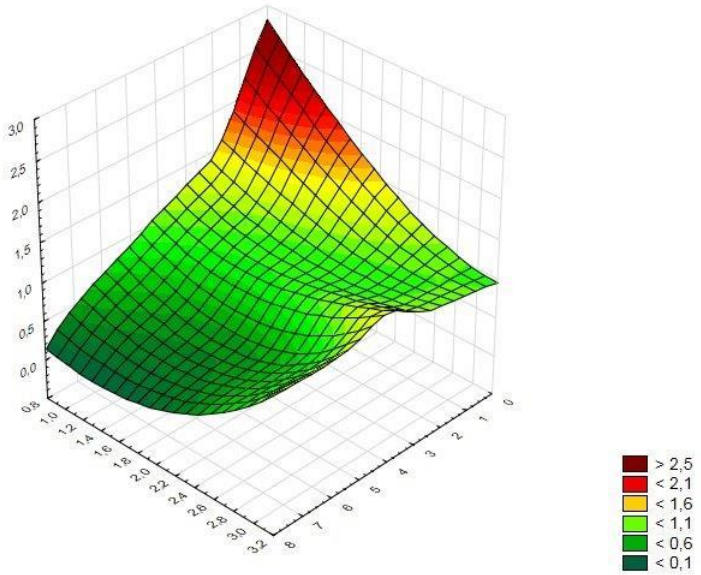
Further simulations of relationships were performed between the emergence intensity of the returns accepted by the enterprises and independence of repackage and sales of the returns as new products as an action related to management of reverse flows and duration of the average returns processing time in the Polish manufacturing enterprises (Fig. 6.4). The category of returns accepted by the enterprises in this research covers: damaged products, products erroneously taken as faulty and waste- and by-products. For the remaining categories of accepted returns, i.e.: outdated products, seasonal products, products unsold in retail, products withdrawn from sales, product components and packagings, the simulations of relationships between their emergence intensity were not presented because their interpretation was non-significant.

Figure 6.4. Simulations of relationships between the emergence intensity of the returns accepted by the enterprises carried out and independence of repackage and sales of the returns as new products (0X axis) as an action related to management of reverse flows and duration of the average returns processing time (0Y axis) in a manufacturing enterprise

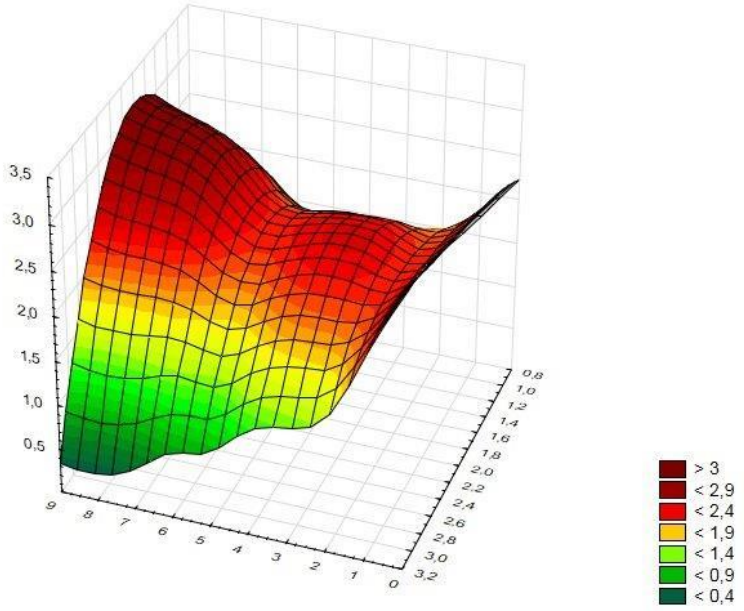
a) damaged products



b) products erroneously taken as faulty



c) waste- and by-products



Source: Own work in the Statistica 12 package.

Simulations presented in Fig. 6.4 allow drawing the following conclusions.

The enterprises that do not carry out the actions of reverse flows management on their own in case of repackage and sales of returns as new products observe a moderate intensity of the defective products returns along with extension of the returns processing cycle to more than several months.

The enterprises that carry out the actions of reverse flows management on their own in case of repackage and sales of returns as new products observe an express

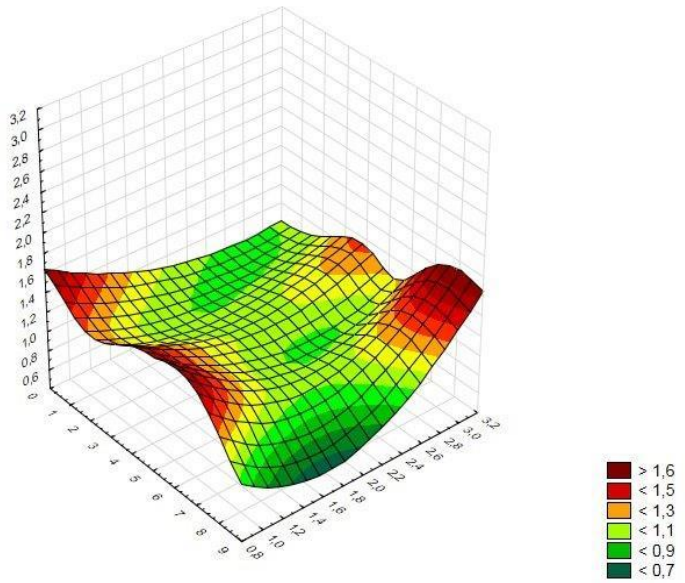
growth in the returns of products erroneously taken as faulty along with extension of the returns processing cycle to more than several months.

The enterprises that carry out the reverse flows management on their own regarding the action of repackage and sales of the returns as new products and commissioning those operation to third parties record a high level of returns of waste- and by-products, regardless of the returns processing time; the enterprises that do not manage the reverse flows in this aspect do not record them at all.

