TOOLS AND ANALYSIS OF KEY SUCCESS FACTORS FOR MECHANIZED FOREST CONTRACTORS SPECIALIZING IN MECHANIZED HARVESTING, IN THE AQUITAINE REGION

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Abstract: *the factors which contribute to sustain and develop the companies are of great importance for the forest contractors who have invested in expensive machines such as harvesters, forwarders… In order to identify these key success factors, from 2008 to 2010, FCBA carried out a project in Aquitaine (south-western part of France).*
The first step of this project was to examine the economic data of a sample of 83 forest contractors specializing in harvesting. With 3 to 4 financial years per company, 278 accounting years were analyzed, with a dataset of 34 values per year and per company. 9 groups of firms were statistically defined taking into account their economic results and their size. With the Data Envelopment Analysis method (DEA), we determined also the economic efficiency of each company.
Then 42 entrepreneurs, among these 83 companies, have been interviewed with 60 yes/no questions and other open-ended questions, in order to precise the way they manage their company. 6 topics were detailed: (i) financial and (ii) work force management, (iii) production, (iv) machine availability, (v) quality and customer satisfaction, (vi) safety, health and environment. For each theme, the companies were ranked from 1 (basic level of management) to 5 (very high level), in relation with their answers. The analysis showed 6 different kinds of company depending on their level of global management.
Finally, by crossing the results of the 2 previous investigations, we tried to highlight some key success factors. But the link between the management classification and the previous one concerning the economic results are not so clear. The human factor and the socio-economic environment of the companies are in fact determining parameters. From the results, the last step was to define with the forest contractors some action plans in order to enhance their management and their economic efficiency.

1. Introduction

FCBA, technical institute resulting from the merger in 2007 of AFOCEL and CTBA, has been carrying out for many years research and development projects in order to measure and improve the performance of logging companies. For instance, recent works relate to mechanized harvesting systems for

broadleaved trees (Cacot and al., 2006), the use of synthetic rope for skidding (Villette and Cacot, 2008), but concern also the ergonomic evaluation and improvement of workers in logging companies, with the participation in European projects named ERGOWOOD and COMFOR (Bigot, 2010).

Beyond purely technical aspects concerning mechanization and organization of logging sites, the management and organization of the companies (accounting, customer relationship, human resources management…) are of importance to explain their performance and efficiency. Canadians and Americans were interested from the '90s in this problem by developing tools to measure and monitor these parameters (Lebel, 1996). In collaboration with the Canadian team Prefort (Research Program on Transport and Harvesting Forest Contractors), FCBA used in 2005, for the first time in France, these tools to analyze the performance of a dozen forest contractors specializing in forwarding (Bigot and Lebel, 2005).

In 2009-2010, we implemented this analysis method on a greater scale in order to identify objectively the key success factors (KSF) of the forest contractors, who are only service providers. In this objective, the method was applied to the forest contractors specializing in mechanized harvesting in the Aquitaine region (south-western part of France). Aquitaine is the first French forest region in terms of forest area (1,8 million hectares including 1 million of maritime pine plantations) and annual harvest (9 million cubic meters [Mm^3] harvested annually for a national harvest of 37,7 Mm^3). It is also the region where the forest mechanization is the most important with one third of the national harvester fleet (250 machines for 750 at the national level). Moreover, two distinct forest areas exist in this region allowing comparisons on the working conditions of the companies:
- on one side, "Landes de Gascogne" with maritime pine plantations, on flat and sandy land, with large-sized logging sites (> 4 ha);
- on the other side, Dordogne where broadleaved stands (chestnut and oak coppices) dominate, on a more hilly terrain and with a fragmentation of the forest properties leading to smaller logging sites (approximately 1 ha).

This project, carried out in partnership with the Forest Contractors Association of Aquitaine, aimed more precisely (i) to identify the factors which allow the sustainability and the development of the forest contractors equipped with harvesters and (ii) to inform individually these contractors on their economic performances and their positioning compared to the others. We present here the applied methodology before detailing separately the results of the economic analysis of enterprises then those regarding their key success factors.

