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The impact of forecasting on operational performance: Mediation effects through flexibility enablers

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Abstract Literature has devoted increasing attention to the problem of supply and demand management in uncertain contexts. Only limited contributions, however, can be found regarding the interaction between forecasting and flexibility enablers to manage demand as well as regarding the flexibility enablers' effect on company performance. We will discuss the impacts of flexibility and forecasting on dynamic interactions. The aim of this work is to study the mediation effect of forecasting through flexibility enablers on company performance, i.e., customer satisfaction and cost efficiency. Our results provide evidence that the relationship between forecasting and customer satisfaction is mainly due to process flow management, while the relationship with cost efficiency is mainly due to layout.

Keywords Flexibility · Performance · Forecasting · GMRG

1 Introduction

Forecasting is well known in management to be a strong lever against uncertainty; thus, it has potential to contribute to better performance. In contrast to other uncertainty-hedging possibilities, such as inventory management and capacity management, forecasting is known to act as a direct lever against uncertainty. Therefore, forecasting can contribute to improving performance by directly impacting perceived uncertainty. Literature traditionally considers accuracy as the relevant performance to be evaluated in a forecasting process (Mentzer and Bienstock 1998; Chase 1999). When forecast accuracy increases, cost and delivery performance consequently improve, as they are typically correlated with forecast error. Inventory levels and thus related costs, can be reduced; manufacturing systems can be better managed as equipment utilization improves and companies can effectively plan actions to be undertaken in advance (Vollman et al. 1992; Ritzman and King 1993; Fisher and Raman 1996). In turn, manufacturing and production costs decrease. Delivery performance (e.g., order fulfillment and delivery speed/punctuality) also improves because when forecast accuracy is higher, it is more probable that products are available when the customer orders them (Enns 2002; Kalchschmidt et al. 2003).

In contrast, forecast inaccuracy causes major rescheduling and cost difficulties for manufacturing (Ebert and Lee 1995) and it may impact logistic performance such as delivery timeliness and quality (Kalchschmidt and Zotteri 2007). On one hand, it is not surprising that several surveys show accuracy as the most important criterion for selecting a forecasting approach (Dalrymple 1987; Mahmoud et al. 1988); on the other hand, this may explain why some authors have even recommended to eliminate forecasts entirely (Goddard 1989), especially when forecast accuracy is very difficult to achieve. Forecast accuracy, however, is not important per se, but is important for its impact on operational performance. However, in practice, this relationship is not entirely straightforward (Ritzman and King 1993; Reiner and Fichtinger 2009; Kerkkänen et al. 2009). This

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may be because flexibility somehow substitutes forecast accuracy by absorbing unseen demand, i.e., forecast errors (Zotteri and Kalchschmidt 2007).

Flexibility is commonly recognized as a key solution to the environmental uncertainty of demand and supply management. Flexibility has been widely studied at the manufacturing level (see, e.g., Slack 1987; Kara and Kayis 2004; Koste and Malhotra 1999 and Vokurka and O'Leary-Kelly 2000 for reviews); recently, there has been expansion of knowledge regarding supply chain flexibility (see Stevenson and Spring 2007, for a review). However, understanding the relations between flexibility and performance still presents open challenges. On one hand, evidence of the positive impact of flexibility on performance has been provided (e.g., Suarez et al. 1996; Das 2001; Jack and Raturi 2002; Hallgren and Olhager 2009); on the other hand, important knowledge required to understand clearly flexibility and the mechanism of its relationship with performance is still believed to be missing. One explanation for this gap is, of course, the complexity of the flexibility concept, which, for example, still lacks a consensual definition (Zhang et al. 2002).

