SELECTED PROBLEMS OF MANAGEMENT OF THE SUPPLY SUBSYSTEM IN THE ENTERPRISE OF THE FOUNDRY SECTOR: DETERMINATION OF THE PURCHASING SOURCES AND THE LEVELS OF UNIT MATERIAL CONSUMPTION

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Abstract

The paper characterizes the tasks of the selected logistic subsystem in the area of the enterprise operations. The main aim of the study is to identify and analyse two tasks of management of the supply subsystem in the Enterprise X operating in the foundry sector. Firstly, planned sources of purchasing in the Enterprise X for the proposed redesigned manual meat mincer were determined. The phase of purchasing is composed of the partial functions and tasks which integrate real and information processes. The content of these processes can be determined by the reply to the most important questions connected with enterprise's core activities, concerning in particular make-or-buy decisions, which are connected with determination of the scope of permanent cooperative relationships. Next, the level of unit material consumption for manufacturing of cast products was evaluated for the proposed redesigned manual meat mincer. Effective operations of the Enterprise X depend on the effective meeting material needs for the internal production, auxiliary components for manufacturing of cast products and moulding materials which were estimated and presented in this study.

The paper is based on the two items of the literature and author's own examinations conducted using the method of interviews with employees and customers in the Enterprise X. An important source of information was internal materials obtained through collaboration with authorities and employees of the enterprise.

Keywords: Supply subsystem, management, foundry sector

1. INTRODUCTION

This paper is devoted to characterization of the tasks of the selected logistic subsystem in the area of the enterprise operations [1, 2]. The main aim of the study is to identify and analyse selected tasks of management of the supply subsystem in the Enterprise X operating in the foundry sector.

The paper is a continuation of the study with similar title, presenting the theoretical approach to the supply subsystem in the systematic logistics concept, providing a brief characterization of the object of activities of the Enterprise X from the foundry sector and identifying and analysing two problems of management of the supply subsystem in this entity: customers' needs in the area of products expected and the predicted production levels and sales levels [3]. This study identifies and analyses another two problems of management of the supply subsystem in the entity: determination of planned sources of purchasing in the Enterprise X and estimation of the level of unit material consumption for production of cast products [4].

The paper is based on the two items of the literature and author's own examinations conducted using the method of interviews with employees and customers in the Enterprise X. An important source of information was internal materials obtained through collaboration with authorities and employees of the enterprise.

2. DETERMINATION OF THE PLANNED SOURCES OF PURCHASING IN THE ENTERPRISE X

Of the broad range of products offered by the Enterprise X, one of the most important items in the national and international market is household goods, which include e.g. manual meat mincer - the product which can be used for identification and analysis of the tasks of the logistic subsystem of the entity in this paper. Furthermore,

while taking opportunities of the logistic subsystem of the Enterprise X based on the selected product, i.e. manual meat mincer, it will be redesigned and modernized. The equipment manufactured by the Enterprise X will be modified after conclusions drawn based on the analysis of internal materials of the enterprise X and, first and foremost, the interviews made with employees.

The phase of the purchasing is composed of many partial functions and tasks which integrate the real and information processes [1, 3, 4]. The content of these processes can be determined by the reply to the most important questions connected with enterprise's core activities, concerning in particular make-or-buy decisions, which are connected with determination of the scope of permanent cooperative relationships [5].

The make-or-buy decisions have to be preceded by a full analysis of all factors that take into consideration the sometimes contradictory interests of various units in the entity [6]. In the Enterprise X, the purchasing managers' decisions are made based on the following information:

- internal production - high level of value added, unique technology, strategic character of the casting technology,
- deriving goods from cooperation - opportunities for profitable active cooperation.

It should be emphasized that the decisions concerning internal production or cooperation should be made at early phases of product development [7], especially at the stage of the assumptions for the project of meat mincer modernization presented in this paper.

According to the project assumptions of meat mincer modernization, planned list of parts for internal production and purchasing at other manufacturers was prepared for the product representative in the Enterprise X - manual meat mincer A -1 (see **Table 1**).

