TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics, Mechanics, and Engineering
Vol. 67, Issue III, September, 2024

DEVELOPING THE EMPLOYEES' EXPERTISE IN AUTOMOTIVE OFFSHORE BRANCHES

Marius GAL, Lucian LOBONȚ, Claudiu V. KIFOR

Abstract: *The development of products from research and development centers has entered an era of intensified competition, driven by clients' demands for higher quality, market-driven innovation, accelerated development timelines set by business management, and reasonable pricing expectations from stakeholders. Offshoring can aid companies in expanding their international presence, discovering new talent, and maximizing employee effectiveness. This paper proposes a framework specifically designed for automotive software companies to manage offshoring processes effectively, ensuring project quality is maintained from design & development to delivery. It is crucial that software products developed or tested overseas adhere to internal standards, meet customer quality requirements, and comply with team-established criteria.*
Key words: *offshoring, management, expertise, orders allocation, knowledge transfer.*

1 INTRODUCTION

The competitive landscape for product development in research and development centers has become increasingly intense, driven by clients' demands for higher quality, market-driven innovation, accelerated timelines set by business management, and stakeholders' expectations for reasonable pricing. Offshoring offers companies opportunities to enhance international exposure, access new talent, and improve employee efficiency. This paper presents a framework tailored for automotive software companies to manage offshoring processes effectively, ensuring high project quality from initiation to delivery. It is essential that software products developed or tested abroad meet internal standards, customer quality requirements, and team-established benchmarks [1].

This applies also to the automotive industry, where the companies are striving to offer the best price for the best quality. Especially in the last two decades, the pressure is rising on the costs of the producers, and companies are looking for new solutions [2].

Globalization and the increasing number of competitors force multinationals to find more efficient and innovative ways for the development and testing of software applications, with the objective of obtaining competitive leads and performance growth. The new software applications have become increasingly costly, requiring specialized human resources.

In order to face the competition, companies must be efficient, provide projects to the clients on time and keep costs between the budget limits. Moreover, the requirements and preferences of the customers are in a continuous change. In light of these challenges, companies are moving entire projects or segments of projects from their headquarters to new branches, often situated in developing countries where there are more favorable human resources and lower costs; this practice is commonly referred to as offshoring. [3].

2 EXPANDING THE MARKET AND OFFSHORING

Reducing the price of a product can significantly increase demand. In the automotive industry, for example, a 30% reduction in a car's price can nearly double its global demand [4].

Received: 30.07.24; **Similarities**: 19.08.24: **Reviewed**: 20.08./31.07.24: **Accepted**:20.08.24.

Figure 1 illustrates that car demand increases significantly as prices decrease. Therefore, it is crucial for manufacturers to optimize costs, and one proven method used by other companies is offshoring.

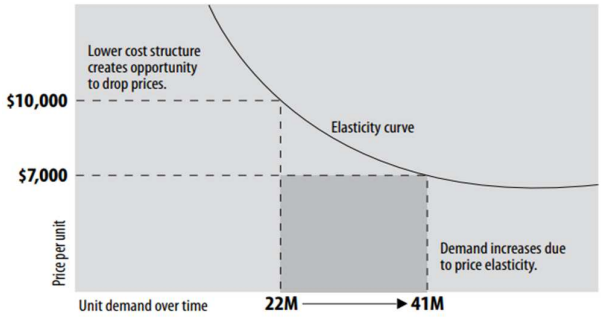

Fig. 1. Increase of demand in automotive industry [4]

According to Fabienne, offshoring of production is "relocation of parts of production to own locations abroad as well as to other suppliers abroad" [5].

Traditionally, the offshoring strategy included mostly manufacturing activities, but in the recent years this strategy started to incorporate also "administrative and technical services as well as advanced services and R&D-related functions" ([6]; [7]; [8]; [9]).

Starting with the 1990s, offshoring – relocation a part or complete process of a company from a country to another for various reasons, as described later, it is raised as one of the most widespread strategies adopted by Western industrial companies to keep and gain an economical advantage over the competitors [10].