2. Methodology

2.1. Collection and analysis of contractors' economic data

An inventory of the forest machines located in Aquitaine, done just before our study, had revealed the presence of 125 forest contractors equipped with harvesters on this region (Emeyriat and al., 2008). The accounting data of 83 of them (66 % of the companies gathering three quarters of the regional harvesters) have been collected. For each company, between one and four accounting years (annual balance-sheet and income statement) have been provided, representing a total of 278 financial years. For each of them, 34 values have been entered in a database for analysis: shareholders' equity, liquid assets, tangible and intangible assets, short and long terms liabilities, turnover, added value, gross operating profit (EBITDA), cash flow, working capital requirement… These data, supplemented by some ratios (Added Value/Annual Turnover, Labour Costs/Added Value…), have been chosen to reflect as well as possible the financial structure of the companies: activity level, management, productivity, profitability… (Difle and Giraud, 2003).

These data have been analyzed according to two complementary methods. The first one consists in initial calculation of the technical efficiency of the companies. We took for this calculation the ratio Operating result (EBIT)/Operating expenses. Then using Data Envelopment Analysis (DEA) method, we compared these ratios between them in order to highlight the companies making the best use of the available

resources (called inputs, here the operating expenses) to generate products or services (called outputs, here the operating result). This method allows a comparison between companies, thus it is a kind of "benchmarking" approach. It has been used for several years for the performance analysis of forest contractors in United States and Canada (Lebel, 1996; Bonhomme, 2003). It was also tested successfully in France for forest contractors specializing in forwarding (Bigot and Lebel, 2005).

In detail, this method consists in, using a mathematical model (linear fractional type), finding among a sample of companies those which are the best to produce a maximum of outputs by consuming a minimum of inputs (Bigot and Lebel, 2005). These observations "wrap" the sample and are the reference which all the others are compared with (see figure 1 below). Only the observations located on the envelope have an efficiency of 1 (100%). The analysis results provide targets to reach for each company with a note lower than 1 in order to improve its performance. These targets come from comparable companies and not from theoretical averages or objectives.
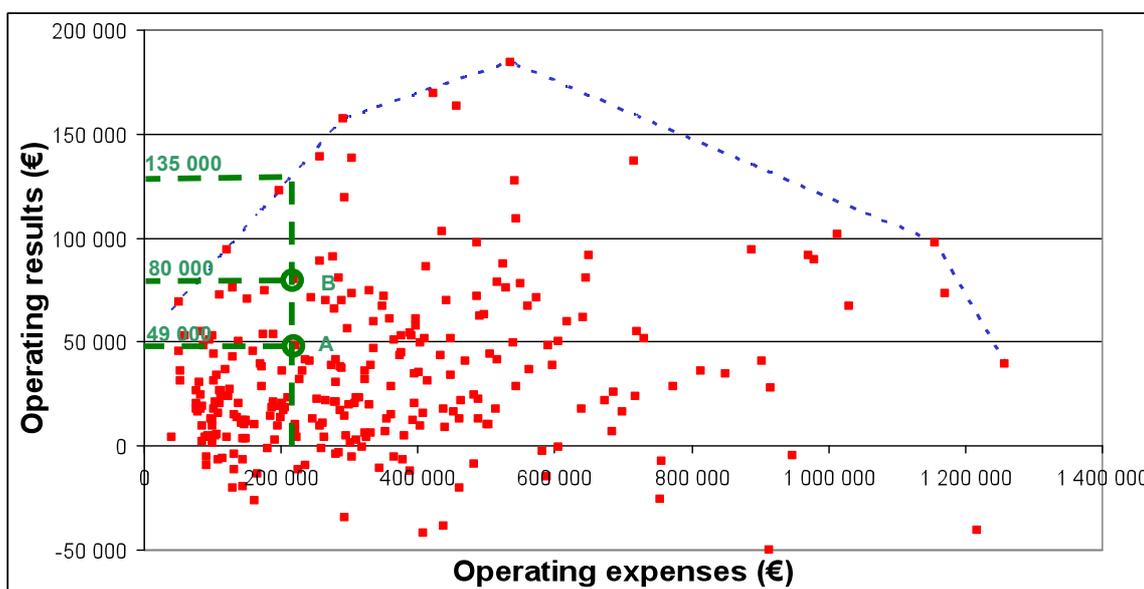

Figure 1. Graphical representation of DEA method (Data Envelopment Analysis). The envelope, formed by the companies maximizing the operating results (annual data), is represented in blue dotted lines. This envelope constitutes the reference which the other companies are compared with: for example, company A has a relative technical efficiency of 36% (49000/135000), the company B of 59% (80000/135000).

