Are companies taking advantage of joint decision in the production planning?

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Abstract

Companies have put a lot of attention to integrate the supply chain. They are using their resources to pursue the integration with their supplier and client, but they have forgotten the internal integration. In this work, we discussed in detail the results of a questionnaire of production planning and deeper interviews with production planning practitioners. In particular, we investigated the decision-making process related to internal planning, operation scheduling, and production activity control at shop floor level. We conclude that there is a lack of integration of the decision-making process with the consequence of lost synergies and possible knowledge sharing.

Keywords: Production planning, Joint decision, Scheduling

Introduction

There is a substantial scientific and nonscientific literature on supply chain collaboration and management and supply chain integration. The literature highlights the advantages of this integration; successful cases are reported in the different industries, such as manufacturing and automotive (Landry, 1998; Akintoye et al., 2009). Some researchers, such as de Souza and Ledur (2011), have empirically confirmed a positive relationship between supply chain management and operational performance; they assume that creating alliances with members of the same chain improves its competitive advantage, reflected by superior performance of all members.

Unexpectedly, the results obtained in the global survey of supply chain highlight that "supply chain managers often perceive that their companies are more accomplished in external integration efforts than they are in internal efforts" (Poirier et al., 2008).

Despite the news and papers about the use of IT decision systems in enterprises that control each area of the companies and all the integration theories, we want to investigate the current degree of integration of the different departments at the shop level.

The aim of this study is to measure the internal integration in the production planning area. Using a survey among production planning professionals in one leading industrial

group in aerospace, defense, and security, we evaluate the degree of integration in the different parts of the company.

The aim of this study is to analyse and measure the internal integration in the production planning area. Using a survey among production planning professionals in different companies of different sector such as electronic, aerospace, defence, and manufacturing,

Frohlich and Westbrook (2001) measure the integration of the supply chain using arcs of integration, and eleven years later (Schoenherr and Swink, 2012), continue this study recognizing internal integration as the strength of the relationship between outward arcs and other performance indicators.

Pagell (2004) developed a model of the drivers for the internal integration; he claims that a better integration fosters the strength and competencies of the firm. He highlights the structure and the measurements and rewards cross-functional teams, job rotations, top management support, information technology, and communications as drivers for performance.

Internal integration is the missing link in establishing how visibility affects the responsiveness of the supply chain. Accurate, timely, and complete information is not enough if there is a lack of internal integration (Williams et al., 2013).

Additionally, there is a discussion on the use of IT in different areas such as inventory, where Mishra et al. (2013) found evidence that firms' IT capabilities have significant positive effects on their inventory efficiency.

However, there is a lack of information about specific types of integration in the production planning area. We want to research on the integration of the production planning through a survey to know the current integration degree of the industry (Williams et al., 2013).

Finally, an increase in the awareness of key structural decision in internal integration facilitates external the integration with customers and suppliers (Langowitz, 1988; Millson et al., 1992)

The remainder of the paper is organized as follows: objective, methodology, questionnaire design, data analysis, results, and conclusion, followed by the references and appendix.

Objective

Integration should occur between internal and external functions. Inside the organization, the different departments should work together. The focus is on the internal planning process. In particular, the survey investigated the decision-making processes related to internal planning, operations scheduling, and production activity control at the shop floor level (be it a job shop/parts manufacturing or assembly department).

Several studies have revealed that some companies fail despite that the different departments are achieving their objectives because of a "silo view" and make decision in complete isolation without considering other departments' opinions (Capasso and Dagnino, 2012). We want to know if the decision makers in the different stages, share the same department or person.

A study of the complexity of the organizations performed by Malhotra and Mackelprang (2012) warns us that the complexity of the organization is continually increasing. The matter that obtains an advantage of an integrated supply chain is more complex than the research expected.

Preposition 1. *It is possible measure the misalignment between the perception of the integration of the supply chain and the integration degree calculated using the drivers proposed by Pagell (2004).*

Preposition 2*: Group orientation could explain better the relationship with the production planning performance process.*

Methodology:

The methodology used for this research was a survey, following the steps proposed by Forza (2002), which could be summarized as follows: link to the theoretical level, design, pilot-test, collect data for theory testing, analyze the data, and conclude.

