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CROSS-SECTORAL COMPARISON OF THE EFFECT OF SALES PLANNING PRACTICES ON MANUFACTURING STRATEGY IN SUPPLY CHAINS

Abstract: The goal of the paper is to make a cross-industrial comparison of the effect of sales planning practices on different types of manufacturing strategies applied in 343 producing companies operating in European, Asian and African supply chains. In order to achieve an empirical aim a necessary methodology and statistical analyses have been employed. In the result of the analysis multiple regression models have been developed for specific manufacturing strategies in supply chains operating in different industries worldwide. It enabled to make cross-sectoral comparisons of the contribution to variance in manufacturing strategy.

Keywords: forecasting, production systems, manufacturing companies.

1.   Introduction

One of the most important links of supply chains are manufacturers who developed many supply chain strategies to address the problems of product proliferation and meeting exact customers' needs. Among many strategies aiming at perfect customer service and balanced asset utilization, manufacturing strategies have been identified as important characteristics of competitive supply chains. However, an implementation of manufacturing strategy may require a significant reconfiguration of the supply chain and all companies being its links have to participate in that effort.

In practice, a number of manufacturing strategies in a supply chain may be distinguished, namely make-to-stock (MTO), assembly-to-order (ATO), make-to-order (MTO) and engineer-to-order (ETO). Those strategies are determined by the appropriate location of material and information decoupling points indicating a specific organization of physical and information flows in a supply chain. Therefore, in order to apply a particular manufacturing strategy, one should possess an appropriate data

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base for making decisions. An ingredient of crucial significance determining the efficiency of decision making process are characteristics of sales planning practices used to predict future customer demand.

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2.   Manufacturing strategies in supply chains

Customer requirements and their implications determine an operations strategy in manufacturing supply chains. They differ in the way they meet the demand. Some supply chains deliver products to their clients from finished goods inventories as their production anticipates customers' orders; others, however, manufacture only in response to customers' orders. Those two situations are connected to different transactional standards of customer service, namely the customer's sensitivity to product availability and delivering unique products adjusted to the individual customer's requirements. In this connection the emphasis is now more and more to competition in terms of time and customization. Time competition requires an emphasis on time which should not be wasted and is supported by fewer and faster activities being performed [16]. On the other hand, customization means performing some activities according to the unique requirements of an individual customer [18]. Competition in terms of time and customization is reflected in the most popular classification of manufacturing strategies in supply chains, namely: make-to-stock (MTO), assembly-to-order (ATO), make-to-order (MTO) and engineer-to-order (ETO).

In make-to-stock manufacturing products are standardized but not necessarily allocated to specific locations; the demand is anticipated to be stable or readily forecasted at an aggregate level. In assemble-to-order system products can be customized within a range of possibilities, usually based upon a standard platform. Make-to-order is characterized by raw materials and components which are common but can be configured into a wide variety of products. In the last manufacturing system engineer-to-order products are specially designed from engineering specifications. While the products might use some standard components, at least some of the components or arrangements of components have been specifically designed by the customer or the customer working with the producer [13, 3, 8].

