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ORIGINAL ARTICLE

Deriving and Assessing Strategic Priorities for Outsourcing Partner Selection in Pharmaceutical R&D: an Approach Using Analytic Hierarchy Process (AHP) Based on 34 Experts' Responses From Korean Pharmaceutical Industry

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Abstract

Purpose Despite an increasing proportion of activities along the pharmaceutical R&D value chain being outsourced, little attention has been devoted to examine the factors affecting the outsourcing partner selection process. This paper aims to suggest priorities of influencing factors for maximizing the efficiency in governing outsourcing arrangements.

Methods This paper adopts the analytic hierarchy process (AHP) based on 34 experts' responses from Korean pharmaceutical industry to rank a set of different criteria substantial for establishing a new outsourcing relationship. A total of 14 sub-criteria (encompassing a range of task-related and partner-related issues) were identified and used to construct the AHP model. Two different outsourcing scenarios were considered: (1) outsourcing of R&D activities in the early stages of drug discovery and (2) outsourcing of regulatory affairs tasks.

Results In case of R&D outsourcing, the criterion "Cost-saving potentials" was the most dominant factor affecting the partner selection decision followed by "Commitment" and "Partner compatibility." In case of outsourcing regulatory affairs task, "Reputation" and "Specialized expertise" were perceived as significant selection criteria.

Conclusions The study facilitates the process of assessing factors that have a major impact on the outsourcing partner selection. It further contributes to building consensus within the organization and can serve as a reference point for learning about challenges encountered in outsourcing decision. The findings can also provide lessons for other research-intensive industries that have not yet developed their outsourcing activities to the same extent.

Keywords AHP · Outsourcing · Partner selection · Task-related issues · Partner-related issues

Introduction

Outsourcing in pharmaceutical industry, which traditionally referred to as a short-term strategy to reduce costs or obtain additional manufacturing capacity, is being increasingly perceived as a suitable option to improve performance in all stages of the pharmaceutical value chain [1]. Confronted with different challenging market conditions [2], pharmaceutical companies have focused on operational improvement through elimination of redundancy in the drug development process and the creation of strategic approach to insourcing and outsourcing to remain competitive [3]. Outsourcing provides considerable flexibility to efficiently manage the rapid ramp-up and ramp-down of activities in particular areas and access to external expertise that companies do not own or do not wish to own within their organizations. The selection of an appropriate partner is an important prerequisite, if the outsourcing is to succeed. A well-qualified partner cannot only provide the necessary breathing space to relocate the focus of internal capabilities to core competencies but can also enhance the financial picture by reducing the need for heavy capital expenditures [4].

While a few literatures highlighted the importance of outsourcing and examined the motives and key determinants to outsourcing success in the pharmaceutical industry [5–7], an attempt to prioritize factors relevant to partner selection in

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R&D (research and development) outsourcing context is scant. With outsourcing providers able to offer dedicated solutions to almost any given problem [8], it is of theoretical and practical interest to explore the determining factors that support the process of selecting the most qualified outsourcing partner. The literature, however, mainly dealt with outsourcing strategies in designing optimal supplier and manufacturer network and less underlined the inter-organizational compatibility as a decision-making factor [9, 10]. Depending on the given outsourcing scenario, determining the appropriate "weight" of different influencing factors is required to improve outsourcing outcomes in a competitive business environment. Ranking priorities of influencing factors is critical to more clearly identify the impacts of influencing factors on the goal hierarchy and to drive discussions about them. Although AHP appears to be pseudo-quantitative, AHP can provide the robustness and flexibility needed for the decision-maker to break down the decision problem. Thus, it can be taken as an easily understandable and defensible approach, especially to practitioners [11]. This motivated us to develop a framework based on the multi-criteria decision making method—analytic hierarchy process (AHP)—to provide guidance in establishing associated partner selection policies. An AHP approach has a number of features that make it particularly useful in a complex managerial decision-making environment. It provides a framework for formalizing the evaluation of multiple criteria, all of which affect the final decision [12]. Moreover, as AHP allows to effectively rank a finite number of decision alternatives, rather than prescribing a single correct solution, this method is beneficial to find a consensual rationale in the context of partner selection. This is due to the fact that if multiple decision alternatives are present, decision-makers can better understand the trade-offs between alternatives. Previously, AHP techniques have proven successful in assisting supplier selection and in prioritizing risk dimensions in the drug development process [13, 14]. However, it is not advisable to make a partner selection decision solely based on the results of AHP. Instead, AHP approach should be perceived as a supplement to traditional candidate ranking methods to better reach consensus within organization. Practitioners can leverage the findings to encourage communication with potential partners in a more efficient way. Consequently, this leads to the following research question: Which criteria affect the most the decision to select an R&D outsourcing partner?