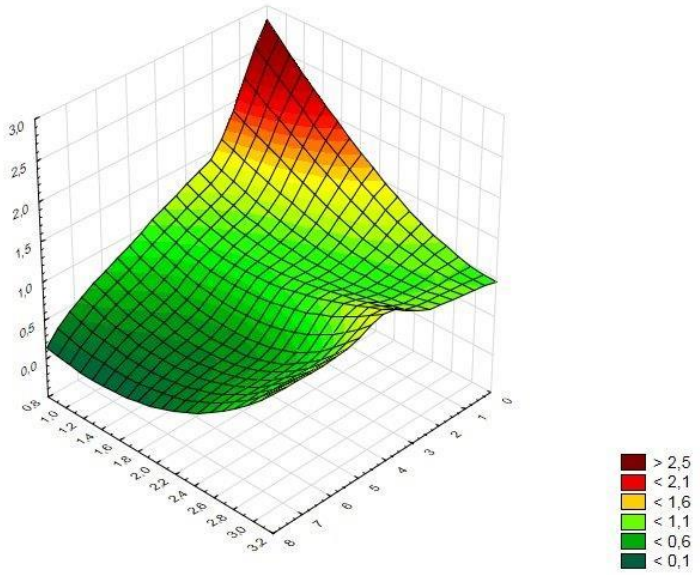
The last simulations of relationships were performed between the emergence intensity of the returns accepted by the enterprises and independence of the sales of returns as accepted as an action related to management of reverse flows and duration of the average returns processing time in manufacturing enterprises (Fig. 6.5). The category of returns accepted by the enterprises in this respect covers: damaged products, products erroneously taken as faulty and waste- and by-products. For the remaining categories of accepted returns, i.e.: outdated products, seasonal products, products unsold in retail, products withdrawn from sales, product components and packagings, the simulations of relationships between their emergence intensity were not presented because their interpretation was non-significant.

Figure 6.5. Simulations of relationships between the emergence intensity of the returns accepted by the enterprises carried out and independence of repackage and sales of the returns as accepted (0X axis) as an action related to management of reverse flows and duration of the average returns processing time (0Y axis) in a manufacturing enterprise

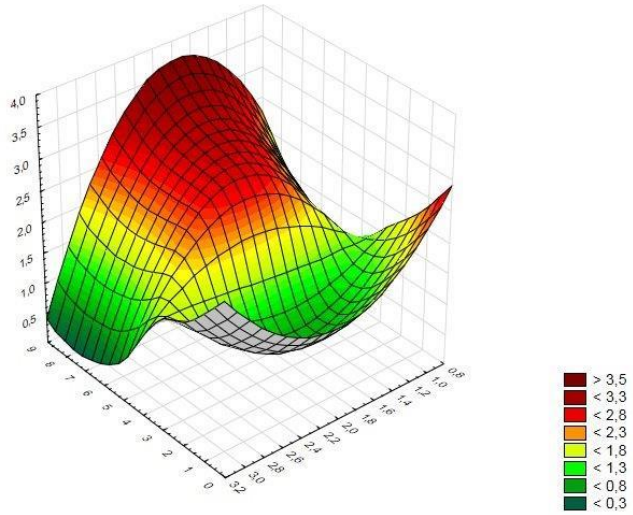
a) damaged products



b) products erroneously taken as faulty



c) waste- and by-products



Source: Own work in the Statistica 12 package.

Effects of the performed simulations of the relationships between the emergence intensity of the mentioned categories of returns accepted by the enterprises and independence of sales of the returns as accepted as an action related to management of reverse flows and duration of the average returns processing time allow to draw the following conclusions. The enterprises that sell the returns as accepted on their own record the moderate increase in the damaged products returns at the most, along with shortening of the returns processing cycle to less than several months. The enterprises that do not manage the reverse flows in this aspect

record an opposite situation - the returns reach moderate intensity along with extension of the returns processing cycle to more than several months. The enterprises that carry out sales of returns as accepted on their own observe an express growth in the returns of products erroneously taken as faulty along with extension of the returns processing cycle to more than several months. The enterprises that commission the sales of returns as accepted observe an express growth in the returns of waste- and by-products along with extension of the returns processing cycle to more than several months. In turn, the enterprises that deal with this aspect of reverse flows on their own or do not implement it at all, record high levels of waste- and by-products returns only for the short-term returns processing cycle.

All of the above simulations were performed for selected sets of original data categories, where consideration was given to the possibilities of obtaining some interesting interpretative threads. These threads were presented and discussed under graphically represented simulations. The remaining simulation that are not considered in the presented comparison did not prove any significant correlations from the research task's perspective, or were non-feasible regarding lack of data or their incompleteness.

In the last part of the empirical study, to determine the interdependence between variables related to the defective products' flows management, or more precisely in order to determine the significance of difference between the main categories of the defective products and the actions in the scope of their flows management in groups of Polish manufacturing enterprises selected regarding the number of employees, the Mann-Whitney U test on statistical significance was carried out.

The Mann-Whitney U test (a non-parametric test for means significance differences) is one of the most common alternatives for the t-Student test for independent samples. It is intended to compare two independent groups. The zero hypothesis says that the samples come from the same population, i.e. there are no significant differences towards them, in comparison to the alternative hypothesis stating that the samples being compared come from various populations (they are significantly different).

The testing statistics is as follows [Aczel 2000]:

$$Z = \frac{\left(R_{\min(k)} - \frac{n_k (n_k + 1)}{2} \right) - \frac{n_1 n_2}{2}}{\sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12} - \frac{n_1 n_2 \sum_{i=1} \left(t_i^3 - t_i \right)}{12(n_1 + n_2)(n_1 + n_2 - 1)}}}$$

where:

$R_{min\,(k)}$ — sums of ranks for the group where the sum is lower

n_k — number of observations in the group with a smaller sum of ranks

n_1 — first group size

n_2 — second group size

t — number of observations with the same rank

p (p-value) is the probability of making the I type error (rejecting the tested hypothesis). It is the lowest significance level leading to rejection of the tested hypothesis.
If p (p-value) is lower than the assumed significance level, then the tested hypothesis is rejected to the benefit of an alternative hypothesis.

The Mann-Whitney U test was employed to find out whether the differences in evaluation of the main returns categories and actions in the scope of the defective products' flows management are statistically significant in the groups of manufacturing enterprises selected according to the number of their employees.