Competition in terms of time requires adopting make-to-stock strategy in order to meet immediately customer's order from inventory. On the other hand, creating unique products is only possible if the customer can influence its properties which means that the product to some extent is engineered-to-order, made-to-order or at least assembly-to-order. Consequently, to customize products, some production-
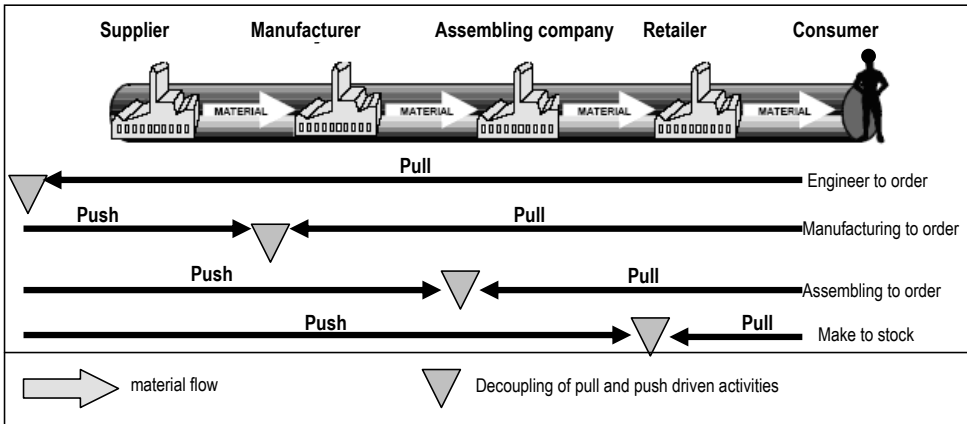
Fig. 1. *The extent of application of a specific manufacturing strategy in supply chains [9]*

related activities are influenced by customer requirements, whereas others are not [18].

The level of products' customization may decrease or increase gradually in supply chains being determined by an appropriate location of material decoupling point. In the opinion of Hoekstra and Romme "the decoupling point is the point that indicates how deeply the customer order penetrates into the goods flow" [9]. The material decoupling point is a buffer between upstream and downstream partners in the supply chain. This enables them to be protected from fluctuating consumer buying behaviors and therefore to establish smoother upstream dynamics, while downstream consumer demand is still met via a product pull from the buffer stock [11].

As the decoupling point is moved upstream in the supply chain, the degree of customization is expected to increase ceteris paribus, because customers would have the possibility to affect the production process at earlier stages [2]. Moving the point downstream in a supply chain results in manufacturing and delivering more standardized products, thus limiting the impact of customers on the extent of products' functionality, its appearance and other characteristics, but raising supply chains' competition in terms of time. Therefore, the location of material decoupling point is often perceived as an important measure of the levels of product customization in supply chains.

3. The characteristics of selected sales planning practices performed in manufacturing firms

Manufacturing strategy depends on the demand. The demand determines which strategy might be applied. When the demand is stable and its variability is low, the make-to-stock strategy (MTO) seems to be the most appropriate to use. In other case, more proper is to implement other strategies such as: assembly-to-order (ATO),