One definition of *internal integration* is proposed by Zhao (2011) as "the degree to which a firm can structure its organizational practices, procedures and behaviors into collaborative, synchronized and manageable process." In addition, it includes the use of data and information system, real-time data, integration of the different activities, and cross-functional cooperation. Finally, internal integration identifies that the company should not act as functional silos but as an integrated process.

From the main drivers that are proposed by Pagell (2004), we focus on the structure, the measurements and rewards, job rotations, information technology, and communications as drivers for performance in order to measure the degree of integration of production planning and to get further knowledge of the integration of the schedule of production, inventory, and replenishment.

Past studies (Swamidass and Newell, 1987) has described the difficulty to obtain financial measure, despite the additional difficult to isolate the plant from the others departments and business units, although is preferable obtain objectives measure this are difficult to compare in different sectors, and production structure, then we decide to ask for perceptual measurements of managerial performance.

To study the internal integration degree, we decided to give questionnaires to production planner specialists regarding their perception of the production planning process and its degree of integration.

Questionnaire design

To collect the data, a semistructured questionnaire was developed that contained open-ended and closed-ended questions. The questionnaire survey looks at the production planning specialists in different plants (we define *production plant* as the unit of analysis in order to make a better comparison for different-size plants) and, in some cases, compares the results from among plants from the same company.

We ran a pre-test using a company with several plants; the comments received from the pre-tester helped us modify the scales and questions.

The questionnaire, accompanied by a cover letter, was sent through two methods: e-mail and LinkedIn. In the first one, we emailed different companies and then asked to forward to the production planning responsible. The second and most successful was through LinkedIn, we look for groups of professional of production planning practitioners, and we found mainly two groups APICS and POMS. We sent a personal small message invited them to participate in the study. We obtained 72 answers, 56 valid entries, and 16 invalid entries since they did not complete the questionnaire.

This research was considered exploratory. The questionnaire was designed to be answered between 15 and 20 minutes. It consists of 23 questions, with a majority of multiple-choice questions and Likert scales, and with 4 long open questions.

Three versions of the questionnaire (English, Italian, and Spanish) were done to facilitate the answers of the respondents, especially for the open questions. The web-based survey tool Typeform© was used. Some scales are inspired from Koste et al. (2004) to capture some flexibility attributes.

Respondents were asked to describe their decision-making and planning algorithms or software that they use, with respect to the following:

- Characteristics of their production plant (size, workers, and clients)
- Resources scheduled/planned (machines, work centers, and production lines)
- Degree of integration and performance
- Constraints taken into account
- Inputs of the planning process
- Outputs and goals

Data analysis

Before to start with the analysis, a clean of the data was done, we eliminated 16 incomplete answers and an open question since the majority of the answers were extremely simply.

We coded the multiple option questions scale following the next equivalences- For Job rotation was assigned a zero if it is not allowed up to 5 points if it is strongly advised. It is interesting highlight that only two respondents answered that was strongly recommended, despite of many rotation ideas, it is not widely implemented in the companies.

The philosophy we assigned 0, 1, or 2. Since LEAN, JIT, TOC persuade the integration we assigned two points if they mention it. 1 point for any other and if no philosophy or they do not know it 0 point. The inventory scale, we assigned 0 points, if they do not track. 1 point if they do it manually. 2 point if they do it automatically.

For Goals, if they are based on single performance we assigned the minimum of 1, as they include more areas we rate up to 5 for the entire company. For the use of IT/Optimization software, we assign 0, 1 or 2 points according with the given software.

The most difficult part to integrate to the integration index was the open question since the transformation from text to a numeric value is always subjective. The open question asked about the schedule, replenishment, inventory, and exception management. We assigned one point for the index for each part of the description of the decision-making process that took into consideration something that was not from this area (e.g., for the replenishment, if they answered constraints related to scheduling or production, they got an integration point.

The maximum assigned points was 5. We limit the assign to 5 mentions per type of answer, since a long answer has more chances to mention other items, the size of the answers varies a lot, answer shorter that 100 characters was discarded (10 were eliminated). The rest of the scales were rated on a five-point Likert scale.