The manufacturing enterprises that took part in the research were divided into groups regarding the employment level - i.e. micro, small and medium-sized enterprises. There were no large enterprises considered in the research because the share of their representative taking part in the survey was too low. Therefore, the performed test compared:

- micro and small enterprises;
- micro and medium-sized enterprises;
- small and medium-sized enterprises.

The test results along with mean evaluations for particular variables in those selected groups of enterprises are presented in a table form. Table 6.1 demonstrates the test values in a case when a variable was assumed as the emergence intensity and quality of particular returns categories in terms of defective products in the reverse flows of manufacturing enterprises.

While interpreting the results presented in Table 6.1, it may be concluded that the emergence intensity of damaged products in the micro enterprises is significantly different - smaller - than in case of small enterprises (Z = 4.7680; p < 0.0001) and medium-sized enterprises (Z = 3.4766; p = 0.0005); quality condition of the damaged products returns in micro enterprises is significantly better when compared to returns of those products in the medium-sized enterprises (Z = 2.0243; p = 0.0429).
The products unsold in retail emerge in the reverse flows significantly more often in the group of medium-sized enterprises than in micro (Z = 4.1084; p < 0.0001) and small enterprises (Z = 3.0485; p = 0.0023). The products erroneously taken as faulty emerge significantly less often in the group of micro enterprises than in small enterprises (Z = 3.0221; p = 0.0025) and medium-sized ones (Z = 2.9190; p = 0.0035); the quality condition of the products erroneously taken as faulty in the micro-enterprises is significantly worse when compared to small enterprises (Z = –2.4027; p = 0.0163). The qualitative condition of the waste- and by-products is significantly better in the micro than in the small enterprises (Z = 2.1017; p = 0.0356).

Table 6.1. The Mann-Whitney U test values and mean evaluations for emergence intensity and quality of particular categories of defective products returns in reverse flows of manufacturing enterprises as variables in the assumed groups of the Polish manufacturing enterprises

Variable	Micro/small		Micro/medium-sized		Small/medium-sized		Mean evaluations of the enterprises		
	Z	*p*	*Z*	*p*	*Z*	*p*	micro	small	medium-sized
Damaged products									
Intensity	**4.7680**	**0.0000**	**3.4766**	**0.0005**	0.0366	0.9708	3.7	3.3	3.3
Quality	0.6394	0.5226	**2.0243**	**0.0429**	1.4947	0.1350	3.5	3.4	3.1
Outdated products									
Intensity	1.3586	0.1743	1.8016	0.0716	0.5829	0.5600	4.0	3.9	3.9
Quality	0.9790	0.3276	0.6620	0.5080	0.4518	0.6514	4.2	3.7	3.8
Seasonal products									
Intensity	0.9351	0.3497	1.7511	0.0799	0.8994	0.3684	3.9	3.9	3.8
Quality	1.9167	0.0553	0.2013	0.8405	–0.9527	0.3408	5.5	4.2	5.0
Unsold products									
Intensity	0.5077	0.6117	**4.1084**	**0.0000**	**3.0485**	**0.0023**	4.0	3.9	3.7
Quality	0.9595	0.3373	1.6594	0.0970	0.0955	0.9239	5.4	4.3	4.1
Products withdrawn from sales									
Intensity	0.6989	0.4846	0.9069	0.3644	0.3286	0.7425	3.9	3.9	3.9
Quality	0.7859	0.4319	-0.9760	0.3291	-1.2725	0.2032	4.3	3.7	5.0
Products erroneously taken as faulty									
Intensity	**3.0221**	**0.0025**	**2.9190**	**0.0035**	0.3787	0.7049	4.0	3.8	3.8
Quality	**–2.4027**	**0.0163**	-0.5974	0.5502	0.6213	0.5344	3.5	4.6	4.1
Product components									
Intensity	0.2187	0.8269	0.8645	0.3873	0.6011	0.5477	3.7	3.6	3.6
Quality	0.4618	0.6442	1.3125	0.1894	0.3014	0.7631	3.0	2.8	2.8
Waste- and by-products									
Intensity	-1.7244	0.0846	-1.4773	0.1396	-0.1841	0.8540	2.6	2.8	2.8
Quality	**2.1017**	**0.0356**	0.4664	0.6410	-1.1586	0.2466	2.6	2.3	2.6
Packagings									
Intensity	1.2017	0.2295	1.2902	0.1970	0.3648	0.7153	3.7	3.6	3.5
Quality	0.8859	0.3757	0.4203	0.6743	-0.3066	0.7591	2.3	2.0	2.3

Source: Own work in the Statistica 12 package based on the survey questionnaire results.

Table 6.2 presents the test values for the following variables: the most frequent period for the defective product return (calculating from the moment of handing it to distribution), duration of the average returns processing cycle in the enterprise, evaluation of the enterprise's policy in the scope of the defective products returns acceptance, impact of the returns on reduction in the enterprise's profits and influence of the manner of defective products' flows management in an enterprise exerted on implementation of the enterprise's objectives.

Table 6.2. The Mann-Whitney U test value and means evaluations for the return period, duration of the returns processing cycle, restrictiveness of the returns policy, impact of the returns to profitability and implementation of the enterprise's objective as variables in particular groups of the Polish manufacturing enterprises

Variable	Micro/small		Micro/medium-sized		Small/medium-sized		Mean evaluations of the enterprises		
	Z	***p***	***Z***	***p***	***Z***	***p***	**micro**	**small**	**medium-sized**
The most frequent return period	-1.2656	0.2057	-0.3253	0.7450	0.7036	0.4817	2.0	2.2	2.0
Duration of the average processing of returns	1.7173	0.0859	-0.2085	0.8348	-1.3250	0.1852	3.5	3.1	3.5
Evaluation of the returns acceptance policy	-0.7829	0.4337	0.7587	0.4480	1.2941	0.1956	4.6	4.8	4.4
Reduction in the enterprise's profitability because of the returns	1.8255	0.0679	1.3639	0.1726	0.0189	0.9850	2.7	2.6	2.6
Impact of the reverse flows management on implementation of the enterprise's objectives	0.6077	0.5434	-0.0363	0.9710	-0.4839	0.6285	5.1	5.2	5.2

Source: Own work in the Statistica 12 package based on the survey questionnaire results

The results presented in Table 5.12 allow for the statement that the differences in the scope of variables: return period, returns processing cycle duration, restrictiveness of the returns policy, influence of the returns on profitability and implementation of objective in particular groups of the Polish manufacturing enterprises, are not statistically significant.

