OPERATIONS STRATEGY AND FLEXIBILITY IN ENGINEERING CONSULTING FIRMS

Daniel Arias Aranda
Javier Llorens Montes
Luis M. Molina
María del Mar Fuentes Fuentes
Ignacio Tamayo Torres
Departamento de Organización de Empresas
Universidad de Granada

ABSTRACT

In this paper, the relationship between operations strategy and flexibility is analysed within the service setting of engineering consulting firms in Spain. A framework for service strategy dimensions is suggested while manufacturing flexibility dimensions are applied to service operations considering necessary adaptations. A path analysis model is applied in order to enhance the understanding of interactions between both constructs. This research proves that service operations strategy has a significant positive and direct effect on service delivery flexibility. It is especially relevant the fact that flexibility on distribution of information behaves completely opposite to the rest of the flexibility dimensions.

Keywords: Service operations strategy, Flexibility, Engineering consulting firms

1. INTRODUCTION

Operations strategy has been contemplated in the field from a conceptual point of view and has dealt mainly with the content of strategy [1]. All this research has configured the operations strategy concept as a pattern of decisions and actions driven to support the strategic goals established by the business unit. Operations should fit the needs of a business by striving for consistency between business capabilities and policies and business’s competitive advantages [2]. However, the scarcity of studies relating the effect of strategy and process variables has become one of the great weaknesses in operations management research [3-6]. Moreover, for service operations strategy, this panorama is still more meagre which leads to higher research opportunities.

The concept of flexibility in service processes suffers from the same confusion that overwhelmed manufacturing for years [7]. The nature and sources of manufacturing flexibility have been broadly studied, so comparison between manufacturing and services provides a good starting-point to the study of service flexibility. Flexibility is generally regarded as the ability to respond to or conform to new situations and is usually classified as process, product, or infrastructure related [8]. Although the importance of flexibility has been broadly acknowledged, efforts to bring existing theoretical research and practices together have not reached a substantial progress in order to evaluate both manufacturing and service flexibility [9]. In particular, the relationship between operations strategy and manufacturing flexibility has not received adequate attention when making investment...
decisions in manufacturing technology [10], nor does it receive adequate recognition in the implementation phase [11].

The purpose of this paper is multiple and threefold: (1) to suggest a service strategy dimensions framework based on service management literature; (2) to apply a manufacturing flexibility framework to service operations considering necessary adaptations to service industries nature; (3) to enhance the understanding of interactions between service operations strategy and flexibility by applying a path analysis model to the different dimensions defining both constructs in order to investigate the relationships between them. The empirical verification of this research will be developed within the service setting of engineering consulting firms in Spain.

2. LITERATURE REVIEW AND THEORY DEVELOPMENT

Operations Strategy

Operations strategy has received intense treatment for more than three decades [12]. Issues regarding operations strategy content and process are continually discussed in current operations literature. The process of operations strategy is termed according to how strategic decisions are reached in an organizational setting [13]. Definitions of strategy always mention enhancement of the firm’s competitive position in the marketplace through resources building or positioning [14]. Most research focused primarily on the number of decision areas and goals of manufacturing in terms of performance criteria [6]. Skinner (1969) [15] identifies a set of decision areas through which manufacturing objectives are achieved. Later research proves a generally high agreement, even though many authors have developed different sets of manufacturing decision areas (see [16]).

However, traditionally OM literature has addressed service operations strategy to the development of the service delivery system in order to match customer expectations with customer perceptions [17]. Models and frameworks have been suggested to explain this process through different services classifications and schemes. However, many gaps still remain concerning the differentiation and interaction between the different dimensions configuring the service operations strategy and much remains to be done.

Strategy in service operations

Literature on service operations management identifies 3 basic operations strategies according to the firm’s focus of activities. Therefore, service industries can pursue process, service or customer-oriented operations strategies (see among others [18-29]). From a reflective analysis of these studies, 9 dimensions configuring the basic service operations strategies were extracted. These are Type of operations layout, PUSH/PULL orientation of the service delivery process, Degree of process standardisation, Number of different services offered, Use of Information Technologies (cost reduction vs. service improvement), Back and Front office activities relationship, Human Resources specialisation, Degree of customer participation and New service design and development.
Type of operations layout directly influences the way operations are configured in the service delivery process. A process layout tends to organise service delivery as a sequential activities process [20]. On the opposite side product layout does not imply task sequentiality. This leads to task development with no pre-established order [18]. Mixed layouts in which only a part of the service delivery process is sequential while other parts are developed according to service specific characteristics is also considered [19].

PUSH/PULL orientation of the process determines the production philosophy of the service delivery. PULL oriented service firms initially consider customer needs when developing service activities. Activities do not end until the service firm has satisfied perceived customer expectations [21]. PUSH oriented service firms undertake important investments in production capacity in order to satisfy demand. Demand is fostered through big marketing efforts [21, 26]. Again, mixed PUSH/PULL configurations are considered.

Degree of service standardisation refers to the extent to which task procedures are pre-established. Therefore, it also influences employees’ empowerment [30, 31]. Standardisation tries to minimise variability in the service delivery process, so procedures of developing each task are limited [32].

The number of different services offers measures the degree of diversification of the firm according to the final products/services delivered [22]. This dimension shows how the firm is oriented towards many or few customer segments [33]. It also regards how related the final products/services are, so a firm offering 2 products/services lines with few similarities between them is considered to detain a higher degree of product/service amplitude than a firm offering many related products/services lines.

Use of Information Technologies (IT) is considered according to two parameters. On one side, IT can be used in order to reduce costs through, for instance, substitution of workforce by technologies [34]. On the other side, IT investments can be made for final service improvement, like, for instance, through simulation technologies to verify service quality and reliability [35-36].