make-to-order (MTO) or engineer-to-order (ETO). A valuable demand management process can enable a company to be more proactive to anticipated demand, and more reactive to unanticipated demand [5].
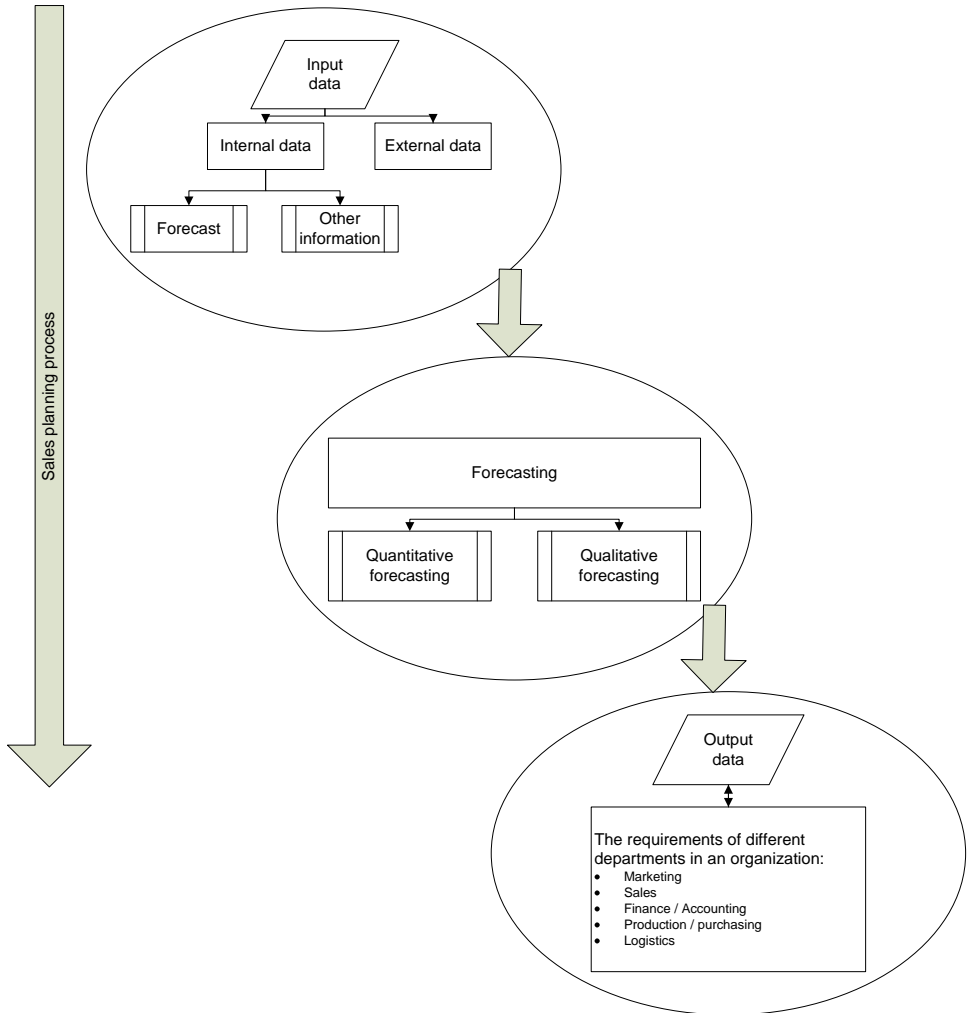

Fig. 2. *Sales planning process*

Sales planning is embedded in a wider concept of demand management. Demand management strives to manage all the activities associated with discovering markets, planning products or services for those markets and then fulfilling the customer's needs. It is an integrated process across the manufacturing supply chains. When the demand management process is implemented within the structure of the organizations more appropriate term for that process is sales planning.

Hardly ever, the volume of sales is the same as volume of demand, but sales is recorded in a software and the demand is not. Sales are the activities involved in selling products or services in return or exchange for money or other compensation. This is an act of completion of commercial activity. The term demand signifies the ability or the willingness to buy products by the customers.

Sales planning consists of several elements inextricably linked, namely: input data and forecasting.

Input data used in the sales planning process are mainly: marketing and sales input, statistical analysis, business plan and strategy and product/brand management [6].

Fig. 3. *Sources of information for sale planning process [14]*

The data used in forecasting process should be divided into two groups: internal and external data. Acting in an integrated environment, it is possible to get forecast burdened small forecast error. Then the control over the forecasting process wouldn't be lost.

Internal data which is needed in the planning process is mainly a result of sales forecast and other information necessary to determine the company sales capabilities. Two main methods of sales forecast can be identified [12]:

1) quantitative forecasting,
2) qualitative forecasting.

Classification of forecasting methods into those two categories is based on the availability of historical time series data. Quantitative forecasting methods are used when the historical data on variables of interest are available - these methods are based on an analysis of historical data concerning the time series of the specific variable of interest and possibly other related time series. Quantitative forecasting can

be categorized into two types of models. The first type, causal models, uses independent variables instead of (or as well as) time in order to generate a forecast. The second type, time series models, creates a demand profile with time as the independent variable [12].

Qualitative forecasting techniques generally employ the judgment of experts in the appropriate field to generate forecasts. A key advantage of these procedures is that they can be applied in situations where historical data are simply not available. Three important qualitative forecasting methods are: the Delphi technique, scenario writing, the subject approach and historical analogy with examples [12].