For this purpose, several influencing criteria were identified through extensive literature review [15–30] and experts' inputs. The individual importance of each evaluation criterion was then rated by incorporating experts' domain knowledge. The present paper selected Korea as a target country to study. Recently, the pharmaceutical sector was selected as a new growth engine to stimulate economic development and attempts to position Korea as the Asian hub for pharmaceutical R&D are being made [31]. As Korea's pharmaceutical companies traditionally focused on generics business, significant efforts are needed to achieve translational research goals and to move the industry from a domestic model to global markets [32]. Outsourcing may provide aspiring companies a way to mitigate complexity in pharmaceutical R&D and stimulus needed for their long-term planning. Understanding the preference of influencing factors in an outsourcing context will be significant for companies seeking to select the most suitable outsourcing partners.

Methods and Data Collection

AHP

AHP, originally conceptualized by Saaty [12], is an effective instrument to simultaneously address multiple alternatives within a complex decision-making environment. It is a multi-criteria decision-making method, which makes use of a hierarchy to represent a decision problem (e.g., breaking down a problem from the more general to the more particular and definite element). It can aid the decision-makers to set the right priorities on the criteria of the hierarchy [33]. AHP requires decision-makers to provide judgments about the relative importance of each criterion, whereby each component in the decision hierarchy is presumed to be independent. The judgments are expressed in terms of pairwise comparisons of items. The advantages of using AHP technique lie in its ability to consider both tangible and intangible variables as evaluation criteria and in its simplicity to solve unstructured problems on the basis of pairwise comparisons, regardless of how many criteria are involved in the decision-making process. On this account, AHP is adequate for solving the research problem.

By reducing a complex matter to a series of pairwise comparisons, AHP enables to capture both subjective and objective measures of evaluation criteria and reach the most suitable decision with a clear rationale [34]. AHP consists of five major steps: (1) structuring a decision problem, (2) construction of pairwise comparison matrix, (3) checking the consistency ratio, (4) deduction of priorities for the criteria and alternatives, and (5) selection of the most suitable alternatives (or prioritization of influencing factors).

A detailed overview on how to apply AHP technique step by step, including theoretical background, can be drawn from the works of Saaty and Vargas [35]. AHP calculations can be performed using electronic spread sheets like Excel or software package such as Super Decisions (https://www.superdecisions.com/). The present study used Excel to analyze and prioritize factors relevant for the selection of the pharmaceutical outsourcing candidate.

Model Construction

A set of relevant criteria for the selection of outsourcing candidate were broadly discussed in the literature [11, 36–38]. The attributes underlying successful outsourcing partner selection can be broken down into task-related and partner-related selection criteria [39]. The task-related selection criteria (TSC) are associated with reviewing the availability of strategic resources and core competencies that can lead to superior innovation performance. Hence, they are more concerned with achieving strategic fit between partners. Such attributes include market knowledge, technological, and managerial capabilities [15]. Thus, an appropriate partner is one who can contribute to access to specialized expertise and improvement of cost control. The partner-related selection criteria (PSC) are associated with the notion of how the degree of organizational and relational fit can influence the outsourcing decision. There is often a high variability in how contracting entity and outsourcing provider perceive each other in terms of the norm for high-quality relationships. However, strong inter-organizational relationships can contribute to unlocking of hidden values beyond formal agreements. The relevant characteristics encompass experience established from previous cooperation success, reputation, participation, and cultural compliance. Thus, an appropriate partner is one who demonstrates a high level of trust, commitment, and communication skills and can develop a shared common vision. Hence, PSC underline the mutual compatibility and trust between cooperating partners.