The relationship between front and back office activities refers to physical location as well as to workforce information exchange. Such relationship directly affects customer perception on service delivery. When both activities are physically separated, customer effort to obtain information about back office activities is higher and will be moderated by the mechanisms of information exchange between both front and back office activities [37, 24]. However, physical closeness of both activities increases information effectiveness and reliability for the customer [38].

Degree of workforce specialization intends to determine personnel versatility when accomplishing various and different activities. Hence, the staff can be prepared either to undertake one or few specific tasks or else, to carry out any activity total or partially [39, 25, 26]. A more versatile workforce responds more quickly and efficiently to environmental changes while highly specialized personnel tend to be more rigid [40, 41, 42]. This fact is especially relevant for those service firms that have IT with fast degree of obsolescence as basis of their activity.
Degree of customer contact and participation relates to the level of interaction between customer and service delivery process. Such interaction can be utilised either to transfer some activities to customers in order to reduce process costs or to customise service delivery [43, 44]. In the first case, the customer acts as staff by developing tasks of the service delivery process [45]. In the second case, the customer exchanges information with the performers of the service delivery activities, but such activities are developed in the firm [27, 28, 46]. In both cases customer act as a quality controller by assuring that his/her expectations fits his/her perceptions at least for those tasks he/she performs.

Finally, intensity of design and development of new services refers to whether or not the firm sets new service delivery procedures through new tasks organisations and investments in specific resources. Therefore, this dimension assesses the firm willingness to innovate in new processes and services [47, 20, 48, 29]. Table I shows the influence of each of these service strategy dimensions on the three basic service strategies.

[Take in Table I]  

**Flexibility**

Flexibility as competitive goal still lacks a clear and accurate definition. In service firms, flexibility is a fuzzy concept due to a lack of models that determine service flexibility dimensions. However, flexibility is generally accepted as an useful tool to improve the competitive position of the firm, but it still lacks attention when related to the process of decision making of process technologies adoption and implementation [10-11]. Slack (1987) [49] analyzes a sample of 10 manufacturing firms concluding that managers’ vision of the flexibility concept is only partial and incomplete. Managers usually focus more on machines flexibility than on the whole system flexibility. Flexibility when focused only on technology implementation does not lead to a competitive advantage [50]. It is crucial to carefully plan and manage the whole system flexibility [51] by creating a plant infrastructure that allows such system flexibility [52].

One of the key challenges to achieve a flexible operations system emerges when focusing and managing the different dimensions of flexibility [53]. This is mainly due to the fact that flexibility is not accumulative; so more flexibility in different parts of the system does not imply a more flexible operations system. Changes in flexibility are of strategic nature, so they should not only involve process engineers but also production and even business managers [54]. Operations strategy determines the level of uncertainty to be supported by the service delivery system by adapting the different flexibility dimensions to environmental changes [53-54].

OM literature has focused on identifying different dimensions and types of flexibility [55-63]. However there is no consensus about which are the exact costs and benefits of flexibility implementation. In many cases, flexibility benefits have been considered in terms of machine programming and production models integration [64]. In some other cases, such benefits are considered in terms of workforce versatility [65]. Some authors sustain that flexibility is always beneficial while others affirm it can even be harmful in some cases.
Such discussion leads to the multidimensional character of flexibility, which is shown in Table II from the study of Ramasesh and Jayakumar (1991) [69].

In Service industries, customer interaction and customization imply a high degree of flexibility. Nowadays, customers are more demanding for integral services provided by the same firm [77]. This fact will entail a new and different conception of service flexibility. However, Electronic Data Interchange (EDI) and Information Technologies (IT) provides of new market opportunities for service firm without high flexibility investment efforts. Consequently, reengineering processes are easier to accomplish in service delivery systems than in manufacturing systems [78]. Also, service firms are able to design delivery systems in which customer is actively involved, becoming self-service delivery systems. This makes flexibility simpler and easier to implement considering that the customer develops certain activities of the service delivery system, especially when compared to the high costs of workers training for manufacturing firms.

From the above discussion, it can be inferred that service operations strategy and service delivery flexibility are deeply interrelated. What is not clear is which are the interrelationships among the different dimensions configuring both constructs and the strength and magnitude of such relationships. Once the different constructs and dimensions have been defined, the main hypothesis to be tested in this study is as follows:

\[ H1: \text{"Operations strategy directly influences service delivery flexibility"} \]

This main hypothesis can be disaggregated into a total of 63 subhypothesis. Each one of these subhypothesis refers to every direct effect of the 9 service strategy dimensions on the 7 service delivery flexibility dimensions to be detailed in the next section.

3. METHODOLOGY

Sample and the sampling procedure

This study was conducted in the context of Engineering Consulting Firms in Spain. The previously stated dimensions of operations strategy are of particular importance in this service sector. 3 firm types (Civil, Industrial and Environmental) were considered covering most activities of Engineering Consulting Firms. Table III shows the main activities of every type.

According to the Spanish Ministry of Industry (1998) [79], the nature of the work undertaken such firms in Spain is determined by the following patterns:

- Interior demand is mainly covered. Only 10 per cent of turnover average comes from exterior markets. Also, more than 55 per cent of turnover is due to Public Administration.

- Intermediate demand plays a fundamental role as constructors act as intermediaries for final demand of infrastructures and equipments.
- It is a knowledge-intensive sector. Fix personnel costs represent about 65% of all fix costs of the sector due to professionals hiring.

- Most projects performed are prototypes. Hence, production processes are not easily industrialised.

- Investments are written off in short periods of time, especially for computer equipments that have to be continually renewed in order to stay competitive.