To succeed in offshoring process, a rapid transfer of knowledge is necessary in the companies, so that the new offshoring team must learn as much as possible from the processes and expertise of colleagues from the Head Quarters. To present this transfer process, we have developed a framework (figure 2) that includes all the processes involved. This framework is composed of three stages, and in each stages specific processes and tools are provided, in order to support the transition in the offshore branches. To effectively monitor the evolution of the team, the following chapter presents a set of indicators designed to provide valuable insights.

3 FRAMEWORK FOR THE NEW OFFSHORE R&D BRANCHES

The designed framework supports any automotive development and software testing company in the transition in offshoring.

This framework gathers all the solutions proposed so far by the authors, the solutions which are chronologically ordered based on the expertise of the employees from the research and development centre.

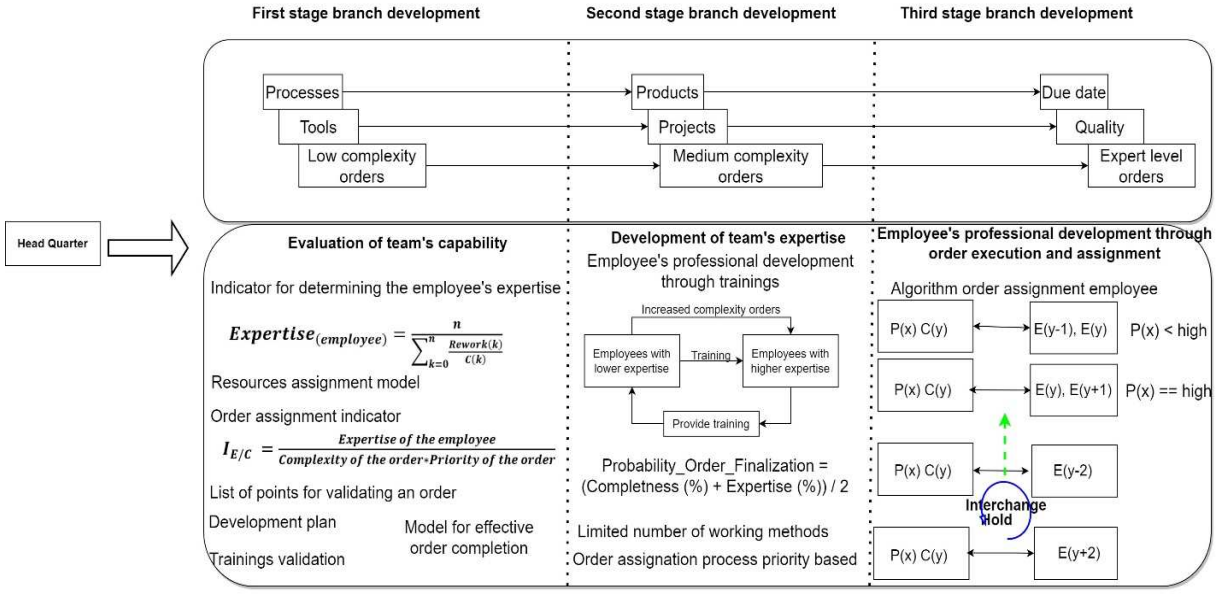

Fig. 2. Framework for new offshoring R&D branch

The Framework for orders deployment in offshore branches is based on three development stages:

- First stage: trainings are based on how the processes and tools work and on low complexity orders.

The following models and tools are recommended in this stage: the indicator and method for determining the employee's expertise; the model for effective order completion; the resources assignment model for a newly created team; the completeness order verification list; the proposed process for assigning an order; $I_{E/C}$ indicator; development plan for new employees.

- Second stage: trainings on product development and project management, knowledge capitalization and dissemination, algorithm for trainings evaluation and development; development path for becoming mentors within the team for medium and high expertise employees.

Tools recommended here: – Making offshore branches independent from HQs; proposed model for increasing the expertise during the order execution; Proposed process for assigning an order; $I_{E/C}$ indicator; development path for becoming mentors within the team for medium and high expertise employees.

- Third stage: trainings are focused on high complexity orders, the algorithm for efficient and sustainable assignment of orders is applied.