Table 6.3 includes test values where the assumed variables were the motives for acceptance of the defective products returns by the manufacturing enterprises.

Table 6.3. The Mann-Whitney U test and mean evaluations for motives for acceptance of the defective products returns as variables in particular groups of the Polish manufacturing enterprises

Variable	Micro/small		Micro/medium-sized		Small/medium-sized		Mean evaluations of the enterprises		
	Z	***p***	***Z***	***p***	***Z***	***p***	**micro**	**small**	**medium-sized**
Improvement in customer service quality	–0.7838	0.4332	-0.0363	0.9710	0.5248	0.5998	2.0	2.1	2.0
Getting rid of unnecessary products from the market	**–2.6472**	**0.0081**	**–2.0842**	**0.0371**	-0.2230	0.8235	1.4	1.7	1.7
Meeting the legal and environmental requirements	-1.6314	0.1028	0.2701	0.7871	1.5286	0.1264	2.1	2.3	2.1
Recovery of materials and components	-1.7790	0.0752	-1.0286	0.3037	0.1696	0.8653	1.8	2.0	2.0
Development of an environmentally-friendly company reputation	-1.3416	0.1797	-1.0831	0.2787	0.0739	0.9411	1.9	2.0	2.0
Prevention of displacement of new products by products from the secondary market.	-1.4966	0.1345	**–2.3234**	**0.0202**	-1.2040	0.2286	1.5	1.7	1.8
Reduction in the loss on value of unsold or defective products	-1.4030	0.1606	-1.0348	0.3008	0.0577	0.9540	2.0	2.1	2.1

Source: Own work in the Statistica 12 package based on the survey questionnaire results.

The results presented in Table 6.3 suggest that the micro enterprises believe that getting rid of unnecessary products from the market is significantly less important when compared to evaluation of this motive for acceptance of the defective products returns by small enterprises (Z = –2.6472; p = 0.0081) and medium-sized enterprises (Z = –2.0842; p = 0.0371). The micro enterprises believe that preventing displacement of new products by the secondary-market products is less important when compared to evaluation of this motive for acceptance of defective products returns by medium-sized enterprises (Z = –2.3234; p = 0.0202).

Table 6.4 covers test values where the assumed variables are the actions in the scope of the defective products' flows management undertaken by manufacturing enterprises.

Table 6.4. The Mann-Whitney U test and mean evaluations for actions related to the reverse flows management as variables in particular groups of the Polish manufacturing enterprises

Variable	Micro/small		Micro/medium-sized		Small/medium-sized		Mean evaluations of the enterprises		
	Z	*p*	*Z*	*p*	*Z*	*p*	micro	small	medium-sized
Returns acceptance	**4.5058**	**0.0000**	**2.8389**	**0.0045**	-0.3592	0.7194	1.9	1.4	1.4
Charity donation	1.8154	0.0695	0.5514	0.5813	-0.6526	0.5140	2.7	2.5	2.6
Repackage and sales as new	1.9548	0.0506	**2.8572**	**0.0043**	1.1934	0.2327	2.7	2.5	2.3
Sales in the same form as the product was accepted	**2.7307**	**0.0063**	1.6194	0.1054	-0.3244	0.7456	2.7	2.5	2.5
Remanufacture	1.8879	0.0590	1.3310	0.1832	-0.1264	0.8994	2.1	1.9	1.9
Production from recovered components or raw materials	**2.9245**	**0.0035**	**3.3651**	**0.0008**	0.8431	0.3992	2.6	2.3	2.2
Sales	**2.7153**	**0.0066**	**2.7774**	**0.0055**	0.6510	0.5150	2.6	2.3	2.2
Recovery of components	1.1743	0.2403	**3.6522**	**0.0003**	**2.5344**	**0.0113**	2.7	2.6	2.2
Recycling	-0.1324	0.8947	0.7955	0.4263	0.8630	0.3881	2.2	2.2	2.1
Scrapping	0.5469	0.5844	1.8792	0.0602	1.2927	0.1961	2.8	2.7	2.6

Source: Own work in the Statistica 12 package based on the survey questionnaire results.

Following the interpretation of results from Table 6.4, it may be concluded that the micro enterprises undertake actions in the scope of reverse flows management intended to returns acceptance significantly less often when compared to small enterprises (Z = 4.5058; p < 0.0001) and medium-sized enterprises (Z = 2.8389; p = 0.0045). The micro enterprises undertake actions in the scope of reverse flows management intended to repackage the returns and sell them as new products significantly less often when compared to the medium-sized enterprises (Z = 2.8587; p = 0.0043).The micro enterprises undertake actions in the scope of reverse flows management intended to sell the returns as accepted significantly less often when compared to the small enterprises (Z = 2.7307; p = 0.0063). The micro enterprises undertake actions in the scope of reverse flows management intended to perform production from recovered products or components significantly less often when compared to the small enterprises (Z = 2.9245; p = 0.0035) and medium-sized enterprises (Z = 3.3651; p = 0.0008).

The micro enterprises undertake actions in the scope of reverse flows management intended to organize sale significantly less often than the small enterprises (Z = 2.7153; p = 0.0066) and medium-sized enterprises (Z = 2.7774; p = 0.0055).
The medium-sized enterprises undertake actions in the scope of reverse flows management intended to recover the components significantly less often than the small enterprises (Z = 2.5344; p = 0.0113) and micro enterprises (Z = 3.6522; p = 0.0003).

Table 6.5 includes test values where the assumed variables were the barriers for effective management of the defective products' flows in the manufacturing enterprises.