- These firms tend to centralise resources for service delivery. Only multinational firms have offices abroad for commercial purposes, this is why no distinction was made between overall firm size and average office size (Table IV shows the operations patterns of these firms according to [79]).

[Take in Tables III and IV]

Initially, a copy of the questionnaire was sent to 10 firms representing every turnover and activity group as a pretest. They were asked not to answer the questionnaire but to remark all doubts or possible mistakes detected. Only small syntactic changes were made but none of the firms remarked difficulties for concept understanding or misuse.

The data for the empirical investigation of the model were obtained through a field study in Spain. Data were collected from participating firms predominantly via e-mail to the operations managers/executives or equivalent having a high level of responsibility in their companies. The Spanish Association of Spanish Engineering Consulting Firms (Tecnibería) provided all information about addresses and firm names. Initially, and in order to attract the maximum number of participating firms, an e-mail was sent to all firms registered in Tecniberia soliciting their participation while stressing the importance of the study. The researchers considered a total of 129 firms with a turnover higher than 150,000 euros. As a second step, a copy of the questionnaire was sent to all of them. A total of 12 firms requested the questionnaire to be sent via ordinary mail with a 100% response rate. Nonrespondents were contacted as much as three times in order to get them to participate in the study. Of these, usable data was collected from a total of 71 firms (55 per cent). The questionnaire original language was Spanish. Table V shows a description of the sample according to the 5 turnover categories.

[Take in table V]

Comparing the sample distribution with the sector as a whole, no significant discrepancies were observed. Most of the firms’ turnover ranges from 300,000 to 3,000,000 euros (60% approx. of the total sample). On the other hand, civil engineering firms represent the higher percentage of the sample (49%) compared to 17% of industrial engineering and 34% of environmental engineering. Table VI shows the turnover distribution of the firms according to [79].

[Take in table VI]
**Measures**

Questions related to operations strategy are based on a five-point Likert scale. Every one of the 9 dimensions of operations strategy was clearly represented in differentiated blocks in the questionnaire. Control questions were included in order to verify internal consistency of the questionnaire. For every dimension, a set of items was included in the questionnaire. Questions relating to service strategies were developed after an extensive literature review and inputs from a panel of service managers. For every item a Likert scale ranging from 1 (Completely agree) to 5 (Completely disagree) was used to measure agreement of the Operations Managers/Executives with such items (See Appendix)

Partial indicators were developed in order to know the firm positioning for every operations strategy dimension. Such indicators combine the different items corresponding to each dimension in order to measure the firms’ trends. A global indicator was developed to measure operations strategy according to such trends having into account that indicator’s rank should flow between 1 and 5 values in order to be consistent with the Likert scale previously used. So, it was designed as follows:

$$ Eb_n = \frac{5\left(\Sigma_{i=a}^{b} A_{in} - \Sigma_{i=c}^{d} A_{in}\right) + |(\Sigma_{i=c}^{d} A_{in} - 5\Sigma_{i=a}^{b} A_{in})| + 1}{[(5\Sigma_{i=a}^{b} A_{in} - \Sigma_{i=c}^{d} A_{in}) + |(\Sigma_{i=c}^{d} A_{in} - 5\Sigma_{i=a}^{b} A_{in})| + 1]} $$

being:

- $Eb_n$ the indicator.
- $A_{in}$ the score obtained in question $i$ of block $n$ in the questionnaire. Rank $[a,b]$ represents questions scoring towards one of the trends in each block.
- Rank $[c,d]$ represents questions scoring towards opposite extremes of rank $[a,b]$ in each block.

Hence, $(\Sigma_{i=c}^{d} A_{in} - 5\Sigma_{i=a}^{b} A_{in})$ represents the smallest reachable value, supposing that one firm scores the highest (score 5) in all questions for one of the trends and the smallest (score 1) in all questions of the opposite trend. On the other hand, $(5\Sigma_{i=a}^{b} A_{in} - \Sigma_{i=c}^{d} A_{in})$ represents the smallest reachable value for a firm positioned at one extreme, scoring the smallest (score 1) and the highest (score 5) for the opposite trends. Once the extremes and possible intermediate values have been obtained, the indicator transforms this rank in a scale from 0 to 5 by adding to the value obtained, the smallest reachable value plus 1. The value obtained is finally divided by the highest reachable value adding the smallest value plus 1 in order make the scale positive. Finally, the obtained value is multiplied by 5 to transform it to the 1 to 5 scale.

Partial indicators of the 9 dimensions of operations strategy were obtained, so combining these partial indicators into a global indicator; firms are classified according to the Operations strategy they pursue. Such indicator intends to resume the multidimensional nature of operations strategy. Therefore, it is possible to know every firm’s positioning in or near one of the three basic strategies previously defined.
A factor analysis was performed in order to test whether the items used to measure the different flexibility dimensions grouped consistently. Seven flexibility dimensions were identified through this analysis. Those are expansion, distribution of information, routes, equipments and personnel, market, services and servuction and process, programming and volume flexibility. Items configuring each flexibility dimension were also measured through a five-points Likert scale. In this case agreement with each of the statements defining every flexibility dimension configured all items relating system flexibility. According to the specific nature of service industries, some adaptations were included in the manufacturing flexibility dimensions and items in order to fit correctly in the model to be empirically validated. These adaptations are shown in Tables VII and VIII.

Inter-item analysis was used to check scales for internal consistency or reliability. Specifically, Cronbach’s reliability coefficient (alpha) is calculated for each scale (dimension), as recommended by empirical research in operations by many researchers [85-86, 1]. Cronbach’s alphas and trends for every dimension according to the indicator values are shown in Tables IX and X.

