# R&D Outsourcing Contract Stimulates the Efforts of Sharing Implicit and Explicit Knowledge

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***Abstract***

*The main aim of this article is to support a R&D outsourcing contract designoutline to incent R&D outsourcing provision of distribute implicit and explicit knowledge. The principal-agent theory to formsmultitask principal-agent model which focuses on dual cases. First one is that the effort costs of explicit and implicit knowledge sharing are complementary, while another is the effort costs are identical.When the costs of explicit and implicit knowledge sharing are complementary, theconsumer can increase the enticement coefficient of explicit knowledge sharing to motivateimplicit knowledge sharing. This motivation process not only stimulates implicit information sharing, but also stimulates the effort levels of explicit knowledge sharing. Furthermore, the multitask R&D outsourcing deal can motivate the effort of explicit knowledge sharing to attain system optimization, but it fails to motivate the effort of implicit knowledge sharing to accomplish system optimization.*

*The paper encompasses prior literature by scheming multitask R&D outsourcingcontract in order to share the implicit knowledge. Here not only consider the cost of switch the relationship between tacit knowledge and explicit knowledge, but also study the cost of complementary relationship.*

**Research limitations:***In this paper consider only the outsourcingrelationship is short-range, so the multitask R&D outsourcing deal is formal. In fact, the outsourcing relationship might be long-term, and the multitask R&D outsourcing contract will be informal.*

**Keywords:** *R&D outsourcing, knowledge sharing, implicit knowledge value, explicit Knowledge value, principal-agent, incentive contract.*

## I. INTRODUCTION

Nowadays, many companies with large R&D budgets gradually require their laboratories to justify their presence by selling their service area to product/process business units within the corporation/group or even to other, non-affiliated firms. Some companies now conduct less than 10% of their R&D at corporate R&D centres. At the extreme, companies may out-source their entire R&D, retaining only the ability to specify and buy-in what they need.

The main task of research and development (R&D) productivity within the pharmaceutical industry are fully documented. Same response over the last few years has been a race to large-scale strategic clinical outsourcing pacts moving sincea traditional base of transactional and adversarial relationships.

For getting external knowledge quickly, the originalities may outsource R&D business to professional service providers (SP). Knowledge can be split into explicit knowledge and implicit knowledge. Utmost of explicit knowledge in R&D outsourcing is stated in the form of reports, patents software and so on. The value can be confirmed by third-party organizations, such as examination panel, Patent Office and Software Testing Center. In difference, tacit knowledge can be communicated and shared between SP and enterprises through communication, but its value cannot be confirmed like explicit knowledge.

Based on literature survey the pharmaceutical and biotech industry have the highest levels of R&D outsourcing across hi-tech industries, with its outsourcing evolution rate exceeding internal investment. The previous discoveries across industries, functions, and types of outsourcing,recommended that outsourcing had matured beyond cost reduction. It had become a way for associations tobetter access talent and capabilities, gain more flexibility, reinvent their business model and drive innovation. In a PwC Global Outsourcing review of 226 customers and 66 outsourcing service providers in 19 countries, 91% of respondents, either happy or not. The PwC Annual CEO review in 200810 found that various top global executives believed that they increase major competitive advantages from outsourcing functions including R&D.

## II. DESIGN MODEL

Consider a risk neutral consumer outsourcing R&D project to a risk neutral SP. Normallytalking, service providers generate and innovate knowledge technology by investingknowledge and human investment in R&D, most researches use the degree of service provider's hardworking to describe the R&D's

investment of service providers quantitatively. For that reason, this paper follows this method, but it divides effort into two types according to the characteristics of knowledge, which contains explicit and implicit knowledge. One is *p1*, the level of efforts made in sharing explicit knowledge, which can be stated by coding and whose value can be confirmed by the third-party organizations; the other is *p2*, the level of efforts made in sharing implicit knowledge, which cannot be conveyed by coding and whose value cannot be tested by the third-party organizations, wherein $0 \le p1 \le 1$, $0 \le p2 \le 1$. Assume further that thecost function of these two efforts is $C(P1, P2) = \frac{1}{2}(k1\, p1^2 + k2\, p2^2 + sp1p2)$, wherein *k1*and *k2*areindependent quadratic cost coefficients for the two efforts correspondingly, *s* is the cost correlation coefficient of the two efforts. The cost functions above the common features of convex function, which cost and bordering cost increase gradually. If $s < 0$, it means that the increase of one effort can lead to the decrease of the borderingcost of the other effort. In thesame way, if $s > 0$, it means that the increase of one effort can lead to the increase of the bordering cost of the other effort.