Table 1 Planned list of parts the proposed redesigned manual meat mincer A-1 for internal production and purchasing at other manufacturers

No.	Name of parts	Material	Pc./item	Type of part
1	Mincer body	Grey cast iron 150	1	Original
2	Worm	Grey cast iron 150	1	Original
3	Crank	Grey cast iron 150	1	Original
4	Nut	Grey cast iron 150	1	Original
5	Cross blade	165 steel	1	Original
6	Mesh plate	Steel 115	1	Original
7	Bolt (holding, fixing)	Steel 3S	1	Original
8	Fixing bolt	Steel 3S	1	Original
9	Pivot	Steel A10X	1	Original
10	Rivet	Steel 2N	1	Original
11	Holder	Steel 08X	1	Original
12	Sealing bushing	Steel 2N	1	Original
13	Holder cap	Black rubber	1	From purchasing
14	Stem cap	Black rubber	1	From purchasing
15	Handle	Beech wood	1	From purchasing

Machine parts, such as wooden handles and rubber caps (stem cap and holder cap) according to the project assumptions of meat mincer modernization are planned to be purchased by the Enterprise X from nearby cooperating companies according to the following sources of purchasing:

1) Wooden handles are manufactured for the enterprise by other woodwork service providers from Katowice, Częstochowa and Blachownia (Southern Poland),

2) Rubber pads for the entity are manufactured by an enterprise that offers services of plastic/rubber processing and machining from Poręba near Zawiercie (Southern Poland).

Due to above mentioned handling the database on supplies will contain information necessary for the choice of best source of purchasing i.e. adequate evaluation from the standpoint of current prices, quality of products, costs of transport, deliveries and technical support.

3. DETERMINATION OF THE LEVEL OF CONSUMPTION OF MATERIALS FOR PRODUCTION OF CASTS IN THE ENTERPRISE X

In the most of enterprises, the structure of material requirements is quite complex. Great number of materials and raw materials with different level of processing and technical readiness for application leads to different approaches to processes of planning and purchasing in the supply subsystem [8].

Information that allows for adequate material requirements planning in the Enterprise X include in particular [9]:

- current production and sales plans for finished products, presented in the part 1 of this paper,
- catalogues of materials available in the market of products of the foundry sector, price lists, catalogues, bids, advertising brochures, which are of substantial interest in the field of marketing,
- the normative database, which involves especially unit consumption of materials for internal production, auxiliary components for manufacturing of cast products and moulding materials which are presented below.

The database as below are developed on the basement of author's own examinations conducted using the method of interviews with employees of the Enterprise X, analysis of internal materials obtained through collaboration with authorities of the Enterprise and using the statistical methods.

According to the project assumptions of meat mincer modernization, the unit consumption of materials for part of manual meat mincers unified for internal production in the Enterprise X was estimated. The comparison of the data is presented in **Table 2**.

Similar estimation of unit consumption of materials for internal production was made using natural material units (cast iron, steel, rubber) of kilograms, which is presented in **Table 3**.

Table 2 Estimation of the unit consumption of materials for internal production for the proposed redesigned manual meat mincer A-1

No.	Name of parts	Material		Pc./item	Unit consumption [%]							
					Machine A							
					1		2		3		4	
1	Mincer body	Zl 150	Zn	1	55.8	1.2	55.3	1.2	55.7	1.3	56.5	1.3
2	Worm	Zl 150	Zn	1	16	0.2	19.9	0.2	19.7	0.3	19.8	0.3
3	Crank	Zl 150	Zn	1	7.9	0.2	6.1	0.2	5.9	0.3	5.7	0.3
4	Nut	Zl 150	Zn	1	8.03	0.15	7.75	0.15	8.3	0.2	7.5	0.2
5	Cutting blade	Steel 165		1	0.8		0.9		0.9		1.0	
6	Mesh plate	Steel 115		1	2.6		2.5		2.8		2.6	
7	Set bolt	Steel 3S		1	0.8		0.6		0.45		0.45	
8	Fixing bolt	Steel 3S		1	2.8		2.2		1.6		1.55	
9	Pivot	Steel A10X		1	0.85		0.9		0.7		0.7	
10	Holder	Steel 3S		1	0.6		0.6		0.45		0.4	
11	Rivet	Steel 2N		1	1.25		0.9		0.7		0.8	
12	Sealing bushing	Steel 2N		1	0.8		0.6		0.7		0.6	
Total				12	100		100		100		100	

Table 3 Estimation of the unit consumption of materials for internal production in natural units for the proposed redesigned manual meat mincer A-1