In the proposed AHP model, three main criteria related to TSC and two main criteria related to PSC were identified. These criteria were obtained by synthesizing the results of previous research findings and by consulting experts in order to reflect their expertise and to double-check the plausibility of the overall model construct. The five main criteria were further broken down into 14 sub-criteria (see the lower half of Fig. 1). The same set of experts were consulted to confirm the adequacy of derived model construct, prior to collecting survey data (see the "Data collection" section for details). Because the relative importance of TSC and PSC is likely to be framed by the underlying outsourcing context, the present study considers two different outsourcing scenarios to support the outsourcing decision-making problems. Outsourcing can occur in different contextual scenarios along the pharmaceutical value chain. These include, inter alia, supplier selection in manufacturing context, IT outsourcing, or partner selection in R&D outsourcing. For this study, the case of pharmaceutical R&D outsourcing at the early stage of drug development and outsourcing of regulatory affairs task at the late stage of drug development are taken into account. In the former case, much of the proprietary knowledge and intellectual property underpinning the R&D must be generated in the course of outsourcing cooperation. In the latter case, reports for submission to regulatory agencies, such as United States Food and Drug Administration (US FDA), must be prepared. Figure 1 provides the proposed AHP model.

Explanation of Criteria

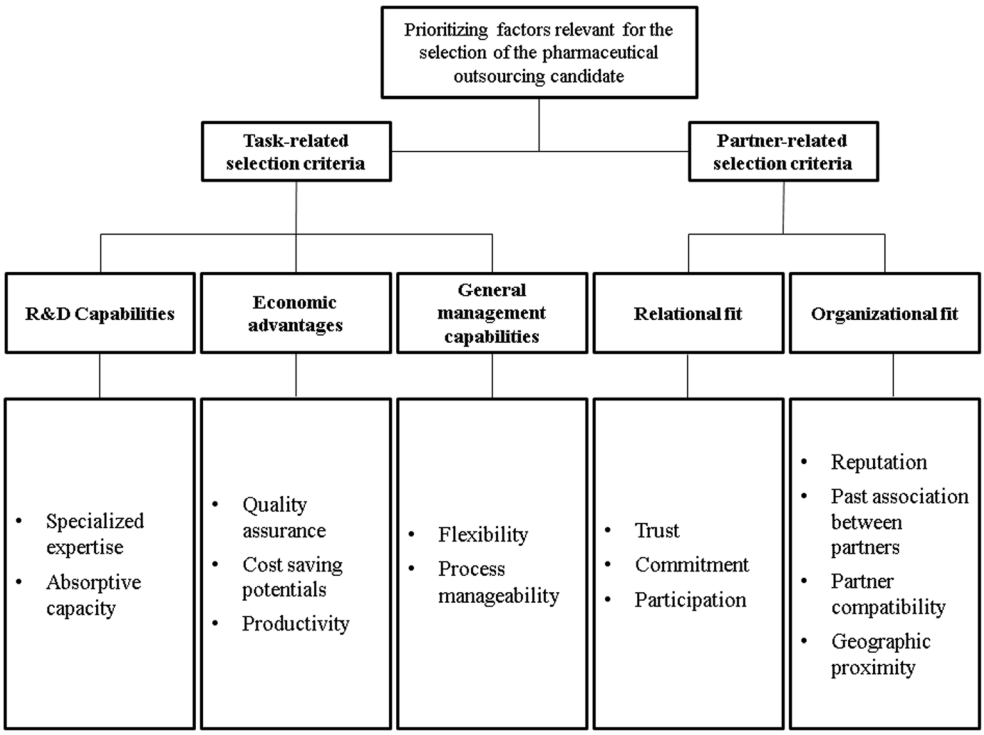
Task-Related Selection Criteria

A firm contemplating R&D outsourcing must carefully review that the outsourcing partner is equipped with an appropriate level of domain knowledge to carry out the outsourced function effectively. Especially, organizations deciding to outsource highly complex processes are required to thoroughly assess the availability of specialized knowledge, analytical thinking, and judgment skills [40]. Recent evidences suggest that the contractor's dynamic capabilities, operational flexibility, and the cost-cutting rationale are central to outsourcing decision making [7, 16].

Within "R&D capabilities" (RDC), sub-criteria related to the organization's R&D capabilities to meet the current and future demands of the contracting entities are subsumed. Specialized expertise (SE) refers to the level of knowledge which is essential to undertake a project with acceptable quality and assist the further development of innovations. Although the responsibilities of outsourcing companies and their contractors would vary depending on the contractual details, the contractor commonly assumes the responsibility for ensuring that the results for which the contracting entity has commissioned are delivered. R&D outsourcing offers companies an opportunity to bring in specialized/complementary knowledge not available internally. A lack of expected technical expertise may result in project stalling and a failure to deliver on given opportunities. The presence of specialized expertise can thus be a good indicator of partner's firm-level capabilities. Absorptive capacity (ACAP) refers to the ability of an organization to identify, assimilate, and exploit knowledge from external resources [17]. In general, the higher the absorptive capacity is, the better the firms are at understanding the instructions received from the contracting entity. Subsequently, firms with higher absorptive capacity tend to better capture the intrinsic value of the knowledge. Without proper level of absorptive capacity, the outsourcing provider might struggle to learn from their clients, and the acquisition of outside knowledge can only be achieved at excessive expense.