Usually, a value of 0.7 in the Cronbach’s alpha is considered as adequate in order to ensure reliability of the internal consistency of the questionnaire [88]. However, a margin of 0.5 to 0.6 is generally considered adequate for exploratory work [88, 89]. Construct validation is a process of demonstrating that an empirical measure corresponds to the conceptual definition of a construct [90]. Consequently, three types of validity can be established: nomological or theoretical validity, vertical validity and horizontal or criterion-related validity. We can argue that the measurement instrument establishes the basis for nomological or theoretical validity since all items are developed through an extensive review of the service operations strategy body of research. Factor analysis was used to check unidimensionality of scales, which provides evidence of a single latent construct [85]. Cronbach’s alpha values address vertical validity, which describes the extent to which a scale represents its construct. Evidence of criterion-related validity is presented through the Browne and Cudeck (1993) [91] cross-validation index for covariance structure modelling. Index value for this research is 0.642, which indicates a high probability that the model results are consistent with population parameters. Table VIII shows the definition of the service operations strategies according to the 9 basic dimensions.

4. ANALYSIS AND RESULTS

According to the objective of our analysis, the technique of path analysis seems to be the most adequate to empirically verify the hypothesis. Such technique estimates the magnitude of the linkages between variables. Through these estimates it is possible to provide information about the underlying causal processes [92]. It also allows one to distinguish between direct and indirect effects in case there are compound paths. Our path
analysis model is recursive as it assumes that there is not reciprocal causality in the form of causal feedback.

For every path, a beta coefficient is calculated. This coefficient’s sign indicates the direction of the relationship (positive or negative) and its magnitude represents the strength of the interrelationship between the variables. When obtaining the beta coefficients, a regression of each endogenous variable on those variables that directly affect it is performed. Table XI reports the standardised beta coefficient, the F-ratio, the $R^2$ and the p-value resulting from the regression analyses for each of the relationships analysed.

[Take in Table XI]

All operations strategy dimensions have a direct effect on the flexibility dimensions, although not all of them are significant. Fixed layout, PUSH orientation, high level of standardisation, use of Information Technologies for costs reduction, separation of back and front office activities and a specialization policy in human resource management influence negatively and in a significant way (p<0.01) all flexibility dimensions (beta values range from –0.048 for market flexibility to 0.748 for equipment and personnel flexibility) with the exception of the flexibility dimension of Information technology systems. The influence of the operations strategy dimensions on this flexibility dimension is uneven. Customer participation influences negatively while a high number of services offered and new services development are not significant for such dimension. Next, all influences will be analysed separately:

- Fixed layout influences negatively and significantly (p<0.01) all flexibility dimensions (beta values range from –0.725 for expansion flexibility to –0.486 for equipments and workforce flexibility). However, information distribution flexibility is positively affected (beta value is 0.138; p<0.05).
- A PUSH oriented service delivery influences negatively and significantly (p<0.01) expansion ($\beta$=-0.623), routes ($\beta$=-0.742), equipment and workforce ($\beta$=-0.421) and process, programming and volume flexibility ($\beta$=-0.42). Likewise, a PUSH oriented service influences positively and significantly (p<0.01) flexibility on distribution of information ($\beta$=0.486).
- Standardisation is negatively and significantly related (p<0.01) to all flexibility dimensions (beta values range from –0.317 for Services and Servuction flexibility to –0.763 for expansion flexibility) except for flexibility on distribution of information for which the relationship is positive and significant ($\beta$=0.506; p<0.01) and services and servuction flexibility for which the relationship is not significant.
- The number of services offered influences positively and significantly all flexibility dimensions (beta values range from 0.461 for routes flexibility to 0.649 for equipments and workforce flexibility) except for information distribution and market flexibility for which the relationship is not significant. Significance level decreases slightly for flexibility on programming, processes and volume ($\beta$=0.379; p<0.05).
- Use of IT for cost reduction influences negatively and significantly all flexibility dimensions (beta values range from –0.273 for Service and servuction flexibility to
–0.793 for market flexibility) except for flexibility on distribution of information for which the relationship is positive and significant (β=0.646; p<0.01).

- Separation of back and front office activities influences negatively and significantly (p<0.01) all flexibility dimensions (beta values range from –0.412 for service and servuction flexibility to –0.794 for expansion flexibility) except again for flexibility on distribution of information for which the relationship is positive and significant (β=0.546; p<0.01).

- A human resource management focused on specialization influences negatively and significantly (p<0.01) all flexibility dimensions (beta values range from –0.518 for process, programming and volume flexibility to –0.834 for expansion flexibility).

- Customer participation influences positively and significantly all flexibility dimensions (beta values range from 0.414 for process, programming and volume flexibility and 0.53 for market flexibility) except for flexibility on information distribution for which the relationship is negative and significant (β=–0.463; p<0.01) and equipments and workforce and service and servuction flexibility for which the relationship is not significant.

- New services development affects positively all flexibility dimensions (beta values range from 0.798 for equipment and workforce flexibility and 0.465 for routes flexibility) except for flexibility on information distribution for which the relationship is not significant.

The standardised R\(^2\) explains between 79.7 per cent and 88 per cent of the total variance on every flexibility dimension. This value decreases to a 42.6 per cent for process, programming and volume flexibility. According to these results it can be affirmed that service operations strategy is closely related to the design of the service delivery flexibility. This empirically verifies the main hypothesis of this study (H1) positively but partially as determined influences are not significant as seen before. This is a remarkable result even though the model was quite simple and the objective was to understand interrelationships as opposed to trying to explain the nature of service flexibility.