A special group of qualitative methods used in forecasting is market research. This technique is used when historical data are not available and there are no similar products which can serve as an analogy model, for example for completely new, innovative products introduced on the market. New product forecasting should not rely solely on internal sources and company personnel judgment. If possible, external sources both in terms of data and judgment should be canvassed, especially data and judgment from current and potential customer [10]. Three different types of testing may occur with customers throughout the new product development [10]:

1) concept testing,
2) product use testing,
3) market testing.

The diverse group serves as methods of forecasting the market. When a manufacturing company in a supply chain intends to enter on the new market, market research is needed. Assessing market potential involves observing and quantifying relationships among different social and economic factors that affect purchasing behaviors. Analysts at the industry level look for causal factors that, when linked together, explain changes (upward or downward) in demand for a given set of products or services. This may be done on the local level, the national level, or even on the international stage.

The information obtained from the sales planning process is then used for different purposes. The demand plan helps manufacturers in planning production and managing inventory in supply chains. In consequence, they can satisfy customer orders, keep buffers lower and hence decrease tied-up capital. The forecasting activities performed in different departments of the companies operating in supply chains have been summarized in Table 1.

In the result of fragmentation and dispersion of the specific forecasting activities performed across many different departments in the companies, the prepared forecasts are not usually accurate. Therefore a specific mechanism of integration is needed in order to make the obtained forecasts more reliable and trustworthy for a decision making process in a supply chain.

Table 1. *Forecasting requirements of various management functions* [15]

	Marketing	Sales	Finance / Accounting	Production / purchasing long-term	Production / Purchasing short-term	Logistics long-term	Logistics short-term
Needs	Annual plans (updated monthly or quarterly) for new and existing products or product changes, promotional efforts, channel placement, and pricing	Setting goals for the sales force and motivating salespeople to exceed those goals	Projecting cost and profit levels and capital needs	Planning the development of plant and equipment	Planning specific production runs	Planning the development of storage facilities and transportation equipment	Specific decisions of what products to move to what locations and when

4. Methodology

4.1. Research model, sample and data collection

On the basis of literature review a research model has been developed – Figure 4. As depicted in the model, the independent (explanatory) variables are sales planning practices and their characteristics classified into four groups, namely: qualitative methods and data combined into foreacasting, major aims of forecasting process, data used in forecasting, quantitative forecasting models. The response variables are four types of a manufacturing strategy. Based on literature review, it may be assumed that there are some significant differences concerning sales planning practices between the industries.

The main research instrument used for this study was a questionnaire developed by the Global Manufacturing Research Group consisting of several sections examining manufacturing practices. There is no single meta-theory for guiding the development of GMRG survey. Instead, many aspects of general manufacturing practices were a subject of investigation. Data collected within the fourth release of the survey were gathered by researchers from several countries in Europe, North America, Asia, and Africa. The survey was a random sample of firms in a given geographical area [17].

For the purpose of the research presented in this paper, a number of variables have been selected. Originally 17 (13 independent and 4 dependent variables) were a subject of initial analysis. The opinion items were gathered using 5-point Likert scale.
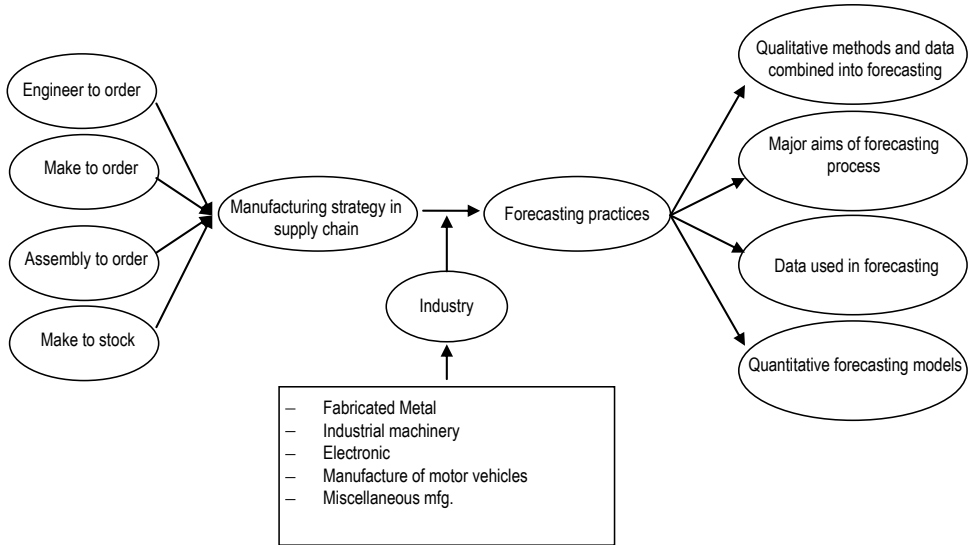
Fig. 4. *Conceptual model of cross-sectoral effects of sales planning practices on manufacturing strategy in supply chains*