Tools and models recommended here: algorithm for increasing the expertise; high complexity orders; IE/C indicator; algorithm for efficient orders allocation and knowledge transfer; function order_allocation (employees, orders); proposed process for assigning an order; proposed model for increasing the expertise during the order execution; development path for becoming mentors within the team for medium and high expertise employees total independence from the Headquarters support in trainings;

The details of each stage from Figure 2, are:

1. In the initial phase, the attention concentrates on tools composed of formulas to identify the team's capability and help evaluate the employees in assigning the orders. It is necessary to acknowledge employee's level of knowledge to distinguish the level of complexity of the orders assigned to them, ensuring a long-term predictability of quality and suitable execution time. Furthermore, based on the current level of knowledge, the support for increasing expertise will continue.

The indicator formula helps to make the decision to assign the appropriate orders to the employee with enough expertise and to help in the medium and long term in the development of the team's expertise and know-how.

2. The second stage aims at developing the expertise of each employee. Depending on the results of the development plan, the employee who has good and very good results will be able to be mentor in the short future for his new colleagues. During the development process, the training feedback is tracked for continuously improvement of the content.

3. At the third stage, in parallel with the development process, the algorithm for efficient and sustainable assignment of orders according to their priority and complexity is applied. Thus, together with a mentor the employee will be able to execute orders of higher complexity than its present expertise.

Considering this framework, the orders are transferred from Head Quarters to the new branch at the steps presented without the customer noticing a decrease in the quality of the software products.

The goal of having the same speed and quality as in Head Quarters will be supported concomitantly by all management levels.

4 EMPLOYEE'S EXPERTISE

Among the most useful things for management at the beginning of the journey is to be able to observe the evolution of the employees. The formula for Employee's expertise allows this to be done much easier and impartially based on the history of employee results.

Employee experience is an important part of a pre-check to verify that an order will meet the

deadline and meet quality standards. As soon as the team becomes independent, the purpose for which it was created has been achieved. Therefore, independence must be achieved in a short time and the team must be able to solve most orders received.

For this, a formula is needed to help the management in an objective way regarding the present expertise as well as the evolution of the employees as well as to more easily observe if there are problems during the transfer of knowledge from Head Quarters to the new branch.

In mathematics and statistics, for finding out the central rate of a finite data set, the arithmetic mean will be determined by dividing the sum of the number of the array to the number of values in the collection [11].

To have the output with the highest precision, an analysis is made on a sample of 10 employees who have completed a certain number of orders of different complexities.

$$Expertise\_1 = \sum_{k=0}^{n} \frac{C(k)}{n} \quad (1)$$

- The mean represents the complexity of all the orders divided by the total number of orders

- n is the number of orders the employee worked on. It was built in this manner for decreasing the potential impact of the rare high complexity orders; when an order with high complexity is coming from the client it will make sure that it will be assigned to an employee who can handle the order properly.

When calculating the employee's expertise, it was noticed that some employees could have, according to the presented formula, a medium expertise only after three orders which is a premature categorization since the number of orders completed by now is low.

This can be seen in Table number 1, where employee number 4, according to this formula, with only three completed orders of low complexity, is close to the same expertise as employee number 2, who has far more orders finalized. Therefore, a new formula was needed for having equity between the employees and it was taken the decision to add a square root number from the total number or orders accomplished until that moment. As a result, the next formula is suggested:

$$Expertise\_2 = \sqrt{n} * \sum_{k=0}^{n} \frac{C(k)}{n} \quad (2)$$

Expertise_2 formula is improved, but it is not bulletproof, it does not give the impartial result when including the rework that was necessary to complete those orders. Therefore, if a rework is considered as an order, the results are not concluding. Between Employee 1 and Employee 3, the gap is too big when compared their work, they have the same number of orders completed, almost the same number of reworks but the results show us that employee number 3 is two times better than the Employee 1.

For the next formula, correlation will be used for linking the causality between the mean of the order's complexity and the mean of the reworks.

In statistics, correlation is a statistical association, in this case, causal between two variables and useful because it can indicate a predictive relationship between our known data [12].