Due to the broad and multidimensional aspect of the concept, numerous difficulties arise when attempting to encapsulate flexibility as a whole in a single construct. A method of resolving this issue is to focus on the practices and policies applied by a company that contributes to flexibility instead of seeking to quantify the flexibility itself. Factors that generate flexibility are found in literature under several names, such as flexibility enablers (e.g., More and Subash Babu 2008), internal determinants (e.g., Reichhart and Holweg 2007) and sources (e.g., Tachizawa and Thomsen 2007). For instance, lead time compression, based on practices such as setup time reduction, is an enabler of flexibility, as it is known to increase the capacity of coping with uncertainty in demand (Reiner and Trcka 2004).

Flexibility enablers constitute the internal flexibility of the system, which can be used to support the system's ability to achieve external flexibility with its environment (Upton 1994). This distinction between internal and external flexibility separates the capabilities of operations resources from the market requirements; they are thus considered as dual influences that need to be reconciled by operations strategy (Slack and Lewis 2002). Based on the latter, it can be summarized that some approaches or practices that are applied, constitute flexibility enablers to fulfill customer requirements and to increase customer satisfaction. Furthermore, these approaches also have an impact on cost efficiency. The total success (customer satisfaction and cost efficiency) of flexibility can only be evaluated by consideration of both aspects (Jammernegg and Reiner 2007).

The relationship between forecasting and flexibility enablers is evaluated in this work. Previous contributions have often considered these two issues as complementary. When forecasting is rather complex and accuracy is difficult to achieve, flexibility enablers become a powerful tool for improving performance (Goddard 1989). Instead of spending great efforts in trying to foresee what demand will be in the future, companies choose to increase their ability to react quicker and more efficiently to sudden variations in demand.

Conversely, when flexibility enablers are more difficult to extend (typically due to limited resources), companies have to rely more on forecasting capabilities to improve both cost efficiency and customer satisfaction. However, investments in flexibility enablers are often decided based on the expected forecast accuracy. For this reason, the relationship may be more complex, as interrelations may exist.

A good explanation of this complex relationship is provided by queuing models (see, e.g., Hopp and Spearman 2007). These models clearly show that waiting times rise with process time, average utilization and variability. We assume that the use of better techniques and information for forecasting will lead to higher forecast accuracy, reduced bias, etc. (see below) and will therefore lead to lower perceived uncertainty, which means that the processes (investments) perform better; i.e., reduced flow time will increase customer satisfaction.

2 Objectives and methodology

The aim of this work is to study the relationship among forecasting, flexibility enablers and operational performance. In particular, this work aims to analyze whether the impact of forecasting on performance is due to the mediating effect of flexibility enablers. To analyze this research question, we considered two different performance measures: cost efficiency and customer satisfaction. The analytical literature suggests that flexibility enablers and forecasting may affect both performance measures, although little empirical evidence can be found for these relationships. Previous works (see Danese and Kalchschmidt 2008, for a review) showed that the impact of forecasting on performance is due not only to accuracy but also to the forecasting management method itself. In fact, having a structured forecasting process may lead to a better understanding of the context (typically by means of more complex techniques) and to an unbiased forecast (typically obtained through the use of forecasting techniques).

We intended to study whether the relationship between the forecasting method (i.e., extent of investment in forecasting) and operational performance (i.e., cost efficiency and customer satisfaction) can be moderated by flexibility enablers. The theoretical model we considered is represented in Fig. 1.

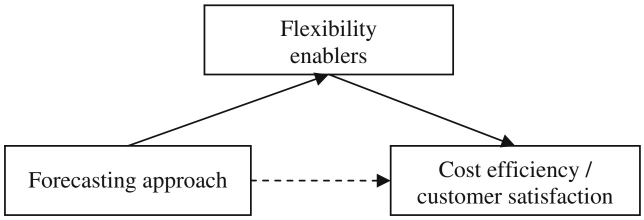

Fig. 1 The theoretical model

The empirical analysis was based on data collected from the 4th edition of the Global Manufacturing Research Group (GMRG) survey. The GMRG collects information on manufacturing practices in several countries. In particular, a specific questionnaire is designed and shared among researchers belonging to different countries. The questionnaire is translated back and forth by academics in each country and based on this tool, data is collected.[1] This data is centralized by the GMRG and shared with all data gatherers. Sampling is not random and we cannot assume that the data is representative of the country where data has been collected.