Table 6.5. The Mann-Whitney U test and mean evaluations for barriers of effective management of reverse flows as variables in particular groups of the Polish manufacturing enterprises

Variable	Micro/small		Micro/medium-sized		Small/medium-sized		Mean evaluations of the enterprises		
	Z	***p***	***Z***	***p***	***Z***	***p***	**micro**	**small**	**medium-sized**
Company's policy	-0.0330	0.9737	**-2.1413**	**0.0322**	-1.8786	0.0603	0.1	0.1	0.2
Aspects of competitiveness	0.0497	0.9604	0.3263	0.7442	0.2727	0.7851	0.1	0.1	0.1
Financial resources	1.0255	0.3051	-0.4251	0.6708	-1.1854	0.2358	0.1	0.0	0.1
Non-significance	-0.0584	0.9534	0.1175	0.9065	0.1466	0.8834	0.0	0.0	0.0
Lack of adequate organizational solutions	-0.5614	0.5745	-0.6521	0.5143	-0.1786	0.8583	0.0	0.0	0.0
Legal circumstances	0.7676	0.4428	-0.0759	0.9395	-0.6656	0.5057	0.0	0.0	0.0
No attention from the managerial staff	0.7495	0.4535	-1.1354	0.2562	-1.5684	0.1168	0.0	0.0	0.0
Incompetent personnel	0.7495	0.4535	-1.1354	0.2562	-1.5684	0.1168	0.0	0.0	0.0

Source: Own work in the Statistica 12 package based on the survey questionnaire results.

Results from Table 6.5 confirm that employees from medium-sized enterprises, when compared to employee from micro enterprises, stress the company's policy significantly more often as the barrier for effective management of reverse flows (Z = –2.1413; p = 0.0322).

Table 6.6 includes the test values for assumed variables that are the employed hardware and software solutions supporting the defective products' flows management in manufacturing enterprises.

Table 6.6. The Mann-Whitney U test and mean evaluations for the employed hardware and software solutions supporting the reverse flows management as variables in particular groups of the Polish manufacturing enterprises

Variable	Micro/small		Micro/medium-sized		Small/medium-sized		Mean evaluations of the enterprises		
	Z	*p*	*Z*	*p*	*Z*	*p*	micro	small	medium-sized
Bar codes	**3.2437**	**0.0012**	**5.7304**	**0.0000**	**2.5677**	**0.0102**	2.9	2.7	2.3
2D codes	**3.4735**	**0.0005**	**4.2070**	**0.0000**	0.8642	0.3875	3.0	2.8	2.7
Computerized returns tracking system	**4.0477**	**0.0001**	**5.7283**	**0.0000**	1.7356	0.0826	3.0	2.8	2.5
EDI	**3.3305**	**0.0009**	**4.0032**	**0.0001**	0.9629	0.3356	3.0	2.8	2.6
RFID	1.6104	0.1073	**2.1586**	**0.0309**	0.6040	0.5459	3.0	3.0	2.9

Source: Own work in the Statistica 12 package based on the survey questionnaire results.

By interpreting of the results presented in Table 6.6, the following conclusions can be drawn.

Existing or planned installation related to bar codes, supporting the reverse flows management in micro enterprises is considered significantly more intensively when compared to small enterprises (Z = 3.2437; p = 0.0012) and medium-sized enterprises (Z = 5.7304; $p < 0.0001$). This issue is considered less often also in small enterprises when compared to the medium-sized ones (Z = 2.5677; p = 0.0102).

Existing or planned installation related to two-dimensional codes, supporting the reverse flows management in micro enterprises is considered significantly more intensively when compared to small enterprises (Z = 3.4735; p = 0.0005) and medium-sized enterprises (Z = 4.2070; $p < 0.0001$).

Existing or planned installation related to computerized returns tracking systems, supporting the reverse flows management in micro enterprises is considered significantly less often when compared to small enterprises (Z = 4.0477; p = 0.0001) and medium-sized enterprises (Z = 5.7283; $p < 0.0001$).

Existing or planned installation related to electronic data interchange (EDI), supporting the reverse flows management in micro enterprises is considered significantly less often when compared to small enterprises (Z = 3.3305; p = 0.0009) and medium-sized enterprises (Z = 4.0032; $p < 0.0001$).

Existing or planned installation related to RFID, supporting the reverse flows management in micro enterprises is considered significantly less often when compared to medium-sized enterprises (Z = 2.1586; p = 0.0309).

Table 6.7 presents the test values for variables related to evaluation of significance of particular aspects of a manufacturing enterprise in development of its competitive position.

Table 6.7. The Mann-Whitney U test and mean evaluations for significance of development of an enterprise's competitive position as variables in particular groups of the Polish manufacturing enterprises

Variable	Micro/small		Micro/medium-sized		Small/medium-sized		Mean evaluations of the enterprises		
	Z	*p*	*Z*	*p*	*Z*	*p*	micro	small	medium-sized
Costs reduction	-0.1076	0.9143	-1.2983	0.1942	-1.0906	0.2754	3.0	3.0	3.0
Price	-0.1861	0.8524	0.5730	0.5666	0.6291	0.5293	4.9	4.9	5.1
Quality	-0.2731	0.7848	-0.1503	0.8805	0.0445	0.9645	5.3	5.3	5.2
Returns policy	-1.2931	0.1960	0.1830	0.8548	1.1500	0.2501	5.4	5.4	5.5
Delivery time	-1.3832	0.1666	-0.3581	0.7203	0.6230	0.5333	4.3	4.7	4.4
Diversity of products	0.0871	0.9306	0.2667	0.7897	0.1940	0.8462	5.0	5.2	5.2

Source: Own work in the Statistica 12 package based on the survey questionnaire results.

Leaning against the results from Table 6.7, it was found out that the differences regarding significance of the aspects of developing a company's competitive position in particular groups of the Polish manufacturing enterprises are not statistically significant.

To put it synthetically (Tab. 6.8): the results of performed tests proved significant differences in management of the defective products' flows between the enterprises divided regarding the employment size into micro, small and medium-sized[30].

The research results presented in this chapter allows determining some significant differences in the defective products' flows management in the Polish manufacturing enterprises, divided in accordance to the employment size. Based on the results, it may be concluded, among others, that size of the Polish manufacturing enterprises influences the intensity and quality of the reverse logistics processes in the field of the defective products' flows, as well as it determined the effects from the defective products' flows management.

[30] These differences turned out to be significant in the research presented in Table 6.8. In turn, the test of other variables did not show any significant differences in management of the defective products flows between micro, small and medium-sized manufacturing enterprises.