Within "Economic advantages" (EA), sub-criteria, which help maximize operational and cost benefits, are subsumed. Besides offering possibilities to complement the limited internal research resources, outsourcing contributes to lower development costs and shorter development times. Therefore, a set of cost and quality drivers need to be considered. Quality assurance (QA) refers to the ability of an organization to fulfill the quality requirements of the highly regulated nature of the pharmaceutical businesses. A high level of quality assurance

Fig. 1 AHP model



is compulsory to guarantee that the outsourced product or service conforms to the accepted quality standards. The contracting entity must verify that the contractor has appropriate quality monitoring processes at hand. Cost-saving potentials (CSP) refer to whether outsourcing can lead to decreased R&D expenses than conducting the related activities internally. Cost is usually not the sole factor based on which an outsourcing decision is made. However, if outsourcing providers demonstrate equally attractive attributes, contracting entity would tend to select an organization, which offers cost benefits. Productivity (PC) in the current context refers to the ability of a service provider to accelerate the pace of project implementation (e.g., rapid exploration of technology) and to meet predefined project timetable. Typically, enhanced productivity allows companies to gain competitive advantage through higher market shares, increased resource efficiency, premium prices, and greater customer loyalty [18, 19].

"General management capabilities" (GMC) characterize the corporate capabilities that help maintain and coordinate supplementary activities relevant for securing competitive advantages. Herein, managerial flexibility and consistency can be good indicators of partner's capabilities to respond to sudden changes in the environment. Flexibility (FLX) indicates the ability to adapt to environmental changes through continuous modifications in strategic actions. Flexible organizations can demonstrate diversity in strategic responses and rapid shifts from one strategy to another. Process manageability (PM) describes the degree of interaction perceived to be required by the contracting entity in the process of implementing and sustaining the outsourcing relationship. It considers the amount of management time invested, specific personnel involved, and individual energy expended.

Partner-Related Selection Criteria

Within "Relational fit" (RF), relational constructs, which are expected to impact the exchanged information quality, are subsumed. The contracting entity should be able to monitor and evaluate how the outsourced projects are progressing. For this purpose, the involved parties are encouraged to create measurable quality standards and guidelines through mutual consultation to minimize the risks entailed in outsourcing relationships [20]. Hence, forging a collaborative working relationship with outsourcing contractor, especially with people who are empowered to take proactive measures to tackle previously unforeseen issues, is critical to successfully implement outsourcing arrangements. This can be achieved if the involved parties show a reasonable degree of relational exchange attributes, which consist of following elements: trust, commitment, and participation [21, 22].

Trust (TR) refers to company's belief that the outsourcing provider will act to benefit contracting entity's interest regardless of the presence of a system to monitor such behavior. It is known to help overcome potential opportunism. A partnership with high trust could enjoy open communication, willingness to take risks, and reduced transaction costs [23]. Commitment (COM) reflects the contractor's willingness to undertake efforts to develop and maintain lasting relationships with its

contracting entity. It has also generally been defined as a willingness to make short-term sacrifices to realize longer-term benefits [24]. Strong commitment could result in uncovering of hidden needs. Participation (PART) concerns the extent and frequency of personnel involvement in the communication between contracting entity and contractor. Active participation, for example, through site visits, can positively impact the shared information quality.

"Organizational fit" (OF) refers to partner's compatibility with the organization's values and mode of operation. It influences the ease with which two organizations can be assimilated [25]. The components of organizational fit encompass reputation, past association between partners, partner compatibility, and geographic proximity [15, 26, 27].

Reputation (RP) refers to the overall assessment of a firm's relative standing among other firms. Obtaining a partner with a strong positive reputation can confer legitimacy and prestige in the marketplace [36]. Past association between partners (PA) refers to the firm's level of experience and learning from past collaborations. Companies with previous collaboration experience have likely encountered the more common challenges and learned from them to ensure its success [28]. Partner compatibility (PC) refers to the level of fit between partner's working styles and cultures [29]. Differences in operational philosophy, management styles, and problem-solving ability may produce conflicts of interest among partners. Geographic proximity (GP) refers to the physical distance separating two entities. Previous study indicated that geographic distance between partners hinders inter-firm knowledge sharing and the development of inter-organizational routines for effective knowledge integration [30].