In the current data set, 330 companies were considered in six different countries (Austria, Hungary, Italy, Korea, Poland and Switzerland), all of which belong to the manufacturing and assembly industry.

Table 1 synthesizes the distribution of the sample in terms of size, while Table 2 shows the distribution among the different countries. The sample size shows several medium and large companies; some small companies are also represented in the data set. Table 3 provides information on the distribution of the sample with respect to the different industries.

With the aim of analyzing the aforementioned relationships, we first defined the proper items and constructs to measure the considered variables. Based on the GMRG database, we were able to collect information regarding the different variables. The reliability of the constructs was tested through confirmative factor analysis and reliability analysis. We then adopted Structural Equation Modelling to identify the moderation effects.

3 Empirical analysis

3.1 Variables definition

To define the different constructs, we applied a confirmative factor analysis based on the items that, according to current literature, should be influenced by these variables. All items were measured on a seven-point Likert scale, one being "not at all" and seven being "to a great extent".

[1] A copy of the questionnaire can be found at http://www.gmrg.org

Table 1 Distribution of the sample by size

Company size	Frequency
Small (less than 50 employees)	21.5%
Medium (50–250)	29.8%
Large (more than 250 employees)	48.7%

To evaluate flexibility enablers, we defined two separate constructs of the enablers of flexibility based on previous literature: the layout, or the organization of the plant and the production equipment in the dedicated process (Upton 1995), and process flow management, or the practices that aim to ease and speed the material flow. Because our goal is to study the impact of flexibility enablers on performance, theoretically, we should have considered flexibility performance. However, it is very difficult to identify flexibility performance that is strictly related to specific practices. For this reason, we decided to evaluate flexibility by means of practices, assuming that a relationship exists between what companies do (i.e., practices) and what they gain (i.e., performance), without involving flexibility.

The use of proper layout solutions can influence performance, either through the use of cellular manufacturing systems or by leveraging automation. Consistent with previous literature and to measure the extent of investment on layout, we considered the extent to which companies have invested in: (1) cellular manufacturing and (2) factory automation. The two items are correlated with each other (the Pearson Correlation index is 0.44 and significant at a 0.01 level). To measure the extent of investment on responsiveness, we considered the extent to which companies have invested in: (1) Just-In-Time activities, (2) manufacturing throughput time reduction, (3) setup time reduction and (4) Total Quality Management. The items are correlated with each other (all Pearson Correlation indexes are above 0.40 and significant at a 0.001 level). Thus, the construct layout and process flow management are defined by averaging the specific items.

We have assessed convergent validity and the one-dimensionality of the defined constructs with a confirmative factor analysis model. The literature recommends using a normed fit index (NFI) and a comparative fit index (CFI)

Table 2 Distribution of the sample by country

Country	Frequency
Austria	5.2%
Hungary	16.1%
Italy	16.4%
Korea	34.7%
Poland	17.3%
Switzerland	10.3%

Table 3 Distribution of the sample by industry

Industry description	US-SIC	Frequency
Food and kindred products	20	2.3%
Textile mill products	22	5.6%
Leather and leather products	31	0.9%
Lumber and wood products, except furniture	24	1.9%
Paper and allied products,	26	2.3%
Printing, publishing and allied industries	27	1.4%
Chemicals and allied products	28	2.3%
Rubber and miscellaneous plastics products	30	3.3%
Primary metal industries	33	0.5%
Fabricated metal products, except machinery and transportation equipment	34	18.1%
Industrial and commercial machinery and computer equipment	35	20.0%
Electronic and other electrical equipment and components, except computer equipment	36	12.6%
Measuring, analyzing and controlling instruments; photographic, medical and optical goods; watches and clocks	38	7.4%
Manufacture of motor vehicles, trailers and semi-trailers	37	8.4%
Furniture and fixtures	25	1.9%
Stone, clay, glass and concrete products	32	3.7%
Miscellaneous manufacturing industries	39	7.4%