No.	Name of parts	Material		Pc./item	Unit consumption [kg]							
					Machine A							
					1		2		3		4	
1	Mincer body	Zl 150	Zn	1	1.2	0.02	1.53	0.03	1.95	0.04	4.1	0.09
2	Worm	Zl 150	Zn	1	0.34	0.004	0.55	0.005	0.7	0.01	1.4	0.03
3	Crank	Zl 150	Zn	1	0.16	0.004	0.17	0.005	0.2	0.01	0.4	0.03
4	Nut	Zl 150	Zn	1	0.17	0.03	0.21	0.004	0.3	0.007	0.6	0.02
5	Cutting blade	Steel 165		1	0.017		0.025		0.031		0.075	
6	Mesh plate	Steel 115		1	0.06		0.07		0.1		0.2	
7	Set bolt	Steel 3S		1	0.017		0.016		0.015		0.035	
8	Fixing bolt	Steel 3S		1	0.06		0.06		0.056		0.115	
9	Pivot	Steel A10X		1	0.018		0.025		0.025		0.05	
10	Holder	Steel 3S		1	0.012		0.016		0.015		0.03	
11	Rivet	Steel 2N		1	0.026		0.026		0.025		0.065	
12	Sealing bushing	Steel 2N		1	0.02		0.017		0.025		0.06	
Total				12	2.14		2.78		3.50		7.30	

Also consumption of cast iron components was estimated for the proposed redesigned manual meat mincer A-1, which is presented in **Table 4**.

Table 4 Estimation of the consumption of cast iron components for the proposed redesigned manual meat mincer A-1

Charge materials	Unit consumption	
	[%]	[kg/making 1kg of the cast product]
Scrap cast iron	60	1.08
Scrap steel	15	0.27
Pig iron	22	0.396
Ferromanganese	0.3	0.0054
Ferrosilicon	2.2	0.0396
Ferrophosphorus	0.5	0.009
Total	100	1.8

In the process of cast product manufacturing, the charge materials are molten in the shaft furnaces. In order to operate such furnaces, estimation of auxiliary components is also needed, with their consumption presented in **Table 5**.

Table 5 Estimation of the consumption of auxiliary materials for production of cast products for the proposed redesigned manual meat mincer A-1

Charge materials	Unit consumption	
	[%]	[kg/making 1kg of the cast product]
Coke	79.7	0.279
Limestone	20	0.07
Carbide	0.3	0.001
Total	100	0.35

In the casting process, part of the cast iron for performing the moulding compound and cores is needful for moulding materials. In addition to cast iron, the following materials are also planned to be used for production of mincer body, warms, crank and nuts:

- Consumption of quartz sand which is estimated as around half of the cast product weight;
- The consumption of quartz sand was calculated from the equation:

$$Unit\ \ consumption\ of\ \ the\ quartz\ sand = cast\ \ product\ weight * 0.18 \quad (1)$$

- The consumption of Ekosil binder was calculated from the equation:

$$Unit\ consumption\ of\ \ the\ Ekosil = cast\ \ product\ weight * 0.081 \quad (2)$$

Unit consumption of individual moulding materials for manufacturing of cast iron parts of manual meat mincers was also estimated for the proposed redesigned manual meat mincer A-1 to be manufactured by the Enterprise X, which is presented in **Table 6**.

Table 6 Estimation of the unit consumption of individual moulding materials for manufacturing of cast iron parts of manual meat mincers for the proposed redesigned manual meat mincer

Part No.	Name of parts	Pc. /item	Material	Unit consumption							
				Machine A							
				1		2		3		4	
				[%]	[kg]	[%]	[kg]	[%]	[kg]	[%]	[kg]
1	Mincer body	1	A	66.7	0.6	66.1	0.76	66	0.97	65.9	2.05
			B	23.3	0.21	23.5	0.27	23.8	0.35	23.5	0.73
			C	10	0.09	10.4	0.12	10.2	0.15	10.6	0.33
			Total	100	0.9	100	1.15	100	1.47	100	3.11
2	Worm	1	A	68	0.17	67.5	0.27	67.4	0.35	66.1	0.7
			B	24	0.06	22.5	0.09	23	0.12	23.6	0.25
			C	8	0.02	10	0.04	9.6	0.05	10.3	0.11
			Total	100	0.02	100	0.4	100	0.52	100	1.06
3	Crank	1	A	72.8	0.08	66.7	0.08	71.4	0.1	66.7	0.2
			B	18.2	0.02	25	0.03	21.4	0.03	23.3	0.07
			C	9	0.01	8.3	0.01	7.2	0.01	10	0.03
			Total	100	0.11	100	0.12	100	0.14	100	0.3
4	Nut	1	A	66.7	0.08	71.5	0.1	68.2	0.15	68.2	0.3
			B	25	0.03	21.4	0.03	22.7	0.05	22.7	0.1
			C	8.3	0.01	7.1	0.01	9.1	0.02	9.1	0.04
			Total	100	0.12	100	0.14	100	0.22	100	0.44

A - resin coated sand; B - quartz sand; C - Ekosil

Estimation of the unit consumption of moulding materials for performing cast products for a single manual meat mincer is presented in **Table 7**.