Table 6.8. The significance of differences in the research over variables in the scope of the defective products' flow management in particular groups of Polish manufacturing enterprises and their interpretation

Significant differences in the research:	Significance interpretation:
Research over emergence intensity of particular categories of defective products returns in reverse flows in manufacturing enterprises	The damaged products emerge in the micro enterprises with lower intensity than in small and medium-sized ones. The products unsold in retail emerge in the medium-sized enterprises with greater intensity than in micro and small companies. The products erroneously taken as faulty emerge less often in the micro enterprises than in the small and medium-sized ones.
Research over quality of returns emerging in categories of defective products in reverse flows in manufacturing enterprises	The quality condition of the damaged products in the micro enterprises is better than in the medium-sized companies. The quality condition of the products erroneously taken as faulty is worse in the micro enterprises than in small enterprises. The quality condition of waste- and by-products is better in micro enterprises than in the small ones.
Research over motives for acceptance of defective products returns by the manufacturing enterprises	Getting rid of unnecessary products from the market is thought to be less important in the micro enterprises than in the small and medium-sized ones.Preventing displacement of new products by the secondary-market products is thought to be less important in the micro enterprises than in the medium-sized ones.
Research over actions in the scope of the defective products' flows management undertaken by manufacturing enterprises	The micro enterprises less frequently undertake the returns acceptance when compared to the small and medium-sized companies. The micro enterprises less frequently undertake the repackage and sales of the returns as new products when compared to the medium-sized enterprises. The micro enterprises less frequently sell the returns as accepted when compared to the small companies. The micro enterprises less frequently undertake production from the recovered products or components when compared to the small and medium-sized companies. The micro enterprises less frequently undertake the organization of sale when compared to the small and medium-sized companies. The medium-sized enterprises more frequently undertake the components recovery when compared to the small and micro companies.
Research over barriers for effective management of the defective products' flows in manufacturing enterprises	The medium-sized enterprises stress the company's policy as a barrier for effective management of reverse flows more often than the micro enterprises.
Existing or planned hardware and software solutions supporting the defective products' flows management in manufacturing enterprises	Existing or planned bar codes are less frequently considered in micro enterprises than in the small or medium-sized ones. Existing or planned bar codes are less frequently considered in small enterprises than in the medium-sized ones. Existing or planned two-dimensional codes are less frequently considered

	in micro enterprises than in the small or medium-sized ones. Existing or planned computerized returns tracking systems are less frequently considered in micro enterprises than in the small or medium-sized ones. Existing or planned electronic data interchange (EDI) is less frequently considered in micro enterprises than in the small or medium-sized ones. Existing or planned RFID is less frequently considered in micro enterprises than in the medium-sized ones.

Source: Own work.

The contents included in this and previous chapter of this monograph can be of considerable application significance when the presented results are referred to the enterprises' practices, and the recommendations for managerial staff will be formulated based on that. However, it is necessary to adopt an individual approach as otherwise, the differentiated parameters of enterprises, as well as specificity of the defective products' flows will not allow indiscriminate adaptation of generally developed conclusions, only some illustrative use of their values.

Conclusion

Management of contemporary enterprises in the present economic reality undergoes continuous transformations. There is a need to consider the notions of sustainable development, globalization processes, changes in the social attitudes directed at ecologic preferences or dynamic development of markets in the management of enterprises. Therefore, it is so crucial to seek, select and employ the most innovative ways allowing the adjustment of the management of enterprises to those changing conditions.

The production enterprises, as entities that are especially prone and sensitive to changes in the economy, have recently developed the concept of reverse logistics, the processes of which provide significant support to the defective products' flows management.

The presented monograph raises the issue of explication of the reverse logistics of defective products in the manufacturing enterprises, which was carried out based on the analysis of implementation and functioning of the reverse logistics processes in the defective products' flows management in Poland.

The studies performed as a part of the work proved that the defective products' flows management in the manufacturing enterprises is employed through implementation and utilization of the reverse logistic processes which allows managing the returned products effectively. Apart from that, certain postulates and statements may be drawn up:

1. Economic sustainability and market development generate the need to implement and employ modern solution in the scope of the defective products' flows management in the manufacturing enterprises.
2. The reverse logistics processes, supported with adequate decisions regarding the defective products' flows management, improve operations of the manufacturing enterprises;
3. For the enterprises, the proposed descriptive model of the reverse logistics of defective products is a basis that can be adapted to their needs what was proved by the verification carried out in the researched enterprises.
4. Both the intensity and quality of the reverse logistics processes, as well as the level of results from management of those processes, implemented in the field of the defective products' flows, depend on the size of the manufacturing enterprise what was proved by the performed statistical research.

The threads raised in the theoretical part were intended to outline the context for implementation of the reverse logistics in the defective products' flows management in the manufacturing enterprises. The starting point for introduction of the reverse logistics concept into the manufacturing enterprises' operations was posed by the assumptions of the sustainable development and their inclusion into the management of enterprises. Hence, there was a conceptual background created for the empirical studies that were carried out afterwards, related to implementation of the reverse logistics processes in the filed of the defective products' flows management in

the manufacturing enterprises. This part allowed for the implementation of the research objectives (1, 2), which were to identify the new spheres of reverse logistics in the manufacturing enterprises and to conceptualize the terms, as well as to determined the scope and specificity of the defective products' flows in the manufacturing enterprises along with specification of the reverse logistics processes as the basis for their implementation. The empirical part of this monograph was carried out based on interpretation of the interviews carried out in selected manufacturing enterprises along with the statistical analysis of the results from the survey studies performed on the representative sample of Polish manufacturing enterprises. In this part, based on the direct interviews, there was a descriptive model for the reverse logistics processes described in the field of the defective products' flows in the manufacturing enterprises. Afterwards, the model was verified in the selected Polish manufacturing enterprises. This allowed implementation of the research objective (3).

This is the part where the statistical analysis of the results from the survey studies carried out in the Polish manufacturing enterprises, which suggest that those enterprises are active in implementation of the reverse logistics processes in the defective products' flows management, but their scope in particular enterprises is varied. Therefore, there were certain interdependencies identified between description of the defective products' flows in the manufacturing enterprises and results of the reverse logistics in management of those flows what posed the research objective (4).