together in assessing the model fit. NFI is 0.98 and CFI is 0.99, which means that the model is acceptable (Hu and Bentler 1999). In addition, the root mean square error of the approximation (RMSEA) is 0.05, which suggests that the model fit is acceptable. Factor loads are all significant and conform to the lower suggested value of 0.40 (Gefen et al. 2000). Cronbach's Alpha was also measured to verify the reliability of the constructs; constructs are considered reliable if the Alpha value is above the minimum requirement of 0.60 (Nunnally 1994).

To evaluate how forecasting is managed, we considered two different constructs: the use of structured forecasting techniques and information gathering.

The forecasting literature suggests the importance of relying on structured techniques to forecast demand (e.g., Armstrong 1983, 1984; Dalrymple 1987; Sanders and Manrodt 1994). Conforming with previous literature and to measure the adoption of structured techniques, we considered the extent to which companies use: (1) quantitative time series models (e.g., exponential smoothing) and (2) quantitative causal models (e.g., regression). The two items are correlated with each other (all Pearson Correlation indexes are above 0.40 and are significant at a 0.01 level).

Proper information gathering is also considered to be a relevant issue in improving forecasting accuracy (e.g., Davis and Mentzer 2007; Bartezzaghi et al. 1999). In line with what previous studies have shown, data on information used in the forecasting process have been collected regarding the extent to which data on the market evolution is used in forecasting. In particular, we considered the following sources of information: (1) current economic conditions, (2) customer sales plans and (3) market research. The four items are correlated with one another (all Pearson Correlation indexes are above 0.27 and are all significant at a 0.01 level).

Thus, the construct technique and information are defined by averaging the specific items. The NFI is 0.97 and the CFI is 0.99, which means that the model is acceptable. In addition, the RMSEA is 0.03, which suggests that the model fits well. Factor loads are all significant and Cronbach's Alpha value is above the minimum requirement of 0.60. In the case of information, the Alpha value is 0.531, which is not extremely high; however, we can consider it reliable because the correlation between the items is significant.

Overall, cost efficiency and customer satisfaction should be considered. Regarding cost efficiency, three items were examined. We asked respondents to provide an evaluation of their performance as compared with their competitors in the following categories, on a seven-point Likert scale (one being "far worse than" and seven being "far better than"): (1) direct manufacturing costs, (2) total product costs, and (3) raw material costs. Regarding customer satisfaction, a similar question was asked for the following: (1) product quality, (2) delivery speed and (3) delivery-as-promised. It can be noted that, as it is difficult to compare performance among companies operating within different contexts, this research focuses on perceptual and relative measures of cost and delivery performance. Thus, the constructs of cost efficiency and customer satisfaction are defined by averaging the specific items. The NFI is 0.99 and the CFI is 1.00, which means that the model is acceptable. In addition, the RMSEA is 0.00, which suggests that the model fits well. The factor loads are all significant and Cronbach's Alpha value is significantly above the minimum requirement of 0.60. Table 4 summarizes the aforementioned information on construct definitions and reliability statistics.

When dealing with the survey data, common method bias (CMB) can affect the statistical results. As suggested by Podsakoff et al. (2003), we checked for this problem by means of confirmatory factor analyses (CFA) on competing models that increase in complexity (Podsakoff et al. 2003). If method variance is a significant problem, a simple one (e.g., a single-factor model) should fit the data as well as a more complex model (in this case, a six-factor model). The hypothesized model containing six factors gave a better fit of the data than did the simple model (one-factor model: CFI of 0.56 and RMSEA of 0.13; six-factor model: CFI of 0.97