In order to perform cross-national comparisons, the companies from five countries were chosen for further analysis. The sample was compiled from surveys of manufacturing firms and originally consisted of 343 manufacturers. As a result of initial data analysis, screening and elimination of observations with missing values, 244 companies remained as the subject of further analysis. The respondents were mainly small and medium-sized companies. This group included manufacturers from Ghana (25,8%), Poland (23,4%), Italy (22,1%), Hungary (21,7%) and Austria (7,0%).

The majority of the surveyed companies operate in fabricated metal sector (21,5%), followed by electronic and other electrical equipment industry (14,9%) and industrial and commercial machinery equipment (12,7%), miscallaneus manufacturing (8,3%), manufacturing of motor vehicles sector (7,2%) and textile industry (6,6%).

4.2. Methods of an empirical study

The aim of the study is to make a cross-national comparison of the effect of sales planning practices on different types of manufacturing strategies applied in 343 producing companies operating in European, Asian and African supply chains.

In order to solve the research problems, a two-step statistical analysis was employed. The first step was the reduction of 13 independent variables through factor analysis. Those variables reflected multidimensional forecasting practices. In order to perform the factor analysis, a Principal Component Analysis (PCA) with Varimax Rotation was applied.

The measure of individual sampling adequacy for each of 13 variables in the anti-image correlation matrix was above a nominal cut off point of 0,5. Therefore, no variable was eliminated from the further analysis. All variables also indicated relatively high factor loadings (better than 0,45).

Finally, the factor analysis which was carried out on 13 items, revealed the following structure of constructs (Table 2):

- Factor 1: qualitative methods and data combined into forecasting (use of qualitative models, management opinion, application of results from market research),
- Factor 2: major aims of forecasting process (sales and budget preparation, production resource planning, new product development, equipment/facilities planning),
- Factor 3: external data used in forecasting (economic conditions, customer's sales plans, supplier information, current order backlog),
- Factor 4: quantitative forecasting models (quantitative time series models, quantitative casual models).

Table 2. *The Structure of the Constructs Obtained through the Factor Analysis*

	Factors			
	1	2	3	4
The extent of use of quantitative time series models				0,748
The extent of use of quantitative casual models				0,733
The extent of use of qualitative models	0,703			
The extent of use of management opinion	0,772			
The extent of application of results from market research into forecasts	0,653			
The extent of application of economic conditions into forecasts			0,526	
The extent of application of customer's sales plans into forecasts			0,585	
The extent of application of supplier information into forecasts			0,767	
The extent of application of current order backlog into forecasts			0,599	
The extent a forecast is used in sales and budget preparation		0,479		
The extent a forecast is used in production resource planning		0,772		
The extent a forecast is used in new product development		0,596		
The extent a forecast is used in equipment/facilities planning		0,780		
Variance explained	16,434	16,673	14,509	14,122
Cumulative variance	16,434	33,107	47,616	61,737
Cronbach's Alpha	0,700	0,725	0,618	0,693

The number of factors was determined according to the analysis of the percentage of variance explained and the Kaiser criterion [1]. KMO coefficient score indicating the suitability of the sample for factor analysis in a space of 13 variables is 0,838 which is a very good result [4]. Bartlett's test of sphericity demonstrated sufficiently high value for the extracted factors at $p <= 0,000$ (Approx. chi-square 1073,522, df = 78). The obtained structure of factor analysis explains 61,73 percent of variance.