Hence, a more detailed formula is needed where the rework is considered different than an order:

$$Expertise\_3 = \sqrt{n} * \frac{\sum_{k=0}^{n} \frac{C(k)}{n}}{\sum_{k=0}^{n} \left(\frac{Rework(k)}{n}\right)} \quad (3)$$

This formula is intended to give a higher weight to the client's satisfaction. The client's satisfaction, in this case, is quantified as the number of complaints received about an order. If the number of reworks is minor, the knowledge of the employee will be increased at a high rate and in the case that the number of reworks is big, the result will be proportionally diminished. This formula does not have the best precision, as it can be observed in the Table 1, when checking the results of employee number 4 with the rest of the employees. Again, the gap in the calculated expertise for Employee 1 and Employee 3 is very big, even though they should be close to the same level. Hence, another formula was developed, Expertise_4:

$$Expertise\_4 = \frac{n}{\sum_{k=0}^{n} \frac{Rework(k)}{C(k)}} \quad (4)$$

C(k) - complexity of the order k

n - number of orders

Rework(k) - represents the number of failed reviews from the client. This means that an order which is sent as finished to the review has been sent back to the developer or tester for rework.

5 RESULTS EVALUATION

The Table 1 was created for evaluating the differences of the outcomes when applying all the four proposed formulas. These data are selected to prove or invalidate the efficiency, accuracy, and objectivity of each formula so the most suitable one can be chosen.

The first column represents the orders and the name of the formulas. There are columns which are written the complexity of each of the orders from one to five. The highest complexity is three and the lowest is one.

Table 1

Output of the proposed formulas.

Order number	Order's complexity for Employee 1	Number of reworks	Order's complexity for Employee 2	Number of reworks	Order's complexity for Employee 3	Number of reworks	Order's complexity for Employee 4	Number of reworks
1	3	2	1	2	3	2	1	2
2	3	1	1	1	3	1	1	1
3	3	1	1	1	3	1	1	1
4	3	1	1	1	3	1		
5	3	1	1	1	2	1		
6	3	1	2	1	3	1		
7	2	1	2	1	2	1		
8	3	1	1	1	3	1		
9	3	1	1	1	3	1		
10	3	3	1	1	3	1		
Expertise_1	2,23		1,09		4,8		0,75	
Expertise_2	7,05		3,44		15,168		2,37	
Expertise_3	5,42		3,13		13,789		0,99	
Expertise_4	21,53		10,09		25,45		2,25	

Table 1 provides the results, every employee having a different knowledge expertise according to the formulas applied.

Reflections over the formula Expertise_1: if Employee 1 is compared with Employee 3 the result of this formula does not reveal the fact that one of them has more experience in the company than the other. A major deficiency of the formula is that it does not take into consideration the number of reworks, which is not the same for both employees. Employee 1 had two extra reworks on the orders, but the formula displays that they have approximately the same expertise, even though they worked on orders with the identical complexity, which is not impartial and rational. This case demonstrates that this formula is not a feasible and objective enough to be used. We also have the case where we compare the expertise of Employee number 1 with Employee number 3. The difference between the two is too big, especially when the difference between the two is represented by two reworks.

The formula Expertise_2 was designed to give more substance to the number of orders which have been resolved, so the square root has been added as a multiplication to the first formula. As in the previous formula, here too we have also a big discrepancy between the expertise of Employee 1 when compared to the expertise of Employee 3, even though their work history is quite similar.

The formula Expertise_3 it is not suitable when we want to find out the expertise of Employees' number 1 and 3, it does not provide an objective answer and it cannot really help in allocating work orders to employees.

Formula Expertise_4 offers the expected results in all the scenarios where the previous formulas showed flaws. First the difference between the Employee 2 and Employee 4 is reliable and it offers the objective perspective over the expertise of the two employees and the highest expertise has the smallest number of reworks. The difference between the Employee 1 and Employee 3 is big enough to underline that Employee 3 is the one with the highest expertise from this example. Employee 3 has a bigger knowhow than Employee 1 since the number of reworks is smaller. Also, Employee 3 when compared to any other member from the team it has the higher ranking because the orders had the highest complexity and the lowest number of reworks.

6 CONCLUSIONS

To be successful, a new office opened in another country must prove its efficiency and the fact that the client can count on those employees that orders will be completed. A complete framework is necessary for the team and management in the first period of offshoring. The work of assigning orders and supporting the development of technical skills will be intuitive and straightforward to apply. This formula will help the company's management to evaluate both the employees and the level of the team. From here, each management team can extrapolate these results for a future increase in the team's knowledge or to appoint mentors or experts within the team to help colleagues from Head Quarters by taking over their work.