Data Collection

A group of experts including R&D managers from the pharmaceutical industry, representatives from academic institutions, and consulting specialists for the value chain management were identified and invited to participate in the survey. The experts were gathered through purposive sampling technique. Purposive sampling describes the deliberate choice of a respondent due to the qualities the respondent possesses [41]. To this end, information-rich participants having significant knowledge and experience of going through the process of outsourcing evaluation were selected. The survey was distributed to 34 experts residing in South Korea and was conducted over October 2017. At the onset of the survey, anonymity of the participants was assured and survey instructions were provided.

Upon distributing AHP questionnaire, pairwise comparisons are made to capture the relative importance of the criteria with respect to the overall goal. The decision-makers can perform simple pairwise comparison judgments, which are then used to compute overall priorities for ranking influencing factors. AHP could be attractive to evaluators, because the pairwise comparison procedure enables them to offer a relative (rather than absolute) individual criterion assessment. To construct the pairwise comparison matrix, experts were asked to assign an importance score for each pairwise comparison. The degree of importance score is quantified on a scale of 1 to 9, whereby a higher importance was assigned to an attribute with an increasing scale factor (Table 1). An exemplary presentation of pairwise comparison matrix is shown in Table 2. Each entry a_{ij} of the matrix represents the importance of the criterion i relative to the criterion j. If $a_{ij} > 1$, then the criterion i is more important than the criterion j, while if $a_{ij} < 1$, then the criterion i is less important than the criterion j. For instance, the EA-RDC comparison cell (i.e., the intersection of the row "EA" and column "RDC") in Table 2 implies that EA is very strongly more important than RDC (EA → RDC = 7). The opposite yields the reciprocal value (RDC → EA = 1/7).

As the construction of pairwise comparison matrix is based on human judgments, some inconsistency is naturally expected and allowed when using the AHP approach. The consistency check is important to ensure that the judgments are executed with consistent view and precision. Consistency ratio (CR) is obtained by applying following equation: CR = CI/RI. CI refers to consistency index, which is given by $CI = (\lambda_{max} - n) / (n - 1)$. Parameter λ_{max} denotes the maximum eigenvalue of the matrix, and "*n*" represents the number of compared elements. The RI (random index) can be extracted from the random matrix consistency index table. The random index table can be accessed from the source specified [33]. CR less than 0.10 can be tolerated. Otherwise, the experts' judgments are considered as not reliable and must be reviewed to improve the inconsistency. In the present study, the consistency ratios of all judgments were within acceptable threshold limits.

Results and Discussion

Having identified that the judgments are consistent, the global priorities (i.e., priority weights among main criteria) are

Table 1 Interpretation of importance score in a pairwise comparison matrix

Importance score	Interpretation
1	Criterion *i* and *j* are of equal importance
3	Criterion *i* is moderately more important than *j*
5	Criterion *i* is strongly more important than *j*
7	Criterion *i* is very strongly more important than *j*
9	Criterion *i* is extremely more important than *j*
2,4,6,8	Intermediate values—for instance, a value of 4 means that criterion *i* is moderately to strongly more important

Table 2 Exemplary pairwise comparison matrix among main criteria (the case of R&D outsourcing)

	EA	GMC	OF	RDC	RF
EA	1	5	5	7	3
GMC	1/5	1	1/3	3	1/5
OF	1/5	3	1	4	1/3
RDC	1/7	1/3	1/4	1	1/5
RF	1/3	1/5	3	5	1

CR = 0.07

Table 4 Synthesized matrix among main criteria (the case of R&D outsourcing)

	EA	GMC	OF	RDC	RF	Global priority
EA	0.552	0.341	0.528	0.339	0.667	0.485
GMC	0.104	0.064	0.031	0.133	0.035	0.073
OF	0.102	0.206	0.098	0.211	0.061	0.136
RDC	0.075	0.022	0.021	0.046	0.034	0.040
RF	0.167	0.367	0.323	0.271	0.202	0.266

derived from the comparisons. In general, the priorities capture the dominance of the order expressed in the judgments of the pairwise comparison matrix and constitute the priority vectors of the pairwise comparison matrix [33]. Since the calculated priorities are valid only with regard to respective hierarchy level (i.e., main criteria or sub-criteria), the resulting values at the main criteria level are tagged as global priorities to differentiate them from the local and overall composite priorities. Local priorities are calculated at the level of sub-criteria. The overall composite priorities are the product of multiplication between local priorities and global priorities. As 34 different experts' opinions are considered, the geometric mean was used for averaging the importance scores. (Importance scores are the indicated preferences between two comparing factors by the survey respondents.) Tables 3, 4, 5, and 6 summarize the averaged matrix values for computing priority vectors for each outsourcing scenario.