Data analysis were undertaken taken using the functional language and environment to statistics STATA© and R© 3.0.2. using RStudio© v0.98.

Table 1 contains the composition of the sample based the size of the production capacity, sectors, and the production structure. The sample is composed from different sectors with a highlight in the Automotive and car component sector; the companies with

more than 50 employees in the production facility represent more than 50% of the sampling. Finally, the production structure is more represented by the Job shop but all the production structure are represented with at least 17%.

In order to underlying the factors that explain these results, ant test our first preposition, we perform an exploratory factor analysis. The eigenvalues of the first 4 factors was 4.59, 1.12, 1.05, and 0.78. We decide to accept the first three components using the typical threshold of 1. The three first eigenvalues explain the 75.3% of the variation. Acceptable values of the Cronbach alpha test were obtained (0.6774). In the Figure 1 we plot the factors of the loadings.

Table 1 - Sample statistics

Employees

	Frequency	Percent	Valid Percent	Cumulative Percent
< 010 employees	14	25,0	25,0	25,0
< 050 employees	11	19,0	19,0	44,0
< 250 employees	20	35,0	35,0	80,0
> 250 employees	11	19,0	19,0	100,0
Total	56	100,0	100,0	

Sector

	Frequency	Percent	Valid Percent	Cumulative Percent
Automotive / Components	18	32,0	32,0	32,0
Defense	5	8,0	8,0	41,1
Electric	3	5,0	5,0	46,0
Electronics	8	14,0	14,0	60,0
Energy	3	5,0	5,0	66,1
Food and Beverage	7	12,0	12,0	78,0
Manufacturing	3	5,0	5,0	83,0
Personal Care	5	8,0	8,0	92,0
Telecom	4	7,0	7,0	100,0
Total	56	100,0	100,0	

Structure

	Frequency	Percent	Valid Percent	Cumulative Percent
Assembly line / Repetitive (semicontinuous, high volume)	14	25,0	25,0	25,0
Batch processing (moderate volume and variety)	15	26,0	26,0	51,0
Job shop (small lots, low volume, general equipment)	17	30,0	30,0	82,0
Projects (Non routine jobs)	10	17,0	17,0	100,0

Total	56	100,0	100,0

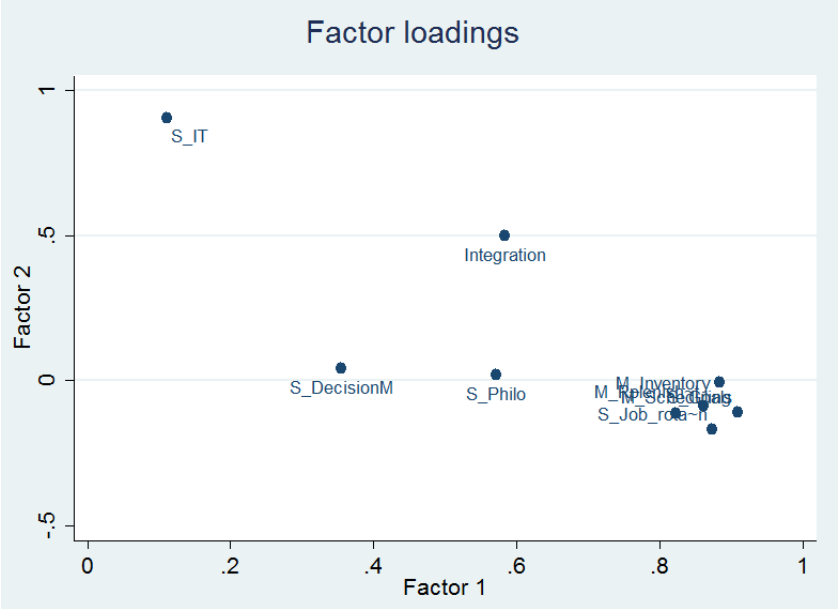

Figure 1. Plot of the Factor loading

Factor 1 explains the majority variables related with the measure of the internal integration, factor 2 explain mainly the use of It and the perceive integration, and the factor 3, the decision maker.