The Cronbach's alpha coefficients were calculated to check the internal consistency of extracted factors. Alpha score of transformed variables in four instances is above the nominal cut-off point of 0,6. Considering the rule provided by George and Mallery, the obtained results of alpha coefficients suggest a relatively good internal consistency of those extracted constructs [7].

In the second stage of the analysis multiple regression models were developed. It enabled to make a cross-sectoral comparison of the contribution to variance in manufacturing strategies. Only variables with observed p-values of less than 0,05 were kept in the model.

Multiple regression models were developed for each of the four response variables indicating specific manufacturing strategy. Response variables were defined as a percentage of manufacaturing orders falling into four categories: engineer-to-order, make-to-order, assembly-to-order and make-to-stock.

First, descriptive statistics was used to make a cross-sectoral comparisons of applied manufacturing strategies in the examined supply chains operating in specific industries. Afterwards, the regression models were developed. Data were analyzed seperately for organizations in 5 sectors.

5.   Results of analysis

5.1.   Identification of manufacturing strategies in the examined companies

Table 3 shows comparisons of the types of manufacturing strategies performed in the supply chains operating in five industries worldwide.

Table 3. *Cross-sectoral comparison of manufacturing strategies performed in examined industries (avg. scores)*

Industry type	Manufacturing strategies			
	Engineer-to-order	Make-to-order	Assembly-to-order	Make-to-stock
Fabricated Metal	15,6%	56,2%	9,4%	11,1%
Industrial machinery	14,7%	52,4%	18,8%	14,1%
Electronic	9,0%	38,6%	21,7%	27,0%
Manufacture of motor vehicles	3,8%	78,3%	13,1%	9,4%
Miscellaneous mfg	20,3%	40,7%	15,7%	23,7%

The obtained results suggest that the prevailing share of manufacturing orders is falling to make to order strategy in all examined industries. The average share of orders initiated in accordance with this strategy is from roughly 40 percent indicated by the companies from electronic sector to over 78 percent of all fulfilled orders reported by the firms from manufacturing of motor vehicles.

The distribution of manufacturing orders performed in line with the other three strategies is rather diverse in supply chains operating in investigated industries. An engineer to order strategy seems to be the most typical for miscellaneous manufacturing, assembly to order strategy has a significant footprint in industrial machinery and electronic sector. The companies from latter one, also report a large share of orders initiated according to make to stock strategy, followed by the supply chains from miscellaneous manufacturing.

Furthemore, a manufacturing of motor vehicles and electronic products is seldom originated with engineer to order strategy. On the other hand, a very low share of fabricated metal products is initiated by an assembly to order strategy while manufacturing of motor vehicles is not typical for make to stock strategy. Judging on the analysis of manufacturing strategies in the supply chains in terms of sectoral framework, it may be highlighted that the sample is rather diverse. This provides a satisfying basis for a futher empirical study on the contribution of identified sales planning practices contributing to a manufacturing strategy in investigated supply chains.

5.2. The contribution of selected sales planning practices to apply a specific manufacturing strategy in the supply chains

The regression analysis for manufacturing strategy showed that each analyzed industry has at least one model with significant independent variables and adjusted coefficients of determination (R^2 adjusted) ranging from 0,089 to 0,405. The strongest models, as measured by adjusted R^2, are reported by the supply chains operating in miscellaneous manufacturing industry, electronic and industrial machinery sector. Table 4 demonstrates the results of regression analysis for five industries, namely fabricated metal, electronic, miscellaneous manufacturing, manufacturing of motor vehicles and industrial machinery.