The second method based on principal components analysis studies the correlations between variables (34 values collected per company and accounting year) and examines the individuals (here forest contractors) taking into account simultaneously all variables. This allows classification of the companies' accounting results in order to create groups of companies the most resembling as possible within each group and the most different between the groups.

2.2. Study of management modes and key success factors of companies

Then we conducted a survey with 42 contractors selected to be as representative as possible of mechanized companies, among the 83 whose we had analyzed the accounting data. A questionnaire was written based on a similar work led in Canada (**www.diagfor.com**). Six topics were addressed in this questionnaire to cover all managers' responsibilities having an influence on company performance (Sink and Tuttle, 1989; quoted by Lepage and Lebel, 2007):
   -   financial management and control tools,
   -   human resources management,
   -   for the machines, monitoring of utilization rate and their hourly productivity,
   -   mechanical availability of machines,

- management of product quality and customer satisfaction,
- results in health, safety and environment.

For each of these topics, 10 yes/no questions (60 close-ended questions in total) have been asked. They are ranked in order to determine where the contractor is in the implementation cycle for a responsibility: 1) to know to measure, 2) to measure to analyze, 3) to analyze to react, 4) to react to correct, 5) to correct to perform. These various levels correspond to the development of management tools within the companies to monitor, analyze and improve their functioning.

Then we could define for each topic the performance level of the interviewed companies according to the following grid:
- level 1: basic knowledge and practices, no active measure;
- level 2: some performance measures, some targeted improvement actions arising from the measures;
- level 3: systematic performance measures, analysis of measures and explanation of gaps;
- level 4: corrective action plans based on analysis of measures, process of management and continuous improvement;
- level 5: continuous and systematic corrective actions, problems solved in 100% of cases.

The average of the levels obtained for the six topics was calculated and used to quantify the level of management for each company.

Open-ended questions supplemented this questionnaire:
- what are, in order of importance, the three main factors for sustainability and development of their company?
- what are the three suggested actions for the forest contractors in general?

Other technical information was also noted during these interviews in order to have a more detailed description of the companies and explain the answers to close-ended questions.

Statistical analysis of these data was then carried out in two stages:
- a first multi-component analysis (MCA) based on answers to yes/no questions (previously translated into 0/1) to draw up a "cartography" of business management types;
- a second analysis to connect the results of economic analysis and the business management types, supplemented by Excel descriptive analysis, in order to draw up as well as possible the typical profile of companies with good results and conversely those with worse results.

3. Economic survey

3.1. Company grading according to accounting data

The principal components analysis pointed out two main sets of parameters which contribute to distinguish the accounting years: on one hand parameters essentially related to company size (turnover, added value, operating expenses, labour costs…), on the other parameters related to results (gross operating profit/turnover, cash flow/turnover, operating result/turnover, annual profit/turnover). Those parameters made it possible to define 6 groups of accounting years.

Table 1. Definition of accounting year groups. The size and result definitions are based on observed averages.