The priorities are obtained by first dividing each matrix element by the sum of its column entries and then computing the row averages. For example, in case of R&D outsourcing (Table 3), the sum of column EA (1 + 0.189 + 0.185 + 0.135 + 0.303) is 1.812. Subsequently, each matrix element of column EA in Table 3 is divided by 1.812; 1 divided by 1.812 returns 0.552 (Table 4). The computation of row averages in Table 4 returns the global priority value ((0.552 + 0.341 + 0.528 + 0.339 + 0.667)/5 = 0.485). The rest of global priority values can be obtained by repeating the former calculation steps. The same computing process was used to determine the local priorities at the level of sub-criteria. Consequently, the synthesis of overall prioritized ranking is performed by multiplying priorities in the lower levels of hierarchy by the priority of their corresponding criterion in the level above. For example, the overall priority for "specialized expertise" (0.027) in Table 7 is calculated by multiplication of 0.040 ("global priority") and 0.685 ("local priority") (0.040 × 0.685 = 0.027). In Tables 7 and 8, the results of the global, local, and overall priorities for both considered scenarios are listed.

In case of R&D outsourcing, the main criterion "Economic advantages" (0.485) was the most dominant factor affecting the partner selection decision followed by "Relational fit" (0.266) and "Organizational fit" (0.136). It appears that the achievement of cost and operational effectiveness and relational coordination are considered as the most influential factors for selecting the outsourcing candidate. This is somewhat not surprising, as many Korean pharmaceutical companies have been reluctant to finance large investment volume in new drug discovery programs [42]. Recently, significant changes in strategic direction for Korean pharmaceutical companies, which aim to become a key contributor to the global pharmaceutical innovation ecosystem, have prompted the industry to invest more in R&D. However, without proper access to specialized knowledge and infrastructure to conduct basic research, it is difficult to achieve such goals relying only on internal resources. The transition from generics-focused drug business towards high-value medicine takes time and involves significant risk of capital loss. By strategically outsourcing the risky, costly, and time-consuming drug discovery activity to an external service provider, the pharmaceutical industry can

Table 3 Averaged pairwise comparison matrix among main criteria (the case of R&D outsourcing)

	EA	GMC	OF	RDC	RF
EA	1	5.3	5.4	7.4	3.3
GMC	0.189	1	0.315	2.9	0.175
OF	0.185	3.2	1	4.6	0.303
RDC	0.135	0.345	0.217	1	0.169
RF	0.303	5.7	3.3	5.9	1

CR = 0.08

Table 5 Averaged pairwise comparison matrix among main criteria (the case of regulatory affairs task)

	EA	GMC	OF	RDC	RF
EA	1	3.2	0.196	0.182	2.1
GMC	0.313	1	0.159	0.185	0.455
OF	5.1	6.3	1	3.3	4.4
RDC	5.5	5.4	0.303	1	6.5
RF	0.476	2.2	0.227	0.154	1

CR = 0.09

Table 6 Synthesized matrix among main criteria (the case of regulatory affairs task)

	EA	GMC	OF	RDC	RF	Global priority
EA	0.081	0.177	0.104	0.038	0.145	0.109
GMC	0.025	0.055	0.084	0.038	0.031	0.047
OF	0.412	0.348	0.530	0.685	0.304	0.456
RDC	0.444	0.298	0.161	0.207	0.450	0.312
RF	0.038	0.122	0.121	0.032	0.069	0.076