Table 4. *Comparison of regression models for manufacturing strategies in considered countries*

Manufacturing strategy	Country	Forecasting practices	Std. Coef.	p-value*	R square**
ETO	Fabricated Metal	major aims of forecasting process	−0,338	0,026	0,166
		quantitative forecasting models	−0,352	0,021	
MTO	Fabricated Metal	quantitative forecasting models	−0,334	0,033	0,089
	Industrial machinery	quantitative forecasting models	0,109	0,010	0,383
	Electronic	quantitative forecasting models	−0,495	0,007	0,216
	Miscellaneous mfg	qualitative methods and data combined into forecasting	−0,508	0,028	0,405
		major aims of forecasting process	0,375	0,050	

Table 4. *Comparison of regression models for manufacturing strategies in considered countries –*
cont'd

Manufacturing strategy	Country	Forecasting practices	Std. Coef.	p-value*	R square**
ATO	Electronic	qualitative methods and data combined into forecasting	−0,461	0,007	0,350
		quantitative forecasting models	−0,465	0,006	
	Manufacture of motor vehicles	external data used in forecasting	0,475	0,086	0,161

* p-value ¡ 0,05
*∗ adj. R sq. significant at 0,05

There are four models predicting manufacturing to order strategy with an adj. R^2 ranging from roughly 0,09 to 0,41 indicated by the supply chains from fabricated metal, industrial machinery, electronic and miscellaneous manufacturing sectors, two models explaining assembly to order strategy with adj. R^2 of 0,35 and 0,16 reported by the supply chains from electronic and manufacturing of motor vehicles respectively. Finally, there is one model predicting engineer to order strategy with adj. R^2 of 0,17 indicated by the manufacturing companies from fabricated metal sector. It is also worth noting that the regression analysis developed for make to stock strategy showed models with no significant independent variable.

There are four significant models predicting make to order strategy demontrated by the supply chains from fabricated metal, industrial machinery, electronic and miscellaneous manufacturing sectors. The obtained results seem to be very coherent, as there is one and the same response variable explaining make to order strategy in three of four investigated sectors. The variables' quantitative forecasting models' is significant for fabricated metal, industrial machinery and electronic sector. However, as the value of a standardized regression coefficient is diverse, the variable may differently contribute to obtain a make to order strategy in the examined industries.

The positive value of a standardized regression coefficient for a response variable in the make to order model suggests that using quantitative time series models and casual models may contribute to implement a make to order strategy in industrial machinery sector. On the contrary, this factor does not seem to be important in the supply chains from fabricated metal and electronic industries, which report that the factor 'quantitative forecasting models' does not support application of make to order strategy.

The obtained results may suggest that there is no need to apply quantitative forecasting models to obtain a make to order strategy in electronic and fabricated metal sector. This may be due to many factors concerning both the internal characteristics of the supply chains as well as the external features of operating environment. For instance, the rapid changes observed in the market of electronic products may diminish the role of quantitative forecasting models. Also, inaccurate historical sales

data gathered by the supply chains from a fabricated metal industry may not provide a valuable basis for quantitative models used in a forecasting process. On the other hand, an institutional character of industrial machinery market make the quantitative models reasonable to use in the supply chains, as sophisticated and advanced tool in the process of sales planning.

The last significant model predicting make to order strategy is reported by the supply chains from miscellaneous manufacturing sector. There are two response variables which contribute to achieve the strategy, namely qualitative methods and data combined into forecasting, and major aims of forecasting process. The negative value of a regression coefficient suggests that qualitative methods and data combined into forecast does not support application of make to order strategy. On the other hand, a positive value of a standardized regression coefficient for major aims of forecasting process suggests that this factor contributes to a greater application of make to order strategy in the supply chains operating in miscellaneous manufacturing sector. At the same time, this may prove that an orderly arranged set of actions performed in a sales planning process, should start with definition of the goals in ivenstigated industry.