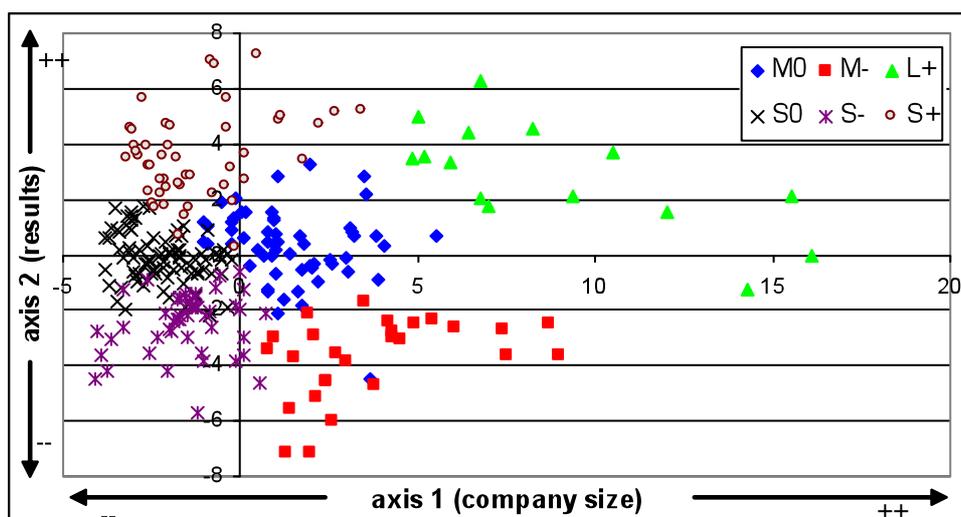| Group	Number of observations	Company size	Financial results
M0	57	Medium	Average-high
M-	27	Medium	Low (even negative)
L+	15	Large	High
S0	83	Small	Average-high
S-	48	Small	Low (even negative)
S+	48	Small	High

Figure 2. Distribution of the 6 accounting year groups according to company size and their results.

This first grading was based on the annual financial years, taken individually. But a company can have fluctuating results and a positive or negative growth of its turnover from one year to another. This led us to define finally 9 company groups:

- the six initial groups: companies still classified in each of these groups;
- group -: companies presenting a negative trend with a decreased turnover and/or result;
- group +-: companies presenting a positive trend of turnover but very fluctuating results from year to year;
- group ++: companies presenting a positive trend of turnover while maintaining stable results.

Table 2. Synthetic definition of the 9 accounting groups according to turnover and company results.

Accounting Groups	Number of companies	Turnover	Financial results
M0	12	++	++
M-	5	++	+
L+	3	+++	+++
S0	18	+	++
S-	10	+	+
S+	12	+	+++
-	7	↘	↘
+-	10	↗	↗↘
++	5	↗	↗

3.2. Characteristics of accounting groups

For each of these groups, technical efficiency has been established (see figure below) as well as the average of each 34 data collected per company and accounting year (balance-sheet items, income statement items, activity ratios, intermediate balances and activity financing).
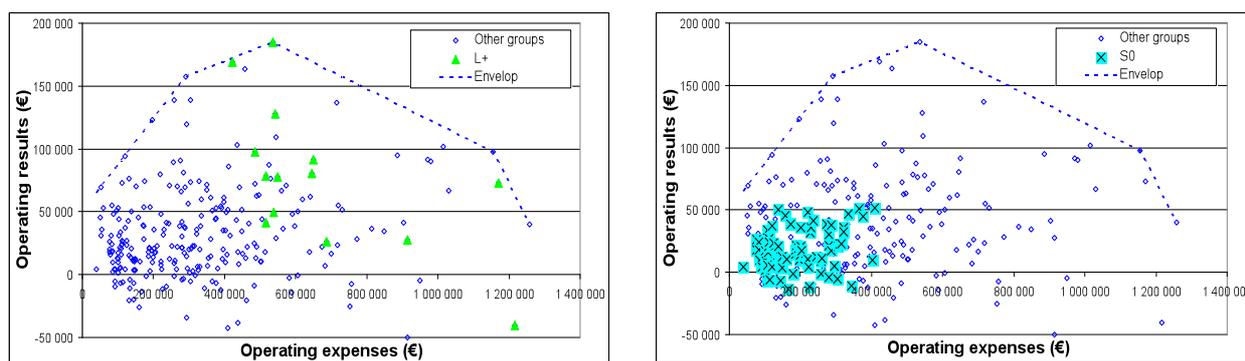
Figure 3. Comparison of technical efficiency (ratio between company's operating result and the maximum value observed for the same level of operating expenses) between the L+ group (left) and S0 group (right).