Table 2. Factor loadings and unique variance

Variable	Factor1	Factor2	Factor3	Uniqueness
Score in Goals	0.909	-0.108	0.050	0.160
Mention of Inventory	0.884	-0.008	0.049	0.215
Score in Job rotation	0.873	-0.166	0.041	0.208
Mention of replenishment	0.862	-0.087	0.028	0.249
Mention of Scheduling	0.822	-0.111	0.058	0.308
Perceived Integration	0.584	0.498	-0.220	0.362
Score in Philosophies	0.572	0.019	-0.622	0.286
Decision Maker	0.354	0.041	0.773	0.275
Score in IT	0.111	0.903	0.123	0.158

It is interesting that the IT and the perceived integration are explained in Factor 2 instead of factor 1, this give us the idea that the use of and IT is correlated with the perception of the integration.

The pairwise correlation, in line with this result in the covariance analysis presented in Table 3, present the highest covariance for IT with the perceived integration with 0.25. The goals and the different mentions of the replenishment, scheduling, and integration maintain a high covariance with more than 0.7.

The points for the decision maker keep a low correlation with the rest of the variables, consequently the third factor explain mainly this item.

Table 3. Pairwise correlations

	S IT	M Sc	M Rep	M Inv	S Job	S Phi	D Mak	S Goal	P Int
Score in IT	1.00								
Mention of Scheduling	0.01	1.00							
Mention of replenishment	0.12	0.69	1.00						
Mention of Inventory	0.12	0.64	0.72	1.00					
Score in Job rotation	0.01	0.66	0.76	0.79	1.00				
Score in Philosophy	-0.03	0.38	0.40	0.44	0.42	1.00			
Decision Makers	0.04	0.28	0.21	0.29	0.27	-0.03	1.00		
Score in Goals	0.02	0.72	0.80	0.79	0.77	0.43	0.30	1.00	
Perceived Integration	0.26	0.42	0.33	0.44	0.35	0.46	0.19	0.46	1.00

Result and discussion

To test our second preposition, that according with Kaufmann and Carter (2006) is related with the performance. The data were cluster –analyzed using principal component analysis. We use the k-mean clustering technique using a Euclidean distance, the number of groups selected was 3, despite the proposed limit by Lehman(1979) to be limited between n/30 and n/60. Since a 2 groups oversimplify the explanation and a bigger one give us few elements in each group.

The clusters were tested using one way ANOVA test, and Scheffe test, to analyze the similarities among the groups. The results are presented in the Table 3 and Table 4. The Scheffe test with a significance of 0.036 allow us to reject the hypostasis that the means for the performance are equal.

Table 4. Summary of the one way ANOVA test with Performance

Cluster	Mean	Std. Dev	Freq
1 (Misaligned)	3.375	0.875	24
2 (Low integrated)	3.563	0.814	16
3 (Highly integrated)	4.063	0.68	16
Total	3.625	0.843	56

Table 5. Analysis of Variance

Source	Sum of S	df	MS	F	Significance
Between groups	4.625	2	2.31	3.55	0.036
Within groups	34.5	53	0.651		
Total	39.125	55	0.711		

Cluster 1: Misaligned

This cluster of 24 units is the most numerous of the three clusters with a 42.8% of the population. This is the most interesting cluster since, the majority claim an integration but they do not encourage the main drivers of the integration, such as personal rotation, they give incentives mainly in personal performance, in the open questions they do not

mention any concept of other areas, in the majority of the case they use software. They perceive a medium performance of the production planning process. This opens an interesting question about if there is also a misperception of the performance or they are achieving averaged. Unfortunately, with the information collect we cannot triangulate the information to answer this.

Cluster 2: Low Integrated
This cluster of 16 units, representing about 28.6% of the cases. They have the lowest average in performance, and a low integration level. They do not encourage the integration of the areas with rotation of personal, the decision makers take the decision in insolation, and in the analysis of the open questions hardly mention any item that there is no typically for this area. They almost no use any IT. The majority of the incentives goals are for single or equip performance.