Table 4 Construct definition and reliability statistics

Construct[a]	Items[b]
Layout (0.600)	Investment in: • Cellular manufacturing (0.75) • Factory automation (0.54)
Process (0.790)	Investment in: • Just-in-time (0.629) • Manufacturing throughput time reduction (0.757) • Setup time reduction (0.769) • Total quality management (0.639)
Technique (0.672)	Extent to which companies use: • Quantitative time series models (0.962) • Quantitative causal models (0.533)
Information (0.531)	Extent to which companies use: • Information on current economic conditions (0.455) • Customers' sales plans (0.480) • Market research (0.662)
Cost efficiency (0.828)	Relative to competitor performance regarding: • Direct manufacturing costs (0.862) • Total product costs (0.875) • Raw material costs (0.636)
Customer satisfaction (0.743)	Relative to competitor performance regarding: • Product quality (0.424) • Delivery speed (0.846) • Delivery as promised (0.884)

[a] Cronbach's Alpha value is reported in brackets. [b] Factor loads are provided in brackets

and RMSEA of 0.04). Furthermore, the improved fit of the six-factor model over the simple model was statistically significant: the change in χ^2 was 1117.50, and the change in *df* was 15 (p<.001). Thus, the CMB does not appear to be important in our analysis.

Previous works using the previous versions of the same dataset have found no significant impact of country and industry on the considered variables, thus we have omitted specific analyses on these variables (see Wacker and Sprague 1998; Danese and Kalchschmidt 2008).

3.2 Statistical analysis

To study the mediation effect, we adopted a Structural Equation Modelling (for a review on mediation and moderation, we refer to Little et al. 2007). To verify that a mediation effect exists in a relationship between two variables X and Y through a third variable M, the necessary conditions are that: i) X is significantly related to M, ii) M is significantly related to Y, and iii) the relationship between X and Y diminishes when M is in the model. We may then have four different situations:

1) Full mediation: when M is added to the model, the direct relationship between X and Y is not significant and all other relationships are significant;
2) Partial mediation: when M is added to the model, the direct relationship between X and Y is still significant, but all other relationships are also significant;
3) Inconsistent mediation: when M is added to the model, the direct relationship between X and Y is significant but with the opposite sign of the estimate, while all other relationships are significant;
4) No mediation: when M is added to the model, the direct relationship between X and Y is significant and at least one of the other relationships is not significant.

Given our objectives, we built eight different structural equation models (all combinations of the two considered performance measures, the two considered forecasting variables and the two considered flexibility enablers). For each model, we proceeded as follows:

1) Verify a correlation between the mediating variables and both forecasting and performance variables;
2) Build the direct relationship model between the forecasting variable and performance to determine the existence of a direct relationship;
3) Add the mediating variable to the model to identify the type of mediation

The results of these analyses are synthesized in Tables 5 and 6. Table 5 provides correlation analyses among the

Table 5 Correlation analysis for the variables (all correlations are significant with $p<0.05$)

	Layout	Process	Cost efficiency	Customer satisfaction
Technique	0.464	0.531	0.210	0.280
Information	0.374	0.422	0.341	0.288
Layout			0.454	0.257
Process			0.331	0.334

variables to verify the necessary conditions for mediation; Table 6 analyses the mediation effects; in particular, for each mediating model, we provided the type of mediation effect and an evaluation of both the direct and the indirect effect. In the dataset, some data are missing; thus, the number of companies changes according to the available data. Table 6 also provides the number of companies available for each analysis. Mediation effects were also tested by means of the Wald statistic (Little et al. 2007).

Table 5 shows that both forecasting variables and flexibility enablers are correlated to operational performance. This result is consistent with the previous literature (Suarez et al. 1996; Das 2001; Jack and Raturi 2002; Hallgren and Olhager 2009). The correlation analysis also provides evidence that necessary conditions for the mediation effects apply: in fact, both forecasting and performance variables are correlated with flexibility enablers, thereby allowing us to study in detail the mediation effects that are summarized in Table 6.