The group L+ (large enterprises with high financial results) differs quite significantly from other enterprises with, in a logical way, high items of the balance-sheet and income statement. Apart this point, there are no highlighted major trends which would give the financial structure types of companies having good and contrary bad economic performances. However, the companies with good results (groups L+ and S+) optimize the ratio Labour cost/Added Value (high value added while controlling labour costs), contrary to the companies with low financial results (groups M- and S-) (see Figure 4 below, right graph). These M- group's companies (medium-sized firms with low or negative results) are characterized by the most important debts and the highest customer and other receivables. It is likely probable that is related to long delays in payment.

LC/AV: Labour Costs / Added Value
AV/(YP+SG): Added value / (Year Production + Sales of Goods)
EBITDA/TO: Gross operating profit / Turnover
OR/TO: Operating Results / Turnover
AP/TO: Annual Profit / Turnover
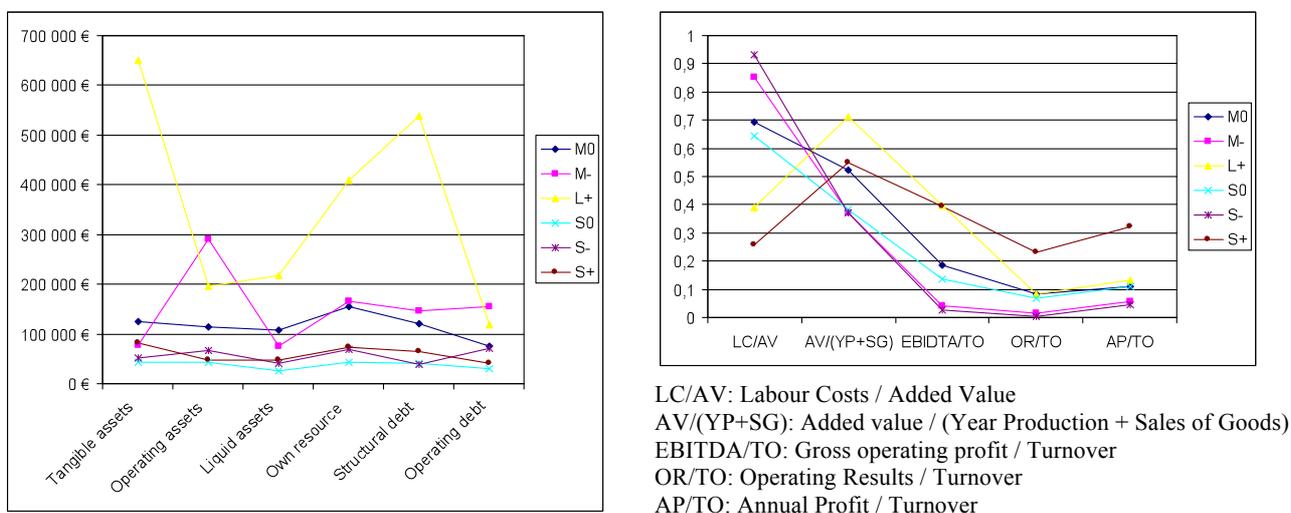
Figure 4. Average level of balance-sheet items (left) and activity ratios (right) for the various company groups. On right graph, the Labour Costs/Added Value ratios are the lowest for the companies having the best economic results (L+ and S+) and the highest for the companies having the worse economic results (M- and S-).

3.3. Accounting results and working conditions

The different working conditions between "Landes de Gascogne" area (large coniferous logging sites on flat terrain, with a large and homogeneous forested area) and Dordogne department (small broadleaved logging sites, on hilly terrain) affect the economic performance but also the size of the companies:

- all the companies whose turnover and/or results evolve (groups -, +- and ++) work in "Landes de Gascogne" area; in addition, the Dordogne companies almost belong to the groups S0, S-, S+ that is to say small-sized companies; in short, the context of "Landes de Gascogne" area is more favourable to constitute large-sized companies and in evolution than Dordogne; this joins the conclusions of the forest machines inventory (2 harvesters on average per company on "Landes de Gascogne" area for 1 in Dordogne) (Emeyriat and al., 2008);
- 11 companies from 13 in Dordogne have average results or below, reflecting firstly the working conditions (logging sites smaller than in "Landes de Gascogne") and secondly the fact that a majority of them carries out mechanized harvesting in hardwoods with a limited productivity thus low profitability (Cacot and al., 2006).