5. CONTRIBUTIONS AND CONCLUSIONS

This research provides several contributions to the field of service operations management. First, based on categories of structure and infrastructure decisions proposed by relevant service management literature, this study operationalizes the concept of service operations strategy. By doing so, new research opportunities are broaden in order to improve and adapt this concept to different environmental conditions. Future operationalizations of the service operations strategy will require additional perspectives under a contingencies analysis. In addition, heterogeneity of service industries involves further attention according to competitive priorities.

Second, a model of flexibility in service industries has been applied including some adaptations to the specific nature of service industries. Such model is based on classical models of manufacturing flexibility. This study examines this critical concept utilizing empirical methods within a field-based setting. Still, some dimensions show low moderate reliability, so future research efforts may focus on improving and determining the exact
internal and environmental factors affecting service flexibility according to specific sector characteristics.

Third, this research proves that service operations strategy has a significant positive and direct effect on service delivery flexibility. The results establish not only the existence of strong links between service operations strategy and flexibility but also the magnitude of the impact of every operations strategy dimension on every flexibility dimension. Nonetheless, the generalization of these findings to other service industries cannot be guaranteed without cautiousness even though the robust statistical results for this relationship suggest the findings are quite reliable.

Fourth, understanding the effects of operations strategy on flexibility is one of the major findings of this study. The different strategy dimensions influence flexibility in diverse manners. It is especially relevant the fact that flexibility on distribution of information behaves completely opposite to the rest of the flexibility dimensions. The other exceptional flexibility dimension is service and servuction for which most interrelations with strategy dimensions are not significant or have a significance level different from p<0.01.

Finally, this research has based all findings on empirical methods of analysis supported by field-based investigation to give support to concepts and relationships that seem reasonable in order to provide empirical verification. The specific methodology of this study and the results suggest that much of the conceptual efforts made in operations strategy for manufacturing may be applicable to service operations as well.

REFERENCES


APPENDIX

Set of items used to measure operations strategy dimensions for service management

Block A.I. Layout

Aspects of a fixed layout:
1) Service delivery activities are performed in a pre-established and fixed place.
2) Production resources are sequentially located.
3) Resources for service delivery are located in order to optimise space and maximise efficiency.
4) Downstream tasks are never performed until upstream tasks are over.
5) Every worker is assigned to an exclusive task.
6) System efficiency goals are have priority when designing service delivery process.

Aspects of a movable layout:
7) Service delivery activities are performed where it is more convenient for the customer.
8) Production resources can move to those places where service is delivered
9) Resources for service delivery are located in order to optimise customer satisfaction and final service delivery.
10) Workers assignment is made on a rotation basis.
11) Workers perform different tasks in the same shift.
12) Customer satisfaction goals are have priority when designing service delivery process.

Block A.II. PUSH/PULL orientation
PUSH orientation
13) Important marketing efforts are made in order to attract new customers.
14) A crucial marketing goal is that customer is delivered as much services as possible.
15) Production output is always maximised.

PULL orientation
16) Important service delivery efforts for improvement are made in order to increase customers’ satisfaction.
17) A crucial marketing goal is that customer is satisfied.
18) Customer satisfaction is more important than output optimisation.

Block A.III. Level of standardisation
19) Service delivery system is designed so there is one or a few ways to perform every task.
20) Variability is continually decreased along the service delivery process
21) Most work procedures are pre-established and cannot be modified.
22) Empowerment degree is very low.
23) All incidents not prevented in the work procedures must be communicated to a superior for resolution.
24) There is a procedures book, which is known by all workers.
25) Most service delivery activities are oriented towards service customisation.

Block A.IV. Different services offered
26) The firm offers a wide range of different services
27) All offered services are customised.
28) New services are continually offered to customers.
29) The firm delivers one of few very specialised services.
30) Services are delivered to satisfy one or few small customer segments.

Block A.V. Use of Information Technologies
31) Acquisition of Information Technologies is oriented towards costs reduction
32) Workforce is replaced by new technologies when possible.
33) Customers can send or receive information about service delivery through Information Technologies such as Internet, EDI, WAP,…
34) Acquisition of Information Technologies is oriented towards customer satisfaction
35) Decisions about Information Technologies adoption are done on the basis of tasks improvements from the worker point of view.
36) Decisions about Information Technologies adoption are done on the basis of service customisation.

Block A.VI. Back and front office activities
37) Front office activities are physically separated and differentiated from the back office activities.
38) The customers cannot access those service activities in which they are not required.
39) Personnel of front office activities works exclusively there and never in back office activities.

Block A.VII. Human resources

40) Personnel are highly specialised.
41) Personnel is able to perform various and different tasks.
42) Job rotation is commonly used.
43) More than half of our personnel are university graduates.
44) Training is given a crucial importance in the firms budgets.

Block A.VIII. Customer participation

45) Service delivery process is designed so customer performs by him/herself those activities he/she is qualified for.
46) Customer performs part of the service delivery activities in order to reduce costs.
47) Customer is informed in detail about all previous activities he/she has to perform before service delivery.
48) Customer knows about cost reductions due to his/her participation in the service delivery process.
49) Customer participates in the service delivery process in order to customise service.