At the end, there was the analysis of interdependencies between different variables carried out, along with simulations for selected relationships of reverse logistics processes in the defective products' flows management in the Polish manufacturing enterprises and the statistical tests for significance of differences in evaluation of the main categories of returns and actions of the reverse logistics in the scope of the defective products' flows management among the groups of manufacturing enterprises differentiated according to the number of employees. This is the basis, which the research objective (5) was implemented on.

During implementation of the research, it was observed that:

- ✓ The Polish manufacturing enterprises experience some problems related to the defective products' flows management within the field of their operations.
- ✓ The Polish manufacturing enterprises adopt the reverse logistics processes in the defective products' flows management.
- ✓ The reverse logistics processes improve the defective products' flows in the manufacturing enterprises.
- ✓ There are some statistically significant interdependencies between the features of the defective products' flows and the results of the reverse logistics in management of that flows.
- ✓ In manufacturing enterprises, a detailed analysis of the shape of the defective products' flows improves their efficiency and effectiveness.
- ✓ There are some statistically significant differences in evaluation of the main returns categories and actions of the reverse logistics related to the defective

products' flows management in the groups of manufacturing enterprises selected according to the number of their employees.

- ✓ Size of the manufacturing enterprise, determined according to the number of employees, influences the implementation manners of the reverse logistics processes in the defective products' flows management in those enterprises.
- ✓ Size of the manufacturing enterprises, determined according to the number of employees, influences the results of the reverse logistics in the defective products' flows management in those enterprises.

The presented conclusions clearly suggest the positive impact of implementation of the reverse logistics processes in the defective products' flows management in the Polish manufacturing enterprises on their operation and functioning on the market. Based on the research, it was also found out that there is an increasing developmental trend related to introduction of new implementation solutions intended to improve those processes in the enterprises.

The notion of the reverse logistics of the defective products in the manufacturing enterprises may be assumed as one of the key conditions and challenges for the contemporary logistics management. Solving problems resulting from implementation of the reverse logistics processes in the field of the defective products' flows management in the manufacturing enterprises becomes its significant task.

However, the deliberations undertaken in this monograph cannot be considered exhaustive and complete, as the multitude and diversity of the issues related to the reverse logistics of the defective products in management of the manufacturing enterprises require further deep studies in this research field.

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Tables

Figures

Attachment 1

SURVEY QUESTIONNAIRE FOR REPRESENTATIVES OF MANUFACTURING COMPANIES

Dear Ladies and Gentlemen!

On behalf of PhD Marta Startostka Patyk from the Czestochowa University of Technology, we would like to ask you to fill in the survey questionnaire performed within the project financed by the National Centre of Science entitled **Logistics management of defective products in Polish manufacturing enterprises.** Your enterprise has been selected for the study in relation to a high probability of product returns emergence and potentially considerable needs related to their management. Purpose of the studies is to identify the practices adopted by the enterprises in relation to logistics operation of the returned products. The questionnaire is completely anonymous, and the collected data will serve solely for the collective statistical analysis. You will need about 5 minutes to fill in the survey questionnaire.

MAIN PART

Question 1	Are there any product returns in the enterprise?	*Please check one answer*
a) Yes		1
b) No (the end of survey)		2

Question 2	Which categories of returned products are recorded in the enterprise?			
RETURNS	**NUMEROUS**	**MEDIUM INTENSITY**	**MARGINAL**	**NOT PRESENT**
Damaged products	1	2	3	4
Outdated products	1	2	3	4
Seasonal products	1	2	3	4
Products unsold in retail	1	2	3	4
Products withdrawn from sales	1	2	3	4
Products erroneously taken as faulty	1	2	3	4
Product components	1	2	3	4
Waste- and by-products	1	2	3	4
Packagings	1	2	3	4
Other (which?)	1	2	3	4

Question 3	Please estimate the percentage of returns according to the place of their emergence:	*Open question*
a) Manufacturer returns (e.g. surpluses of raw materials, returns after quality control, manufacturing remains)		**.....%**
b) distribution returns (e.g. trade returns, surpluses in stock)		**.....%**
c) marketing returns (e.g guarantee and post-guarantee products, products that came to an end of life)		**.....%**
d) Other (which?)		**.....%**

Question 4	What is the average quality condition of the returns when compared to the original product quality?					
RETURNS	**TERRIBLE**	**POOR**	**SATISFACTORY**	**GOOD**	**VERY GOOD**	**PERFECT**
Damaged products	1	2	3	4	5	6
Outdated products	1	2	3	4	5	6
Seasonal products	1	2	3	4	5	6
Products unsold in retail	1	2	3	4	5	6
Products withdrawn from sales	1	2	3	4	5	6
Products erroneously taken as faulty	1	2	3	4	5	6
Product components	1	2	3	4	5	6
Waste- and by-products	1	2	3	4	5	6
Packagings	1	2	3	4	5	6
Other (which?)	1	2	3	4	5	6

Question 5	What is the most frequent return period for the product? [Calculated from the moment of handing to distribution)	*Please check one answer*
a) Up to 1 week		1
b) From 1 week to 1 month		2
c) From 1 to 3 months		3
d) From 3 to 6 months		4
d) From 6 to 12 months		5
f) From 12 to 18 months		6
g) From 18 months to 2 years		7
h) From 2 to 3 years		8
i) From 3 to 5 years		9
j) More than 5 years		10

Question 6	How long does the average returns processing cycle take?	*Please check one answer*
a) Less than 1 day		1
b) From 1 to 2 days		2
c) From 2 days to 1 week		3
d) From 1 to 2 weeks		4
e) From 2 weeks to 1 month		5
f) From 1 to 2 months		6
g) From 2 to 6 months		7
h) More than 6 months		8

Question 7	Please evaluate the returns acceptance policy in your enterprises at the scale from 1 to 6				
VERY RESTRICTIVE					**VERY LIBERAL**
1	2	3	4	5	6

Question 8	How did the returns acceptance policy in your enterprise change within last 5 years?	*Please check one answer*
a) It didn't change (please move to Question 9)		1
b) It changed		2

Question 8a	How much did the returns acceptance policy in your enterprise change?				
TO MORE RESTRICTIVE					**TO MORE LIBERAL**
1	2	3	4	5	6