Cluster 3: High Integrated
The third cluster account for the remaining 28.6% with 16 units. They perceived themselves as an integrated companies and obtain the highest score in the performance. They are consistent encouraging the rotation of personal, in the open question they mention concepts from other areas, they use software, they have their incentives base on company and team performance. They perceive a high performance of the production planning process.

We assume than one of the main influencer in the perception of the integration was the use of information systems (IS) or information technologies (IT), we run a correlation analysis between this two variables and we find a strong correlation. However many authors such as (Gunasekaran and Ngai, 2004) have state that IS by itself it is not enough to guarantee the integral integration of the supply chain. But, it is impossible have it without an IS system. Then we could say that IT is necessary but not sufficient.

Summarizing
For the Preposition 1, after test the first component of the Factor analysis that we could name as an integration index we could realize that exist a correlation but not as high as we expected, mainly explained by the second component that we could explain for problem of a misperception.

For the Preposition 2, we model before and after the clustering. We get a linear model to explain the Performance, but the result was poor, as they are showed in the next table. But after the cluster the correlation improves for the groups Low integrated and High integrated that they have a performance related with the integration as the theory suggest. But for the misaligned depend of which integration we use, the perceived or the calculated indirectly.

OpCos under the same Company.
From our sample, we get ten companies which belong to two group. Despite that for the number of respondents we cannot get any statistical analysis, we could obtain some interesting insights, that will be analyzed in the next part of this research. The first interesting part that was our initial assumption was that the Operational Companies (OpCos) from the same group will behave in the same way.

The only question that was answer preaty similar was the how the goals are defined, that at least for all the OpCos of the company are common. For the philosophies that they

claim to implement they answer with different theories, that despite that could be similar like Lean or JIT are not the same. A detailed analysis of the open question, we realize that the answer as far from each other as any other company of the same cluster.

There are potential synergies that may be realized by combining or standardizing activities such as R&D, manufacturing, purchasing or distribution. (Dessein et al, 2010).

Other possible problems caused loose of synergies is the lack of knowledge sharing, since the best practice are not spread around the group. Or if the knowledge is spread is difficult to spread because of the lack of standardization.

Conclusions

The analysis of the open question gave us interesting results that went beyond the score that we assigned. We got a better knowledge of the integration level; some plants claim a higher integration, but they do not take into consideration other decision factors outside their area, in other words, they continue with the silo view.

In order to get a better understanding of the results obtained through the survey, we performed some face-to-face interviews to enrich the perception and get a deeper vision than what we got from tables and matrix.

With one of the plants further interviewed, we realize that they have reported that they have an IT software, lean philosophy, and they claimed to be integrated, but the interesting fact was that when they explained their decision making, they only reported constraints and variables of the department; they are still pursuing the excellence of their operating silos, not the overall performance. The biggest problem is that they have the perception of integration.

It is very interesting when we have multiple answers from the same company that there is a misalignment in the internal planning process and decision-making activities in all the operation companies (OpCos) of the group. We expected that the same decision pattern was kept among the group. We realized that at a group level, there is no clear and unifying vision of how the internal planning process should be taken. We suggest that the contribution of all internal companies could help devise a similar map that would help the sharing of knowledge and good practices.

A great opportunity area is to try to get more information from the IT / Optimizer used and in which information contains. Unfortunately, many answer are proprietary system, or even the one that use a specific software like SAS© they do not detail which modules they use, and then it was impossible to give a better score for the use of IT. Other opportunity area is the open question, which give us really valuable information for a deeper analysis of the decision making process of the different companies, a content analysis or data mining techniques could help us to extract more information.

The main limitation is the sample size, which does not allow to examine if this behavior depend of the geographic localization of the plant, or production system (ATO, MTO or MTS) since we do not have enough data of each subgroup to make a proper analysis.

In the next stage of this research we are planning to launch a second wave of request of survey to get a larger sample in order to generalize this conclusion to different sectors, countries and production topologies. Them , the next step of this research is conduct the studio in more companies to identify different patterns such as measure the integration level in the different sectors or geographic locations. Creating a bigger database of different will allows to obtain many managerial insights. An immediately feedback tool base on other results will increase the response rate.

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