Block A.IX. Design and Development of new products

50) New procedures for service delivery are continually developed.
51) New services are continually developed.
52) Customer opinions are indeed considered when designing new services.
53) There is an exclusive team for service design and development.
## TABLES AND FIGURES

Table I: Definition of the service operations strategies according to the 9 basic dimensions

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Process oriented</th>
<th>Customer oriented</th>
<th>Service oriented</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Process Layout. Service process activities are mainly sequential. Service location is usually not movable. Main process goal is space optimisation. Workforce is highly specialised.</td>
<td>Product (service) layout. Service delivery tasks are neither sequential nor fixed located. Tasks allocation is flexible.</td>
<td>Layout is hybrid, although usually process oriented. Service delivery tasks tend to be sequential, though task variability leads to a significant degree of customisation through changes in location.</td>
</tr>
<tr>
<td>II</td>
<td>High investments in capacity satisfy large demands supported by strong marketing efforts. Process is Push oriented.</td>
<td>Service delivery process is Pull oriented. Customer satisfaction drives service delivery process.</td>
<td>Operations are Pull oriented. Process capacity tends to be low. Only small demands can be satisfied.</td>
</tr>
<tr>
<td>III</td>
<td>Most activities are standardized. There is one or few ways to achieve service delivery tasks. Task variability is to be minimised. Work procedures are pre-established.</td>
<td>Most service delivery activities are customised. There are few pre-established procedures to develop service delivery tasks</td>
<td>Most process activities are customised, although customisation range is small. There are many different ways to accomplish tasks. Pre-defined general procedures drive service delivery.</td>
</tr>
<tr>
<td>IV</td>
<td>Range of different services offered is short and services are usually closely related.</td>
<td>Differentiation of the services provided is high. Every service delivered can be considered as unique</td>
<td>There are few different offered services, being all of them closely related. Diversification is low.</td>
</tr>
<tr>
<td>V</td>
<td>New technologies investments are accomplished in order to reduce costs. Workforce tends to be replaced by technology.</td>
<td>Use and investment in new technologies has as the main goal to increase customer satisfaction</td>
<td>Use and investment in new technologies tends to balance cost reduction and customisation.</td>
</tr>
<tr>
<td>VI</td>
<td>Back and front office activities are physically separated in order to increase efficiency.</td>
<td>Back and front office activities are physically and integrated by sharing personnel. Customer gets on line information about service delivery.</td>
<td>Back and Front office activities tend to be physically separated, although they share personnel. Such separation is usually due to space optimisation.</td>
</tr>
<tr>
<td>VII</td>
<td>Workforce is highly specialized. Versatility is low. Every worker accomplishes one of few very specific tasks.</td>
<td>Personnel is not highly specialised but trained for versatility. Anybody must be able to develop any task totally or partially.</td>
<td>Personnel are very specialized. However, they are trained for versatility and fast adaptation to organisational and technology change.</td>
</tr>
<tr>
<td>VIII</td>
<td>Low customer contact. Customer participates in the service process only to reduce</td>
<td>High degree of customer contact in order to customise service.</td>
<td>Degree of customer contact is high. Customer participation in the service delivery process is</td>
</tr>
</tbody>
</table>
Table 2: Different types of flexibility and some suggested measures

<table>
<thead>
<tr>
<th>Flexibility type</th>
<th>Definition</th>
<th>Suggested Measures</th>
<th>References</th>
</tr>
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<tbody>
<tr>
<td>Machine flexibility</td>
<td>Capability of machines to perform different operations</td>
<td>Number of different operations performed by machines weighted by the importance of tasks</td>
<td>Brill y Mandelbaum (1989) [60]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cost of switching from one operation to another</td>
<td>Sethi y Sethi (1990) [70]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extent of variation in the inputs that the machine can handle</td>
<td>Gerwin (1987) [58]</td>
</tr>
<tr>
<td>Operations flexibility</td>
<td>Capability of parts to be produced in different ways</td>
<td>Number of different process plans for a part</td>
<td>Sethi y Sethi (1990) [70]</td>
</tr>
<tr>
<td>Material Handling flexibility</td>
<td>Capability to move different parts through the various machines</td>
<td>Ratio of the number of paths available in a system to the number of possible paths</td>
<td>Chatterjee et al. (1984) [56]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increase in the performance of FMS through the use of general purpose fixtures</td>
<td>Newman (1993) [71]</td>
</tr>
<tr>
<td>Routing flexibility</td>
<td>Capability to use alternative processing routes to make a product</td>
<td>Average number of ways in which a product can be made</td>
<td>Chung y Chen (1990) [72]</td>
</tr>
<tr>
<td>[Scheduling flexibility]</td>
<td></td>
<td>Routing entropy</td>
<td>Kumar (1986) [73]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decrease percentage in the throughput caused by machine breakdowns</td>
<td>Browne et al. (1984) [55]</td>
</tr>
<tr>
<td>Program flexibility</td>
<td>Capability of a system to operate unattended for long periods</td>
<td>Expected percentage uptime during second and third shifts</td>
<td>Jaikumar (1986) [11]</td>
</tr>
<tr>
<td>Expansion flexibility</td>
<td>Ease with which capacity can be added when needed</td>
<td>Overall cost and time needed to add capacity</td>
<td>Carter (1986) [57]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Upper limit on the amount of capacity expansion</td>
<td>Browne et al. (1984) [55]</td>
</tr>
</tbody>
</table>
Table 2 (cont.): Different types of flexibility and some suggested measure