concentrate and improve on other aspects of the drug development life cycle. Subsequently, it is obvious that the "Cost-saving potentials" (0.381), which allow a high level of budgetary control, are regarded as the most determining factor. The analysis results further revealed that "Commitment" (0.197) and "Partner compatibility" (0.096) are found to be significant explanatory variables of outsourcing partner selection, while "Quality assurance" and "Specialized expertise" received comparatively low priority ratings. This could be explained by the fact that outsourcing is arranged by contractual means, indicating that the definition of framework conditions (such as access to state-of-the-art expertise and quality management) are essential antecedents to outsourcing performance. Because some degree of outsourcing risk can be managed via increased information transparency and written disclosure, factors regarding "Quality assurance" and "Specialized expertise" might have lesser influence on the partner selection. The potential uncertainties and moral hazard related to innovation activities could be alleviated by establishing relational approaches to engagement and governance. Commitment can act as important coordinating mechanisms in settings, where business processes are difficult to manage, as high level of commitment is known to reduce the risks associated with low process manageability [43]. Moreover, "Productivity" and "Flexibility" were high on the priority list. The ability to accelerate the early stages of the drug development as well as the ability to flexibly respond to sudden changes in development environment are desirable to be more agile in chasing innovation queries. Outsourcing research-intensive activities with unclear outcomes to specialized CROs or service providers in favor of cost optimization seems to be a reasonable strategy.

In case of outsourcing regulatory affairs task, "Organizational fit" (0.456) received the highest priority followed by "R&D capabilities" (0.312) at main criteria level. In contrast to previous case, the organizational values and availability of specialized complementary capabilities, which the contracting entity does not own internally, seem to affect the outsourcing partner selection process most. At the sub-criteria level, "Reputation" (0.274) and "Specialized expertise" (0.254) were perceived as significant selection criteria. This implies that the primary objective is not to accelerate the regulatory approval process nor to achieve cost-effectiveness, but to select a potential candidate based on prestige (e.g., success rate of regulatory approval) and expertise. "Partner compatibility" (0.099) was again an important selection criterion. It can be concluded that a high similarity in management philosophy and cultural values can provide a stable environment for organizational learning and facilitate the smoothness of interactions [44]. In addition, it was suggested that regulatory professionals acting as strategic business partners are critical for successfully navigating the regulatory pathway and for the inclusion of patients' perspectives into regulatory filing [45]. In this sense, to successfully handle the ever-adapting demands of the regulatory process and the growing need for the strong local expertise in globalized market

Table 7 Calculated priorities for the criteria affecting the R&D outsourcing

Main criteria	Global priority	Sub-criteria	Local priority	Overall priority	Overall ranking
R&D capabilities	0.040	(1) Specialized expertise	0.685	0.027	8
		(2) Absorptive capacity	0.315	0.013	11
Economic advantages	0.485	(3) Quality assurance	0.066	0.032	7
		(4) Cost-saving potentials	0.785	0.381	1
		(5) Productivity	0.149	0.072	4
General management capabilities	0.073	(6) Flexibility	0.848	0.062	5
		(7) Process manageability	0.152	0.011	13
Relational fit	0.266	(8) Trust	0.066	0.018	10
		(9) Commitment	0.739	0.197	2
		(10) Participation	0.195	0.052	6
Organizational fit	0.136	(11) Reputation	0.088	0.012	12
		(12) Past association between partners	0.148	0.020	9
		(13) Partner compatibility	0.709	0.096	3
		(14) Geographic proximity	0.055	0.007	14

Table 8 Calculated priorities for the criteria affecting the regulatory affairs task outsourcing

Main criteria	Global priority	Sub-criteria	Local priority	Overall priority	Overall ranking
R&D capabilities	0.312	(1) Specialized expertise	0.815	0.254	2
		(2) Absorptive capacity	0.185	0.058	6
Economic advantages	0.109	(3) Quality assurance	0.091	0.010	12
		(4) Cost-saving potentials	0.586	0.064	4
		(5) Productivity	0.323	0.035	9
General management capabilities	0.047	(6) Flexibility	0.853	0.040	8
		(7) Process manageability	0.147	0.007	13
Relational fit	0.076	(8) Trust	0.291	0.022	10
		(9) Commitment	0.617	0.047	7
		(10) Participation	0.092	0.007	14
Organizational fit	0.456	(11) Reputation	0.600	0.274	1
		(12) Past association between partners	0.139	0.063	5
		(13) Partner compatibility	0.217	0.099	3
		(14) Geographic proximity	0.044	0.020	11

environment, companies are recommended to place high values on promoting efficiency in operation with appreciation of partner's cultural nuances and administrative procedures. Gummerus et al. [28] produced similar results by surveying pharmaceutical companies in Europe. Besides skills in regulatory affairs task and cost-effectiveness, previous contacts from professional history (e.g., "Past association between partners") were perceived as significant selection criterion. On the whole, the criterion "Economic advantages" was less significant, as the regulatory affairs task is less capital-intensive than outsourcing in early drug discovery.