All of the models appear to be reliable and properly fit (all model fit metrics are acceptable). Table 6 shows that several mediation effects occur between the variables. In particular, the layout fully mediates the relationship that both the forecasting technique and the information have with cost efficiency. Process flow management also significantly mediates the relationship with both variables and customer satisfaction. We also identified that layout is not mediating the impact of forecasting techniques on customer satisfaction and that only a partial mediation effect is found between information and operational performance. In the next section, we discuss these results in greater detail.

4 Conclusions

This paper provides interesting results regarding the interaction among forecasting, flexibility enablers and performance (cost efficiency and customer satisfaction).

Forecasting has a significant impact on customer satisfaction (the correlation is significant). This result may appear trivial given the large amount of literature devoted to forecasting; however, we argue that strengthening the result obtained from this sample is important for managers because it proves that attention should be devoted to this topic. Understanding how this impact occurs is certainly more challenging. In fact, our analyses lead us to better understand this relationship

First of all, we provide evidence that there is no mediating effect of layout on customer satisfaction. This means that better forecasting has no impact on customer satisfaction due to the better use of layout as a flexibility enabler. Thus, the use of layout as a flexibility enabler does not "translate" better forecasting into better performance. Moreover, the direct effects are high as compared to the total effects (0.269 as compared to 0.330 for technique and 0.199 as compared to 0.271 for information).

Secondly, there is a strong mediating effect of process flow management on customer satisfaction, meaning that

Table 6 Results of mediation analyses (mediation type: FM—Full Mediation, PM—Partial Mediation, NM—No Mediation, IM—Inconsistent Mediation)

Forecasting variable	Mediation variable	Performance variable	Mediation type	Direct effect	Indirect effect	Total effect	n.
Technique	Layout	Cost efficiency	FM	−0.009	0.214	0.204	307
Technique	Process	Cost efficiency	FM	0.058	0.152	0.210	300
Technique	Layout	Customer satisfaction	NM	0.269	0.061	0.330	258
Technique	Process	Customer satisfaction	FM	0.143	0.137	0.280	254
Information	Layout	Cost efficiency	FM	0.139	0.153	0.292	304
Information	Process	Cost efficiency	PM	0.276	0.106	0.383	298
Information	Layout	Customer satisfaction	PM	0.199	0.072	0.271	256
Information	Process	Customer satisfaction	FM	0.180	0.108	0.288	253

All mediation effects are significant with $p<0.05$ (This is true except for the case of the layout mediation effect on the relationship between techniques and customer satisfaction, where no mediation occurs). Standardized effects are also provided. The number of companies considered in all analyses is provided. (NFI >0.93; CFI >0.95; RMSEA <0.06) when companies make a better forecast, it results in better process flow management and leads to better customer satisfaction. Thus, process flow management explains part of this relationship. Quite interestingly, however, the direct effects are still high (0.143 as compared to 0.280 for technique and 0.180 as compared to 0.288 for information). Thus, there are additional causes of this relationship, which should be analyzed further.

Forecasting has also a significant impact on cost efficiency (the correlation is significant). Again, we argue that this result is relevant for companies because this relationship applies (at least in our sample), regardless of the industry or country studied. We now understand how this effect occurs.

First of all, there is a strong mediating effect of layout on cost efficiency. This means that better forecasting has an impact on cost efficiency due to the better use of layout as a flexibility enabler. In fact, direct effects are irrelevant as compared to the total effects (−0.009 as compared to 0.204 for technique and 0.139 as compared to 0.292 for information). Thus, the layout explains a great deal of this relationship.

Secondly, the mediating effect of process flow management on cost efficiency is not fully consistent. In fact, the relationship between forecasting techniques and cost efficiency is fully explained by process flow management (the direct effects are low: 0.058 as compared to 0.210). However, this is not true for information, where a partial mediating effect occurs (in fact, direct effects are high: 0.276 as compared to 0.383). Thus, there are additional causes of this relationship and the forecasting method is more complex than it appears. Further research should analyze this relationship in greater detail. A structured summary of these findings is presented in Table 7.