<table>
<thead>
<tr>
<th>Flexibility Type</th>
<th>Definition</th>
<th>Suggested Measures</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Process Flexibility</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[Job Flexibility]</td>
<td>Capability to produce different part types without major effort</td>
<td>Number of different parts that can be produced</td>
<td>Browne et al. (1984) [55]</td>
</tr>
<tr>
<td>[Variant Flexibility]</td>
<td></td>
<td>Changeover costs between different known jobs within the current production plan</td>
<td>Gerwin (1987) [58]</td>
</tr>
<tr>
<td>[Output Flexibility]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[Short Term Flexibility]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Product Flexibility</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[Design Flexibility]</td>
<td>Capability of the system to add or substitute products without major efforts</td>
<td>Ratio of total output to setup costs</td>
<td>Son and Park (1987) [59]</td>
</tr>
<tr>
<td>[Parts Flexibility]</td>
<td></td>
<td>Time or cost to change from one product to another</td>
<td>Browne et al. (1984) [55]</td>
</tr>
<tr>
<td>[New products Flexibility]</td>
<td></td>
<td>Option pricing approach</td>
<td></td>
</tr>
<tr>
<td><strong>Volume Flexibility</strong></td>
<td>Capability to operate at different levels of output</td>
<td>Ratio of average volume fluctuation to total capacity</td>
<td>Gerwin (1987) [58]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stability of manufacturing costs over widely varying levels of production volume</td>
<td>Falkner (1986) [74]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Smallest volumes for profitable operation of the system</td>
<td>Browne et al. (1984) [55]</td>
</tr>
<tr>
<td><strong>Labor Flexibility</strong></td>
<td>Readiness with which the number of workers can be changed</td>
<td></td>
<td>Atkinson (1985) [75]</td>
</tr>
<tr>
<td>[Numerical Flexibility]</td>
<td></td>
<td></td>
<td>Kozan (1982) [76]</td>
</tr>
<tr>
<td>[Functional Flexibility]</td>
<td>Different types of tasks performed by the workers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[Financial Flexibility]</td>
<td>Ease with which the compensations schemes allow changes in labor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[Work group Flexibility]</td>
<td>Ease with which the work group handles breakdowns and rerouting</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Material
[Input flexibility]
[Factor flexibility]

| Capability to make the parts with alternative composition and dimensions of raw materials | Gerwin (1987) [58] |

Source: Adapted from Ramasesh y Jayakumar (1991) [69]

Table III: Main activities of Engineering Consulting Firms

<table>
<thead>
<tr>
<th>MAIN ACTIVITIES OF ENGINEERING CONSULTING FIRMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVIL</td>
</tr>
<tr>
<td>- Transportation and Communications</td>
</tr>
<tr>
<td>- Hydrology and Hydraulics</td>
</tr>
<tr>
<td>- Geology and Geodetics</td>
</tr>
<tr>
<td>- Agronomy, Fishing and Cattle</td>
</tr>
<tr>
<td>- Town Planning and Architecture</td>
</tr>
</tbody>
</table>


Table IV: Operations patterns

1) Customer needs and wishes detection for project configuration
2) Feasibility and environmental impact studies
3) Information exchange with customer for final technical and technological specifications.
4) Plans and budgets elaborations
5) Project contract development with final specifications and project termination dates.
6) Project development
7) Project delivery to customer
8) Post-sale services


Table V: Sample distribution (Turnover and Group of Activity)

<table>
<thead>
<tr>
<th>Cat.</th>
<th>Turnover (euros)</th>
<th>Group of Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Civil Firms</td>
<td>Per cent</td>
</tr>
<tr>
<td>1</td>
<td>&lt; 300.000</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>300.000 – 600.000</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>600.001-3.000.000</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>3.000.001-6.000.000</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>&gt; 6.000.000</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>100,0</td>
</tr>
</tbody>
</table>

Source: Own processing
Table VI: Distribution in percentage of Engineering Consulting Companies in Spain

<table>
<thead>
<tr>
<th>Turnover (Euros)</th>
<th>&lt;300.000</th>
<th>300.000-600.000</th>
<th>600.001-3,000.000</th>
<th>3,000.001-6,000.000</th>
<th>&gt;6,000.000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of firms</td>
<td>27,3</td>
<td>32,3</td>
<td>27,2</td>
<td>6</td>
<td>7,2</td>
</tr>
</tbody>
</table>


Table VII. Nomenclature adaptation for service flexibility dimensions

<table>
<thead>
<tr>
<th>Manufacturing flexibility dimensions</th>
<th>Service flexibility dimensions</th>
<th>Adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material handling</td>
<td>Distribution of information</td>
<td>In service industries the main inputs flow is information, while material handling plays a less important role [80-82].</td>
</tr>
<tr>
<td>Machines</td>
<td>Personnel and equipment</td>
<td>Process equipments in service industries are mainly based on information technologies [83]. Personnel flexibility and versatility must be directly considered as they perform a higher degree of the service delivery compared to machines in manufacturing industries [27, 84]. Interconnection and interdependence between information technology and personnel flexibility allows us to consider both as a whole.</td>
</tr>
<tr>
<td>Product and production</td>
<td>Services and servuction</td>
<td>Even though service production and product-service are concepts broadly used we opted by the general denomination of services combined with the servuction term.</td>
</tr>
</tbody>
</table>

Table VIII. Adaptation of the service flexibility items

<table>
<thead>
<tr>
<th>Item code</th>
<th>Adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>Adapted to information technologies respect to the original which refers to material handling</td>
</tr>
<tr>
<td>AA</td>
<td>Adapted to activities performed by information technologies respect to the original which refers to material handling</td>
</tr>
<tr>
<td>BB</td>
<td>Adapted to activities performed by information technologies respect to the original which refers to material handling</td>
</tr>
<tr>
<td>Q</td>
<td>Referred to system dependency on workers errors</td>
</tr>
<tr>
<td>P</td>
<td>Referred to system dependency on workers errors</td>
</tr>
<tr>
<td>DD</td>
<td>Considers costs of workers flexibility when accomplishing new and/or different tasks</td>
</tr>
<tr>
<td>CC</td>
<td>Same as (DD) according to time of tasks completion</td>
</tr>
<tr>
<td>E</td>
<td>Flexibility is measured according to service orders instead of product stocks</td>
</tr>
<tr>
<td>G</td>
<td>Production flexibility is considered to be servuction flexibility</td>
</tr>
<tr>
<td>X</td>
<td>Referred to the workers ability to accomplish different tasks</td>
</tr>
<tr>
<td>Y</td>
<td>Referred to process flexibility according to waiting costs</td>
</tr>
<tr>
<td>H</td>
<td>Referred to autonomy of service delivery system without supervision</td>
</tr>
</tbody>
</table>