Remarkably, in both scenarios, the main criterion "General management capabilities" was considered as not substantially affecting the establishment of outsourcing relation, whereas its sub-criterion "Flexibility" received relatively higher priority. Especially in case of R&D outsourcing, a considerable proportion of investigational compounds does not survive the clinical testing phase. Herein, "Flexibility" is required to accommodate novel observations and take new directions in the R&D.

Conclusion

The present study computed the relative importance of several criteria to prioritize factors relevant for the selection of the pharmaceutical outsourcing candidate. The results, despite of its limited generalizability and subjective response of only 34 responses from the Korean pharmaceutical industry, can be used as a reference point for guiding future drafts of outsourcing policy and have the potential to enlarge body of knowledge in the evaluation of potential outsourcing partners.

Given the fact that the paradigm shift towards an open and R&D-focused model in drug discovery and development is in place, the Korean pharmaceutical industry is gradually transforming its operating and innovation models to meet the challenges arising from declining R&D productivity and strengthening regulatory requirements. In the center of this development, outsourcing has been praised as cost-effective, strategic alternatives to overcome the challenges in combining several operational units under a limited budget. As outsourcing candidate selection becomes a multi-criteria decision making problem, the study employed the AHP method to determine the importance of each underlying criterion and to calculate their weights. The model provides a balanced view of both partner-related and task-related selection criteria. Determining the appropriate "weighting" of different influencing factors is necessary to offer a helpful guideline for choosing the right partner to succeed. The proposed AHP model showed that depending on the considered stages of drug development, the emphasis on selection criteria differs. The economic factors were found to be significant explanatory variables in case of early stages of R&D outsourcing, whereas organizational fit factors were found to be relevant explanatory variables in case of regulatory affairs.

The findings have several important managerial implications both for the innovation-driven pharmaceutical industry and contract research organizations. Firstly, the study facilitates the process of assessing factors that have a major impact on the outsourcing partner selection and can help build consensus within the organization. AHP constitutes a more systematic decision-making framework than just making a decision based on qualitative information or simple scoring system. Thus, it can help reduce subjectivity in decision making. Secondly, CROs may use this information to better prepare for

challenges and difficulties that the potential sponsor firms have encountered when deciding for outsourcing. They can learn about decision-making hierarchies and outsourcing drivers influencing the selection process and then use this information to improve their sales approach, thus capturing on new opportunities by improving the elements that hinder the outsourcing model's success. However, this does not imply that the CROs may focus on improving competitiveness in economic advantages but ignore R&D capability in case of R&D outsourcing. They can only promote their attractiveness in economic terms, if their R&D capabilities are within acceptable industry standards. Furthermore, the provided analysis framework can be effective in supporting R&D and regulatory outsourcing in other hi-tech industries. The results can provide lessons for other research-intensive industries that have not yet developed their outsourcing activities to the same extent. Compared to Delphi technique, which is a method of aggregating expert opinion through a series of iterative communication process, AHP is less time-consuming and more efficient in consensus building in group decision settings. This is due to the fact that Delphi technique requires multiple rounds of questionnaire surveys and careful review of respondent comments. AHP is the preferred method for understanding decision preferences [46].

Nevertheless, caution is advised when interpreting the final outcomes, as AHP technique allows us to only determine which influencing factors are to be prioritized based on the level of importance attached to them. The proposed model should be understood as a supplement to the traditional candidate ranking method, which helps to better reach a consensus among managers. As the work is based only on 34 experts' responses from Korean pharmaceutical industry, it is difficult to generalize the findings from this study to other countries and industries. Depending on the case-specific circumstances, a particular importance score must be fed into the proposed AHP model to determine the relative importance of each criterion. Future research can calculate the relative importance of selection criteria by taking into account the country-specific characteristics. Heterogeneous organizational capabilities and cultural background can lead to a difference in the relative importance attached to partner selection criteria. Moreover, the AHP model assumes the interdependence among the decision criteria. However, some criteria can be in a mutually influencing relationship. Thus, weighting the criteria using the ANP model can act as an area for future research. Lastly, the study on the criteria influencing the outsourcing partner selection is still an incompletely explored area, which can be further elaborated. As the external business landscape constantly evolves, the related key variables might change over time.

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Compliance with Ethical Standards

Competing Interest The authors declare that they have no conflict of interest.

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