Table 7 Estimation of the unit consumption of moulding materials for manufacturing of cast parts for a single manual meat mincer for the proposed redesigned manual meat mincer

Part No.	Name of parts	Material	Pc./item	Unit consumption							
				Machine A							
				1		2		3		4	
				[%]	[kg]	[%]	[kg]	[%]	[kg]	[%]	[kg]
1	Mincer body	MF	1	65.2	0.9	63.5	1.15	62.5	1.47	63.3	3.11
2	Worm	MF	1	18.2	0.25	22	0.4	22.1	0.52	21.6	1.06
3	Crank	MF	1	7.9	0.11	6.7	0.12	6	0.14	6.1	0.3
4	Nut	MF	1	8.7	0.12	7.8	1.14	9.4	0.22	9	0.44
Total			4	100	1.38	100	1.81	100	2.35	100	4.91

MF - moulding materials used in the Enterprise X: resin coated sand, quartz sand, Ekosil binder

Materials for cast product cleaning are also used in the process of cast iron manufacturing. For this purpose, for the proposed redesigned manual meat mincer the cast iron or steel casting shot will be used, with its estimated consumption of ca. 60 kg per tonne of cast products i.e. ca. 6 % of shot mass will be used to manufacture 100 % of cast products.

Cast products cleaned from the moulding compound will be exposed to etching in water solutions of hydrofluoric acid H_2F_2 with concentration of 40 %. Estimated consumption of the solution of H_2F_2 will be ca. 360 l per 1 tonne of cast products i.e. 36 % of the solution mass per 100 % of cast product mass.

Effective operations of the Enterprise X depend on the effective meeting the above estimated material requirements for the internal production, auxiliary components for manufacturing of cast products and moulding materials. According to scientific and practical experts, the level of consumption of these materials represents the basic component of the costs of enterprise activities and it always offers some opportunities for cost reduction [9, 10, 14]. Therefore, a major part of the current assets of the enterprise depends on the above estimations of unit consumption levels. These levels are used to determine inventory levels and the fixed assets are necessary to be involved. Consequently, the processes in this task of the supply subsystem have an exceptional effect on the wholeness of activity of the Enterprise X and other similar business entities as they have a significant effect on its costs and allow for increasing the competitiveness [11].

4. CONCLUSION

Production processes in the Enterprise X in the foundry sector require constant and regular supply of materials. The supply subsystem in the enterprise studied includes a number of tasks, which in reference to the literature of the subject [12, 13, 14] were identified as:

- choice of planned purchasing sources - it is important to select the supplier that is able to meet all the quality requirements of the enterprise and deliver goods in a timely manner;
- determination of the estimated level of unit consumption of materials for production of cast products - the level of a single purchase is connected with planned demand and production or sales plans.

Due to another aim of the paper which was analysis of identified tasks of management of the supply subsystem in the Enterprise X, the presented database were developed on the basement of author's own examinations conducted using the method of interviews with employees of the Enterprise X, analysis of internal materials obtained through collaboration with authorities of the Enterprise and using the statistical methods.

According to the project assumptions of meat mincer modernization, the number of material items to be purchased was estimated which can reach thousand of pieces and generate very high costs. Therefore, it is

critical to make right decisions concerning the supply subsystem in the area of the above tasks, specially due to the project assumptions of meat mincer modernization to plan purchasing and to estimate unit consumption of materials. Management of the supply subsystem in the Enterprise X also involves many other tasks, which, due to the character count limitations, were not discussed in this paper.

According to the literature of the subject although the supply area in the enterprise is a complex process, it can be effectively managed if the manager develops some system solutions to its implementation, coinciding with, inter alia, identification and analysis of its main tasks [1, 3, 4]. As the task-oriented approach to optimizing the management of the supply subsystem in the enterprise increases, decision-making across the entire supply chain is enhanced, providing comprehensive optimization. At the same time, following the detailed identification and analysis of the subsystem's tasks, it is important to emphasize their diversity as a result of different approaches to this type of research problem.

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