\(^1\) Codes are based in [70, 63, 87]
### Table IX: Operations strategy dimensions

<table>
<thead>
<tr>
<th>Operations strategy dimension</th>
<th>Cronbach’s alpha</th>
<th>Value near 0</th>
<th>Value near 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. - Type of operations layout</td>
<td>0,5981</td>
<td>Fix</td>
<td>Moving</td>
</tr>
<tr>
<td>II. – PUSH and/or PULL orientation of the service delivery process</td>
<td>0,6530</td>
<td>Pull</td>
<td>Push</td>
</tr>
<tr>
<td>III. – Degree of process standardisation</td>
<td>0,6844</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>IV. – Number of different services offered.</td>
<td>0,6240</td>
<td>Narrow</td>
<td>Broad</td>
</tr>
<tr>
<td>V. – Use of Information Technologies (cost reduction vs. service improvement).</td>
<td>0,6775</td>
<td>Service improving</td>
<td>Cost reduction</td>
</tr>
<tr>
<td>VI. – Back office and Front office interrelationship.</td>
<td>0,8826</td>
<td>Close</td>
<td>Separate</td>
</tr>
<tr>
<td>VII. – Human Resources specialisation</td>
<td>0,6310</td>
<td>Versatile</td>
<td>Rigid</td>
</tr>
<tr>
<td>VIII. – Degree of customer participation</td>
<td>0,7580</td>
<td>Cost reduction</td>
<td>Service adaptation</td>
</tr>
<tr>
<td>IX. – New service design and development</td>
<td>0,9331</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

Source: Own processing

### Table X.: Cronbach’s alphas for service flexibility dimensions

<table>
<thead>
<tr>
<th>Flexibility dimensions</th>
<th>Cronbach’s alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expansion</td>
<td>0,9616</td>
</tr>
<tr>
<td>Distribution of information</td>
<td>0,9325</td>
</tr>
<tr>
<td>Routes</td>
<td>0,8755</td>
</tr>
<tr>
<td>Personnel and equipment</td>
<td>0,9329</td>
</tr>
<tr>
<td>Market</td>
<td>0,8640</td>
</tr>
<tr>
<td>Services and servuction</td>
<td>0,8676</td>
</tr>
<tr>
<td>Process, programming and volume</td>
<td>0,5829</td>
</tr>
</tbody>
</table>

Source: Own processing
### Table XI: Direct effects of service operations strategy on flexibility

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Layout</td>
<td>-0.725*</td>
<td>0.138**</td>
<td>-0.638*</td>
<td>-0.486*</td>
<td>-0.584*</td>
<td>-0.53*</td>
<td>-0.532*</td>
</tr>
<tr>
<td>PUSH orientation</td>
<td>-0.623*</td>
<td>0.486*</td>
<td>-0.742*</td>
<td>-0.421*</td>
<td>-0.756*</td>
<td>-0.24</td>
<td>-0.42*</td>
</tr>
<tr>
<td>Standardisation</td>
<td>-0.763*</td>
<td>0.506*</td>
<td>-0.738*</td>
<td>-0.452*</td>
<td>-0.695*</td>
<td>-0.317***</td>
<td>-0.493*</td>
</tr>
<tr>
<td>Offered services</td>
<td>0.472*</td>
<td>-0.115</td>
<td>0.461*</td>
<td>0.649*</td>
<td>0.299</td>
<td>0.62*</td>
<td>0.379**</td>
</tr>
<tr>
<td>Use of I.T.</td>
<td>-0.745*</td>
<td>0.646*</td>
<td>-0.724*</td>
<td>-0.507*</td>
<td>-0.793*</td>
<td>-0.273**</td>
<td>-0.462*</td>
</tr>
<tr>
<td>Back and Front Office act.</td>
<td>-0.794*</td>
<td>0.546*</td>
<td>-0.751*</td>
<td>-0.614*</td>
<td>-0.754*</td>
<td>-0.412*</td>
<td>-0.545*</td>
</tr>
<tr>
<td>H.R. Specialization</td>
<td>-0.834*</td>
<td>0.639*</td>
<td>-0.826*</td>
<td>-0.546*</td>
<td>-0.786*</td>
<td>-0.352**</td>
<td>-0.518*</td>
</tr>
<tr>
<td>Customer participation</td>
<td>0.504*</td>
<td>-0.463*</td>
<td>0.515*</td>
<td>0.033</td>
<td>0.53*</td>
<td>-0.048</td>
<td>0.414*</td>
</tr>
<tr>
<td>New services development</td>
<td>0.516*</td>
<td>0.662</td>
<td>0.465*</td>
<td>0.798*</td>
<td>0.172</td>
<td>0.785*</td>
<td>0.519*</td>
</tr>
<tr>
<td>Standard R2</td>
<td>0.828</td>
<td>0.88</td>
<td>0.816</td>
<td>0.797*</td>
<td>0.84</td>
<td>0.878</td>
<td>0.426</td>
</tr>
<tr>
<td>F-Ratio</td>
<td>38.498*</td>
<td>58.259*</td>
<td>35.407*</td>
<td>31.594*</td>
<td>41.859*</td>
<td>56.994*</td>
<td>6.771*</td>
</tr>
</tbody>
</table>

n=71  
*p<0.01  **p<0.05  ***p<0.10

Source: Own processing