7 REFERENCES

[1] Pai, R., U.., Banerji, S.., Garza-Reyes, J., A., Lim, M., Kumar., *Selection and Ranking of Low Cost Countries for Outsourcing and Offshoring in the Manufacturing Sector*, IFIP International Conference on Advances in Production Management Systems APMS 2013, pp. 501-512, 2013.

[2] Woolliscroft, P., Caganova, D., Cambal, M., Holecek, J., Pucikova, L. *Implications for optimisation of the automotive supply chain through knowledge management*, Procedia CIRP, ISSN 2212-8271, 2013.

[3] Meşniță, G., Dumitriu, F., *The Issues of Romanian IT Outsourcing Market*, Analele Științifice ale Universității "Alexandru Ioan Cuza" din Iași, Tomul LII/LIII Științe Economice, 2005/2006.

[4] Farrell, D., *Smarter offshoring*, Harvard Business Review, June, pp. 84-92, 2006.

[5] Fel, F., Griette, E., *An Analysis of the Offshoring Decision Process: The Influence of the Company's Size*. Procedia - Social and Behavioral Sciences. 58, 2012.

[6] Lewin, A. Y., Massini, S., Peeters, C., *Why are companies' offshoring innovation and quest; the emerging global race for talent*. Journal of International Business Studies, 40(6), pp. 901–925, 2009.

[7] Castelli, C., Castellani, D., *The internationalisation of R&D: Sectoral and geographic patterns of cross-border investments*. Economia e Politica Industriale—Journal of industrial and business economics, 1, pp. 127–143, 2013.

[8] Albertoni, F., Elia, S., *The global sourcing of business services: Evidence from the offshoring research network survey*. Economia e Politica Industriale, 41(2), pp. 131–146, 2014.

[9] Castellani, D., Mancusi, M, L., Santangelo, G, D., Zanfei, A., *Exploring the links between offshoring and innovation*. Economia e Politica Industriale March, Volume 42, Issue 1, pp. 1–7, 2015.

[10] Contractor, F. J., Kumar, V., Kundu, S. K., Pedersen, T., *Reconceptualizing the firm in a world of outsourcing and offshoring: the organizational and geographical relocation of high-value company functions*. Journal of Management Studies. 47 (8), pp. 1417–1433, 2010.

[11] Jacobs, H. R., *Mathematics: A Human Endeavor* (Third ed.). W. H. Freeman. p. 547, ISBN 10: 071672426X, 1994.

[12] Croxton, F, Emory., Cowden, D, Johnstone., Klein, S., *Applied General Statistics*, Pitman, ISBL 027340315X, 1968.

Dezvoltarea abilităților angajaților în sucursale offshore din industria auto

Rezumat: Dezvoltarea produselor din centrele de cercetare şi dezvoltare a intrat într-o eră cu concurență acerbă, accentuată de dorința clientului pentru o calitate sporită, inovația constantă cerută de piață, dezvoltarea rapidă dictată de managementul companiilor şi preţurile accesibile dictate de părțile interesate. Offshoring-ul poate ajuta companiile să-și mărească expunerea internațională, să găsească noi talente și să sprijine compania pentru a maximiza eficiența angajaților săi. Lucrarea propune un cadru care poate fi utilizat în companiile de software auto în procesul de offshoring, pentru a menține sub control calitatea proiectelor, de la primii pași, până la livrarea proiectului către client. Este imperativ ca produsul software, care este dezvoltat sau testat în altă parte a lumii decât țara de origine a companiei, să îndeplinească standardele interne, standardele de calitate cerute de client și standardul care a fost creat de echipă.

Marius GAL, PhD, Engineer, marius_gal@yahoo.com, +40753911331, Sat Santion, com Borş, Bihor.

Lucian LOBONŢ, Asist. Prof. PhD., Lucian Blaga University of Sibiu, Faculty of Engineering, Department of Industrial Engineering and Management, lucian.lobont@ulbsibiu.ro

Claudiu V. KIFOR, Prof. PhD., Lucian Blaga University of Sibiu, Faculty of Engineering, Department of Industrial Engineering and Management claudiu.kifor@ulbsibiu.ro