There are two significant models predicting assembly to order strategy demonstrated by the supply chains from electronic industry and manufacturing of motor vehicle.

There are two significant response variables predicting assembly to order strategy reported by the organizations operating in electronic sector, namely qualitative methods and data combined into forecasting and quantitative forecasting models. However, none of the factors contribute to obtain a strategy. Contrary, qualitative as well as quantitative forecasting models do not have a positive impact on application an assembly to order concept. It is a very interesting result as a large share of orders in electronic sector is made to stock and may require an application of diverse forecasting models. However, considering unstable demand and unanticipated changes in a volume and variety of sold electronic equipment, one may conclude that a forecasting is not an element of crucial imoprtance in a sales planning process.

The second model predicting assembly to order strategy is demonstrated by the supply chains manufacturing motor vehicles. The model indicates a positive value of a regression coefficient with one response variable considering external data used in a forecasting. This may suggest that indisputable domination of make to order strategy in the sector requires gathering and processing data from may different sources.

Finally, there is one model predicting engineer to order strategy reported by the supply chains from a fabricated metal industry. It is interesting to observe that the model indicates negative value of regression coefficients with two response variables, namely major aims of forecasting process and quantitative forecasting models. In this case, an engineer to order concept seems to be an ad hoc strategy emerging without any futher, appropriately structured plan. The sales planning practices might here be made in a response to the current market situation which, in practice, suggests implementing a purely pull approach operationally accomplished by an enigeer to order strategy. At the same time, the implementation of the strategy is not determined by the application of quantitative forecasting models. This is understandable, as a

flexible reaction achieved through an enigeer to order strategy requires a different approach from time consuming, stable and orderly executed actions.

6. Conclusions

The conducted study enabled to make a cross-sectoral comparison of the effect of sales planning practices on different types of manufacturing strategies. The obtained results seem to provide an adequate output to formulate the conclusions.

An empirical study revealed a four factoral structure of sales planning practices performed in supply chains of manufacturing companies, namely qualitative methods and data combined into forecasting, major aims of forecasting process, external data used in forecasting and quantitative forecasting models.

Simultaneously, the analysis confirmed that observed associations among sales planning practices and manufacturing strategies in supply chains are specific regarding industrial perspective. The producing companies operating in European, Asian and African supply chains report different contribution of sales planning practices to the specific manufacturing strategies. As the results indicated, differences are noticed among supply chain from industries representing a diverse level of application of a specific manufacturing strategy. It is interesting to observe that a prevailing share of orders in all examined sectors is made to customers' demand. The results also suggest that there is a diverse contribution of selected sales planning practices to achieve a specific manufacturing strategy in investigated supply chains. Among many obtained conclusions, one is specifically striking. The quantitative and qualitative forecasting models are not used as a primary instrument to obtain a specific investigated manufacturing strategy in the examined industries. Contrary, the forecasting models seem to serve a supportive role in sales planning practices. It is indicated by, frequently observed, a negative value of regression coefficients with the factors in manufacturing strategy models. On the other hand, it should also be highlighted that none of the make to stock model has been investigated and thoroughly examined. So, the minor role of forecasting may result from the analysis of pull oriented strategies in the study and the omission of make to stock concept. In the latter one, the dominating role of forecasting models is more important and, thus, might be much better noticeable and clearly indicated. In the light of considerations, it is difficult to definitely say if, indeed, the forecasting models act as a secondary instrument in applying all examined manufacturing strategies in supply chains operating in different sectors.

Finally, apart from an industrial perspective, the effect of sales planning practices on manufacturing strategies is definitely conditioned upon a number of internal and external factors connected to the technological issues, complexity of manufacturing process, types of products and general conditions of their storage, transport and packing, consumer demand and many other needing more in-depth analysis and extensive theoretical and empirical study.

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