Other features arise from the analysis of economic data:
- the companies which have results below the average (groups M- and S-) integrate forwarding activity in 87% of the cases whereas only 45% of companies with results above the average include forwarding; thus forwarding does not seem to contribute to the economic performance of forest contractors; taking into account the cost price of machines (forwarder and harvester), productivity and applied tariffs, the forwarding activity is less profitable than the mechanized harvesting, which confirms the results obtained by Bigot and Lebel (2005);
- we also distinguished the forest contractors according to their harvester cutting capacities (large timber: cutting capacities of harvester head > 65cm; medium timber: 50-65 cm; small timber: < 50cm); the fact of integrating or not a harvesting activity in large timbers does not affect the economic performance of companies; thus profitability does not seem better in mechanized harvesting of large timbers.

4. Survey into modes of companies management and key success factors

During the 42 interviews with the entrepreneurs, the previous economic results have been presented individually and confidentially, by locating the results of each company compared to the 82 others. This was the start of the discussion and a way to inform them on their positioning in terms of technical efficiency and to collect information about their management modes.

4.1. Modes of companies management

Multiple components analysis was based on responses to close-ended questions. It highlights six companies groups which differ according to their management mode. The companies of these management groups have different levels/scores obtained for each of the six topics covered in the questionnaire (financial management, human resources management, utilization rate of machines, machines availability, product quality and customer satisfaction, health/safety/environment).

Table 3. Characteristics of the 6 companies groups according to their general management mode. -: low level of the company for the concerned topic; 0: average level; +: high level.

Management groups	Number of companies	Topics					
		Finance	Human resources	Utilization rate of machines	Mechanics and equipment	Product quality and customer	Health, safety, environment
1a	10	-	0	-	-	-	-
1b	4	-	-	-	-	0	0
2a	6	0	0	0	+	0	0
2b	9	-	0	0	0	0	-
3a	7	+	0	0	+	+	+
3b	6	+	+	+	+	+	+

Entrepreneurs in group 3 have developed tools and processes to monitor finely all the data of their company and to adapt their management if necessary, the sub-group B have generally better tools and monitoring systems for the management that sub-group A. Conversely, entrepreneurs in group 1 have little or not tools for the management whatever the concerned topics (financial, human resources, use and

availability of the machines…). Group 2 is in an intermediate position, with each time the sub-group B having a better implication in the management of their company than sub-group A.

4.2. Link between management modes and economic results of companies

Then we try to see if there were links between the various management modes of companies and their economic results previously analyzed. Clearly, it appears that the larger the companies are the more they are equipped with management tools with a good level, ie a good performance/implication, on the six approached topics. But with the results presented in the table below, there was no apparent relationship between the two classifications: companies with good management levels (management groups 3a and 3b) are not necessarily those with the best economic results (accounting groups L+ and S+) and vice versa. The companies with good and contrary poor economic performance present very variable modes of management.

Table 4. Link between the nine business groups defined according to their economic situation (= accounting groups) and the six company groups defined according to their management mode (= management groups).

Accounting groups	Turnover	Economic results	Management groups						Not investigated	Total
			1a	1b	2a	2b	3a	3b		
M0	++	++	2	1	2		1	2	5	13
M-	++	+			1				4	5
L+	+++	+++			2		1		0	3
S0	+	++	1		1	4	3		9	18
S-	+	+	2	1		1	1	1	4	10
S+	+	+++	2			2		2	6	12
-	↘	↘				1			6	7
+	↗	↗↘	3			1	1		5	10
++	↗	↗		2				1	2	5
Total			**10**	**4**	**6**	**9**	**7**	**6**	**41**	**83**

However, as shown in the chart below, technical efficiency remains limited for the companies with a low management level (low average score obtained for the 6 topics of the questionnaire). Nevertheless all the companies which have a good management level, with management tools, do not have a good efficiency. In other words, to have good management tools is a necessary but not sufficient condition to be efficient.

Figure 5. Relative technical efficiency of companies according to their management level (average score obtained for the 6 studied topics).