Question 9	What are the motives for the returns acceptance by your enterprise? Please evaluate the significance of the below-mentioned motisf.		
MOTIVES	**NON-SIGNIFICANT**	**SIGNIFICANT**	**VERY IMPORTANT**
Improvement in customer service quality	1	2	3
Getting rid of unnecessary products from the market	1	2	3
Compliance with legal and environmental provisions	1	2	3
Recovery of materials and components	1	2	3
Development of an environmentally-friendly company reputation	1	2	3

Prevention of displacement of new products by products from the secondary market	1	2	3
Reduction in the loss of value on unsold or defective products	1	2	3
Other [which?)	1	2	3

Question 10	Do the returns reduce your enterprise's profitability?	*Please check one answer*
a) Yes, significantly		1
b) Yes, slightly		2
c) No, they don't		3

Question 11	Which actions out of those mentioned below, related to the returns management, are carried out independently by the enterprise and which are outsourced?		
ACTIONS	**INDEPENDENTLY**	**OUTSOURCED**	**NOT UNDERTAKEN**
Returns acceptance	1	2	3
Charity donation	1	2	3
Repackage and sales as new	1	2	3
Sales in the same form as the product was accepted	1	2	3
Remanufacture (repair,	1	2	3
cleaning, etc.)			
Production from recovered components or raw materials	1	2	3
Sales	1	2	3
Recovery of components	1	2	3
Recycling (recovery of materials)	1	2	3
Scrapping	1	2	3
Other (which?)	1	2	3

Question 12	What are the barriers for effective management of returns in your enterprise?	*You can check multiple answers*
a) Company's policy		0 "not selected"/ 1 "selected"
b) Aspects of competitiveness		0 "not selected"/ 1 "selected"
c) Financial resources		0 "not selected"/ 1 "selected"
d) Non-significance		0 "not selected"/ 1 "selected"
e) Lack of adequate organizational solutions		0 "not selected"/ 1 "selected"

f) Legal circumstances	0 "not selected"/ 1 "selected"
g) No attention from the managerial staff	0 "not selected"/ 1 "selected"
h) Incompetent personnel	0 "not selected"/ 1 "selected"
i) Other (which?)	0 "not selected"/ 1 "selected"

Question 13	Are hardware and software solutions supporting the returns management installed or planned in your enterprise?		
SOLUTIONS	**INSTALLED**	**PLANNED**	**NEITHER INSTALLED NOR PLANNED**
Bar codes	1	2	3
2D codes	1	2	3
Computerized returns tracking system	1	2	3
Electronic Data Interchange (EDI)	1	2	3
Radio Frequency Identification (RFID)	1	2	3
Other (which?)	1	2	3

Question 14	Please evaluate the significance of particular aspects of your enterprises in relation to development of the competitive position.					
ASPECTS	**COMPLETELY NON-SIGNIFICANT**					**VERY IMPORTANT**
Costs reduction	1	2	3	4	5	6
Price	1	2	3	4	5	6
Quality	1	2	3	4	5	6
Returns policy	1	2	3	4	5	6
Delivery time	1	2	3	4	5	6
Diversity of products	1	2	3	4	5	6

Question 15	How does the management of product returns influence implementation of your enterprise's objectives?				
NEGATIVE					**POSITIVE**
1	2	3	4	5	6

GENERAL INFORMATION ABOUT THE ENTERPRISE

Question 16	What is the type of major activity of the company? [PCA No.)	
14.13	Manufacture of other outerware	1
14.19	Manufacture of other wearing apparel and accessories	2
18.11	Printing of newspapers	3
18.12	Other printing	4
26.2	Manufacture of computers and peripheral equipment	5
26.3 26.4	Manufacture of (tele)communication equipment Manufacture of consumer electronics	6
26.7 26.8	Manufacture of optical instruments and photographic equipment Manufacture of unrecorded magnetic and optical media	7
27.2	Manufacture of batteries and accumulators	8
27.5 27.9	Manufacture of other electrical equipment Manufacture of other domestic appliances	9
28.0	Manufacture of machinery and devices, not elsewhere classified	10
29.3	Manufacture of spare parts and accessories for motor vehicles	11
30.9	Manufacture of transport equipment, not elsewhere classified	12
31.0	Manufacture of furniture	13
32.2	Manufacture of musical instruments	14
32.3	Manufacture of sports goods	15
32.4	Manufacture of games and toys	16
	Other (which?)	17

Question 17	What is the current number of employees in your enterprise?	*Please check one answer*
a) Up to 9 persons		1
b) 10-49 persons		2
c) 50-24 persons		3
d) 250+ persons		4

Question 18	Which positions of the distribution channel are occupied by your enterprise? Please check all occupied positions.	*You can check multiple answers*
a) Manufacturer/producer		0 "not selected"/ 1 "selected"
b) Wholesaler		0 "not selected"/ 1 "selected"
c) Retailer		0 "not selected"/ 1 "selected"
d) Service provider (what services?)		0 "not selected"/ 1 "selected"

e) Transportation	0 "not selected"/ 1 "selected"
f) Warehousing	0 "not selected"/ 1 "selected"
g) Other (which?)	0 "not selected"/ 1 "selected"

FINAL PART

Question 19	Are you interested in receiving a copy from the survey?	*Please check one answer*
a) YES		1
b) NO		2

Question 20	Would you like to take part in the in-depth interview related to environmental impact in implementation of actions that are the subject of this survey questionnaire?	*Please check one answer*
a) YES		1
b) NO		2

CONFIDENTIAL PART

First and last name of the respondent	
Name of the company	
Name of the Department	
Position	
Address	
Place	
Postal code	
Province	
Phone number	
E-mail address	

Thank you for your participation in the survey!

Dr. Marta Starostka-Patyk is an assistant professor at the Faculty of Management, Czestochowa University of Technology in Poland. Her scientific interests include the problems of logistics management and supply chain management. Specifically, her interests focus on reverse logistics and environmental aspects of logistics.

Dr. Starostka-Patyk has been an author of several dozen highly regarded scientific publications. She has participated in research projects funded by the National Science Centre and the European Union and has contributed in many international projects.

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Per aspera ad astra

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ISBN 978-83-65929-01-3
9 788365 929013