In general, it appears that the relationship between forecasting and customer satisfaction is mainly due to process flow management, while the relationship with cost efficiency is mainly due to layout. These results provide interesting evidence for both researchers and practitioners. Research on the impact of forecasting on performance has not devoted much attention to the reasons behind the strength of this relationship. Thus, this work provides some details on the causality of this relationship; however, this should be investigated further.

This study also provides companies with a better explanation of how to improve their performance through forecasting. From a managerial perspective, we argue that situations, in which a full mediation effect is found, are interesting because they explain how improvements (at least within the specificity of this study) occur. From another point of view, the partial mediated relationships offer interesting indications. Specifically, information use within forecasting only partially contributes to better performance but it significantly supports companies in being more flexible. In fact, the availability of additional information helps the actors involved in a specific process to make prompt decisions and align different units that manage each separate part of the production process. Improved forecasting, without related process or layout modification, provides only limited performance improvement, i.e. increased cost efficiency as well as customer satisfaction.

The results also allow us to provide companies with some suggestions on how to increase specific performance measures. In fact, we found that companies wanting to improve cost efficiency and customer satisfaction should focus on forecasting performance. Moreover, companies that consider cost efficiency critical or that are seeking improvements in cost efficiency should strongly focus on layout (i.e., factory automation). The positive impact of greater forecasting accuracy is reflected directly in cost efficiency via investments in the factory layout, making investments in this area critical.

Furthermore, for companies looking for better customer satisfaction, managing the process flow in a better manner seems to also be important because, again, forecast accuracy directly reflects on better process management and implies improvements in this performance.

Table 7 Summary and implications of the mediation analyses results

Performance variable	Mediation variable	Mediation strength	Implications
Cost efficiency	Layout	Strong	• Relationship between forecasting and cost efficiency is mainly due to layout
	Process	Inconsistent	• Mediating effect of process flow management on cost efficiency is not fully consistent, i.e., technique and information are not sufficient to characterize forecasting and further research is needed to understand this relationship.
Customer satisfaction	Layout	None	• No mediating effect of layout on customer satisfaction, i.e., better forecasting has no impact on customer satisfaction due to the better use of layout as a flexibility enabler.
	Process	Strong	• Relationship between forecasting and customer satisfaction is mainly due to process flow management.

This paper thus highlights that according to the performance factors that companies want to improve (and thus their strategic goals), companies should also invest in specific areas of manufacturing (here, process flow management and layout).

Overall, we are aware of several limitations of this work and would like to highlight some of them. First, we did not specifically consider any contingent factor that may influence the different variables and relationships described herein. Future works should focus on factors that may change how variables are defined. We argue that general results will not be drastically affected by these variables because, among other reasons, several degrees of freedom are left to companies regarding how they can impact flexibility enablers, i.e., by selecting which practices they can adopt. At any rate, future studies should compare results among companies belonging to different countries or characterized by different sizes. Secondly, we did not evaluate the impact of strategic objectives on the relationships considered here; in particular, we identified some effects on performance, but internal processes (i.e., forecasting and flexibility enablers) are strongly affected by companies' goals. In the future, this issue should be considered in greater detail. Thirdly, we devoted attention to only two specific flexibility enablers (i.e., process flow management and layout). Several other enablers could have been considered (i.e., information, slack allocation). Future studies will consider more practices so as to extend and (hopefully) more completely define the relationships under investigation. Overall, while our sample is rather numerous, we are conscious that some results may be affected by the specific companies that we have considered, given our research objectives and our model. Thus, future research should replicate these analyses on different datasets, eventually with focus to specific industries.

Lastly, a final limitation is related to the data used to conduct the empirical analysis. The GMRG questionnaire is not designed specifically to study this topic but includes several topics, thus the information collected on flexibility enablers and forecasting process is limited. Besides, the data sampling is not random but should be considered a convenience sample by country.

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