The more detailed analysis of the economic situation of companies according to their management mode (see graphic below) highlights the importance of a good management level (management group 3b) to have good economic results (ratio Value Added/Turnover). Moreover, companies with low management level (management groups 1a and 1b) can have good economic results if the company is small but can not maintain these results if the company is larger (beyond a turnover corresponding to 3 people in the company).
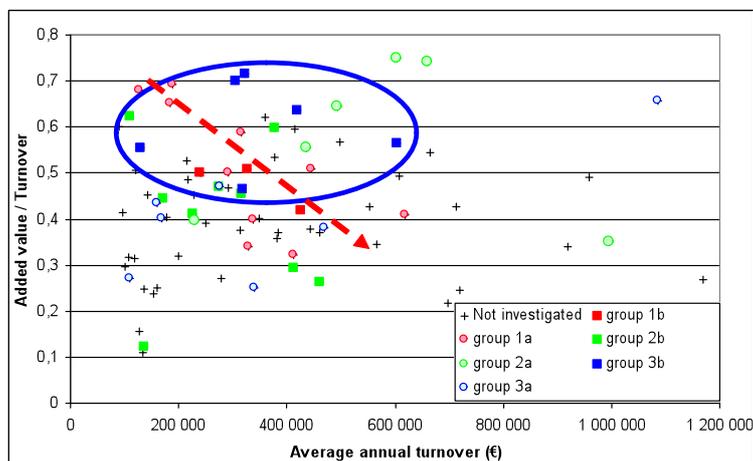

Figure 6. Added Value/Turnover ratio according to the average annual turnover. The companies with a good management level (group 3b surrounded in blue) are in the high fork of Added Value/Turnover. For the companies with low management level (groups 1a and 1b), this ratio decreases with their size (red dotted arrow).

Other findings emerge from the analysis. Thus, the group with the best management level (3b) contains companies whose turnover increases, the ratios Added Value/Turnover and Results/Turnover are high and stable over time. A contrario, the groups with worse management levels (1, 2 and for a part 3a) contain companies whose turnover is more unstable or decreases and with more chaotic economic results. This point is related to the Canadian conclusions (Lebel, 2007): companies whose profits are stable or growing will place more emphasis on administrative tasks than others, in particular in the companies of size above the average.

In the same way, a parallel can be drawn between the ratio Labour Cost/Added Value (LC/AV) (see Figure 4, right graph) and the performance level obtained on human resources management:
-    the companies of accounting groups L+ and S+, which have good economic results and a low ratio LC/AV (maximization of the added value by optimizing personnel costs, see paragraph 3.2), have the highest levels of human resources management;
-    the accounting groups M- and S-, which have poor economic performance, are in an opposite situation (low level on HRM and high ratio LC/AV).
This clearly points out the importance of human resources management and employee motivation to get good results, what was emphasized by the interviewed entrepreneurs (see following paragraph).

Lastly, the influence of various technical and organisational factors on business performance has been analyzed. It reveals that there is not link between the level of economic performance (expressed by the ratio Added Value / Turnover) and:
-    the average annual hours of company's productive machines; in other words, to do many hours is not synonymous with good economic results; Bigot and Lebel (2005) already stressed the fact that producing a maximum and maximum efficiency did not always go together;
-    the presence of a machine transporter in the company;
-    the involvement of the wife (as an employee or not) in financial management;
-    the number of customers;

-   the possibility to negotiate the tariffs with the customer(s).

Finally, it is a combination of factors which explain the performance of companies and not only one taken separately.

To summarize, there is no clear link between performance management and economic results. However, to have good management tools, in particular for human resources, is a necessary but not sufficient condition to have good economic performance, especially when the company employs more than 3 people. Last of all, it is necessary to be wary of some common misconceptions in the profession as "to do many hours to have good results".

4.3. Key factors proposed by the entrepreneurs

Independently of the previous results, the 42 questioned entrepreneurs indicated in interviews the 3 factors that they considered essential for the sustainability and the development of their company. They quoted about twenty factors of which the five more important are:
1. to have a machine fleet high-performance, reliable and well maintained (to maximize their utilization ratio),
2. to have employees autonomous, empowered and motivated (effective team),
3. to have tariffs (implied to increase them) that allow a sufficient margin (for reinvestment and fair compensation for work),
4. to satisfy the customers by work quality and reliability (in general to get factors 3 and 5)
5. to have regular work/employment (regularity of the activity).