Where p1 is the input of service providersin sharing explicit knowledge, p2 is the efforts level of service providers in sharing implicit knowledge, k1 and k2are independent cost factor for the two efforts correspondingly, *s*is the cost correlation coefficient of the two efforts. The cost function above has the general features of convex function, which cost and bordering cost increase gradually. In order to the cross partial derivative of two efforts costfunction is $\frac{\partial^2 C(p1,p2)}{\partial p1 \partial p2} = \frac{1}{2}\, s$ if $s < 0$, means the increase cost of one effort can be decrease the marginal cost of the other effort. In equally if $s > 0$, means that the increase cost of one effort can lead to increase the marginal cost of the other effort. Consequently, the cost correlation coefficient of two effort *s* shows the complementary or substitutionconnection between explicit and implicit knowledge. The value which the customer can earn from explicit and knowledge sharing is $\pi1\ (p1) = \lambda1p1$, $\pi2\ (p2) = \lambda2p2$, where $\lambda1$, $\lambda2$ are the output coefficient. The value $\pi1$ and$\pi2$ can be verified separately. As the employers cannot be observe the efforts of service providers, there is a suitable hazard. The conventional method to solve this problem is offering incentive wage.

This paper uses revenue sharing contract to stimulate service providers to work hard, and continues to use the linear revenue-sharing contract. Let assumes that the amount paid by consumer is $W = F + \beta1\pi1 + \beta2\pi2$, wherein *F* is the fixed-price of R&D outsourcing, $\beta1$ and $\beta2$ are the incentive coefficients of revenue sharing, these are produced by sharing explicit and implicit knowledge. The component $\beta2$ is not compulsory by the third parties since the outcome $\pi2$ is unverifiable. Proper contract is one kind of promise, which is used for ex post verification. Further, it can be forced by the third-party organizations (e.g. collector office). Under the formal R&D outsourcing contracts, the buyer and service providers are playing a single-cycle game. The time series of the game is shown in Figure 1.

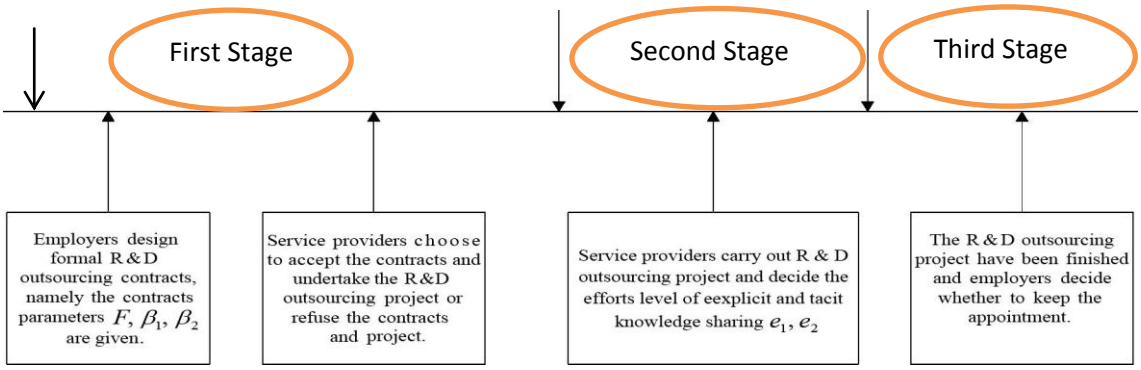


**Fig.1 Time Series of the Game of Formal R&D Outsourcing Contract**

According to the source of reverse resolving in a game, stage 3 is consider as first, the customer decide either to fulfill the contracts or not. There is no problem whether the project succeeds or not, customer need to pay fixed amount. Then, the success of explicit knowledge, as long as being tested by the third-party organizations, they must be pay for the customer as stated in the contracts. If not, the customer may be prosecuted and court will bring in an enforcement verdict. Compared with explicit knowledge, the value of implicit knowledge cannot

$$R = (1 - \beta1)\lambda1p1 + \lambda2p2 - F \qquad (1)$$

be verified by court, if the customer does not pay the money according to contracts, there is no risk in law.

## III. MODEL ANALYSIS

In this case, the consumer will choose to implement implicit knowledge sharing stimulation or not. If they do, $d$ = 1; if they do not, $d$ = 0. Therefore, the expected revenue of the customer$R$ in the third stage is $R = (1 - \beta 1)\ \lambda 1 p 1 + (1 - d\beta 2)\lambda 2 p 2 - F$. For the same reason, in the third step of the game, the customerneed to maximize their interests chosen d = 0, that means they will not declare the value of implicit knowledge sharing. Then revenue of the customer can be expressed as

In the second stage of the game, The SP decides the required efforts need to spend finally to share explicit and implicit knowledge. According to the standard of complete rationality and reverse solving of this stage service providers can predict the customer will not pay for the value of implicit knowledge sharing in the third stage, named as predict $d$ = 0. As a result, theexpected revenue of service provider's$r$ is

$$r = F + \beta_1\lambda_1 e_1 - \frac{1}{2}\left(k_1 e_1^2 + k_2 e_2^2 + s e_1 e_2\right) \quad (2)$$

In the first stage of the game, the customer makes the R&D outsourcing contract. The contract should be satisfy the incentive compatibility limit and the membership constraint of principal-agent relationship. The following optimization model **P1**is describes the inequality constraints:

$$\mathbf{P1} \qquad \max_{F,\beta_1} \quad R = (1-\beta_1)\lambda_1 e_1 + \lambda_2 e_2 - F \quad (3)$$

$$\text{St} \qquad \frac{\partial r}{\partial e_1} = \beta_1\lambda_1 - k_1 e_1 - \frac{1}{2} s e_2 = 0 \quad (4)$$

$$\frac{\partial r}{\partial e_2} = -k_2 e_2 - \frac{s e_1}{2} = 0 \quad (5)$$

$$F + \beta_1\lambda_1 e_1 - \frac{1}{2}\left(k_1 e_1^2 + k_2 e_2^2 + s e_1 e_2\right) \geq U \quad (6)$$

In model P1, formula (3) describes the target function of the customer's revenue maximization, and formula(4) and (5) are incentive compatibility constraints of service providers and formula (6) is membership constriction of service providers, which ensures that when service providers agree R&D, their revenue is not less than reservation utility $U$. Note that the fixed price F is used to change the profits of service providers in membership constraint. If the customer's revenue reaches the maximum value, the equation needs to achieve the optimal condition.

$F = -\beta 1\lambda 1 p 1 + \frac{1}{2}(k_1 P_1^{\,2} + k_2 P_2^{\,2} + s\, P_1\, P_{2)} + U$

## IV. CONCLUSION

R&D outsourcing is one of the most attractive ways to gather external knowledge rapidly. The existing researches only focus on transmitting and sharing explicit knowledge, whose value can be verified, butomit the transmission and sharing of implicit knowledge whose value cannot be supported. Hence leads to the lack of implicit knowledge sharing in R&D outsourcing. In order to stimulate implicit knowledge sharing as well as explicit knowledge sharing, amultitask principal-agent model of immediate stimulation of explicit and implicit knowledge is established and analyse the incentive effects of formal and informal relational contracts.Above result shows that the relationship between the costs of explicit and implicit knowledge sharing are equally substitutable, the formal contract can only stimulate the effort of sharing explicit knowledge but fails to stimulate the effort of sharing implicit knowledge. When the two are complementary, formal contract can stimulate the efforts of sharing explicit and implicit knowledge at the same time. However, it can only stimulate the effort of explicit knowledge sharing to the optimal level, not implicit knowledge sharing.

## REFERENCES


[1] Aksin, O.Z., De Vericourt, F., &Karaesmen, F. (2008). Call center outsourcing contract analysis and choice. Management Science, 54(2), 354-368. http://dx.doi.org/10.1287/mnsc.1070.0823

[2] Bals, L., Kneis, K.C., Lemke, C., & Pedersen, T. (2013). Toward a flexible breathing organization: r&d outsourcing at bayer. Offshoring Challenge, 211-226. http://dx.doi.org/10.1007/978-1-4471-4908-8_12

[3] Buss, P., &Peukert, C. (2015). R&D outsourcing and intellectual property infringement. Research Policy, 44, 977-989.http://dx.doi.org/10.1016/j.respol.2014.11.006

[4] Cai, S., Kai, C., &Zou, B. (2011). Producer services outsourcing risk control based on outsourcing contract design: industrial engineering perspective. Systems EngineeringProcedia, 2, 308-315.http://dx.doi.org/10.1016/j.sepro.2011.10.043

[5] Cheng, J.H. (2011). Inter-organizational relationships and knowledge sharing in green supply chains—Moderating

by relational benefits and guanxi. Transportation Research Part E:Logistics and Transportation Review, 47(6), 837-849.http://dx.doi.org/10.1016/j.tre.2010.12.008

[6] Gershman, M., &Kuznetsova, T. (2013). Efficient Contract in the R&D Sector: Key Parameters.Foresight-Russia, 7(3), 26-36.http://dx.doi.org/10.17323/1995-459X.2013.3.26.36

[7] Han, S.Y., &Bae, S.J. (2014). Internalization of R&D outsourcing: An empirical study.International Journal of Production Economics, 150, 58-73.http://dx.doi.org/10.1016/j.ijpe.2013.12.001

[8] Kultti, K., &Takalo, T. (2000). Incomplete contracting in an R&D project: the Micronas case. R&D Management, 30(1), 67-77. http://dx.doi.org/10.1111/1467-9310.00158

[9] Mulkay, M. (2014). Science and the Sociology of Knowledge. Routledge.Pashupatimath, G.R., & Ramakrishna, H. (2015).Global engineering offshore outsourcing-a literature review.International Journal of Business and Systems Research, 9(1), 32-48.http://dx.doi.org/10.1504/IJBSR.2015.066803