These factors relate to various topics (one factor can relate to several themes) for which we have established a hierarchy based on the number of times the factors have been proposed: (i) logging site management, (ii) customer relations in link with activity and tariffs, (iii) human resources management, (iv) state of the machine fleet and, to a lesser extent, (v) business strategy, (vi) financial management and (vii) wood-based industry. These factors cited by the managers join the parameters proposed by Bigot and Lebel (2005) to explain the efficiency and the profitability of forest contractors: in the relationship with customers, the annual volume of activity, the logging site type and the prospects for several years are fundamental. Apart from the aspects concerning wood-based industry and, to some extent, customer relationship, the contractors have a direct influence on the mentioned factors and therefore on the sustainability and development of their business.

We finally analyzed the answers given by the forest contractors according to the profile of their company (membership of the accounting groups and management modes). The more the contractors have a high management level, the more they highlight the human factor (to have employees autonomous and motivated, to limit the turn-over of personnel…). Conversely, the more the contractors have a low management level, the more they point out the factors tariffs (to be increased) and charges (to be decreased). In a constrained economic environment (fixed and imposed delivery rates and social charges), companies with a good management level count more on human factors and relationship, and are able to optimize the ratio Labour Cost / Added Value, with better and more stable economic results over time (see paragraph 4.2).

5. Conclusion

The results of the study highlight the human factor in economic performance of companies:
-   for forest contractors with less than 3 people, there is no typical profile of successful business, the human factor "entrepreneur" is capital;
-   for forest contractors with more than 3 people, only companies with good management tools, in particular on human resources, with entrepreneurs who take time to administrative tasks (role of manager and not of operator) get good economic results; it is necessary thus that contractors provide the means of growing in size.

To complement this work, individual and collective action plans have been elaborated with contractors to improve their performance, during the interviews and workshops. These action plans are based on the

main conclusions of the study and are principally linked to training, business support and human resources management. In addition to these proposed actions, it would be interesting to monitor over time the evolution of some companies representing various groups defined in the study and to analyze their strategy to overcome the current crisis (economic crisis + salvaged operations after Klaus storm occurred at the beginning of 2009).

More generally, the approach developed in Aquitaine region in this project is interesting for multiple reasons:
- from an operational point of view, working together with representatives of forest contractors, made it possible to mobilize more easily these companies, to communicate in an optimal way about this project, to disseminate findings to the professionals, and to increase the chance to put into practice the actions plans;
- from a scientific and technical point of view, it is a first in France; strongly inspired by Canadian studies and the test of the DEA methodology carried out in France in 2005 about technical efficiency of dozen forwarding contractors (Bigot and Lebel), no other study of this magnitude involving economic and key success factors analysis has been conducted to date;
- from a social point of view, it is a participatory approach based on many exchanges with professionals, through numerous workshops, meetings for the restitution of the various project stages and interviews conducted in the field; that also made it possible to inform the forest contractors on these issues regarding economic performance and technical efficiency, with a benchmarking type approach;
- finally it is likely to inspire the public policies and the general guidelines for the development of forest contractors at a regional level, thanks to the global technical and economic survey, as well as the action plans.

This approach could be now carried out in other regions with different forest contexts in order to analyze local specificities (company structure, influences of forest type and logging sites…) and to compare the results between regions. Beforehand, the methodology should be improved by targeting two points in particular:
- the questionnaire, in particular the 60 close-ended questions, remained principally focused on the company and one could develop the general working environment (precise conditions of logging sites, customer relations, regularity of work…), points highlighted by the entrepreneurs as success factors for their company;
- the factor personality/psychology of the entrepreneur (how does he take decision, how does he take into account the innovation, what about his human relationship…) is not taken either into account whereas the human factor is emerging as a central point in business performance, it is a topic to be added to the six current themes of the questionnaire.

Acknowledgements

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