Risk-Reward Sharing in IT Service Contracts – 
A Service System View

Gerhard Satzger
Karlsruhe Service Research Institute (KSRI)
Karlsruhe Institute of Technology (KIT)
gerhard.satzger@kit.edu

Axel Kieninger
Karlsruhe Service Research Institute (KSRI)
Karlsruhe Institute of Technology (KIT)
axel.kieninger@kit.edu

Abstract
The paper analyzes the sharing of risks and rewards in IT service contracts from a service system perspective. Using a formal model, it can be shown under which conditions a risk-reward sharing contract can be advantageous for both supplier and customer and, thus, make the IT service system that is formed by them more efficient. Decision criteria for the selection and suitable design of such contracts are developed. Risk sharing turns out to be advisable in typical situations with IT providers being more or less risk averse than their customers. The application of these results hinge on the progress of measuring risk and risk aversion in practice.

1. Introduction
Projects based on IT services are usually exposed to a certain amount of risk. In “time-and-material” contracts this risk is completely borne by the customer, while the provider gets his effort paid regardless of his success and the implications for the customer. Alternatively, “fixed price” contracts shift the risk to the provider who is committed to deliver a specified result regardless of his effort put in. Interestingly enough, these unilateral risk allocations still dominate the IT service market. A recent Berlecon study for the IT services market reveals that in 2006 market participants denoted these extreme instances of risk allocation (fixed price contracts and time-and-material contracts) as most important, while contracts with the provider participating in the customer’s commercial success were deemed important only by very few of the interviewed enterprises [2, p.24]. An orientation towards the result of the cooperation of both parties is not taking place. While currently risk-reward sharing contracts do not seem to be common in practice, they are still desirable - particularly from a line of business perspective - when looking for higher outcome quality and more effective management of complexity [12].

Over the last few years, the academic work around Service Science, Management and Engineering (SSME) is centering around the joint value creation of providers and customers forming so called service systems (e.g. [9], [15]). The partners in these systems are supposed to jointly manage the resources within a system for their mutual benefit and to enter into value propositions and realizations that allow for maximization of their individual values. This entails a system view on value propositions and resulting contracts.

This paper is devoted to taking such a system view with regard to risks in value propositions. While IT projects are exposed to a large variety of risks (e.g. lock-in risks), we focus on the revenue risk that is being taken on by the provider-customer service system as a whole and the impact of its distribution on the utility of the involved parties.

Whereas traditional agency theory (e.g. [6]) tries to make agents act in the best interest of a principal (i.e. optimization for the principal under certain restrictions imposed by the principal-agent-setting), we look at Pareto optimal constellations that constitute efficient contracts between the partners.

The paper presents a formal model for contracting IT services. It is shown how risk sharing between provider and customer can generate additional value for both partners. We derive analytical decision criteria to identify the set of Pareto optimal contracts and provide a framework for typical business scenarios of potential provider-customer situations. Finally, we conclude, are conscious of the limitations of our model, outline next steps for future research and discuss potential obstacles to risk sharing agreements in business practice.
2. Collaboration in service systems

IT services are becoming more and more important for many companies. According to a study just recently published [8], IT is regarded as a “key enabler to business goals and mission” today: the vast majority of Chief Information Officers cites improved risk management and enhanced collaboration with client companies as key challenges to execute on this mission. In order to address both of these challenges, we propose to handle IT services rather as collaborative value creation processes of providers and customers (and not only as services sold to the customer) requiring a deeper understanding of partners and an increasing individualization of contracts.

This practical observation coincides with a number of efforts currently being undertaken in the academic literature:

- As stated above, the emerging perspectives of “Service Science, Management and Engineering” (SSME) and a “Service-Dominant Logic” are postulating a paradigm shift: focus is no longer on service(s) as the outcome, but on the joint, collaborative and interactive co-creation of value that finally would even abstract from a directed provider-customer view and a hard product-services distinction (e.g. [15], [17]). Value creation instead takes place in service systems connecting a variety of partners in different roles via value propositions (e.g. [10]).

- Closely related to this view is the literature around service value networks dealing with the economic and technical aspects of forming heterogeneous, but still flexible and agile value creation networks based on SOA principles (e.g. [3], [5], [16], [7]).

- Also, the service management literature dealing with Service Level Agreements (SLAs) increasingly looks at the joint creation (e.g. [14]), the dynamic nature / life cycle (e.g. [1, pp.171-212]) and the business orientation (e.g. [13]) of IT SLAs – all requiring increased collaboration between the parties to manage IT services.

- Finally, the service innovation literature very much focuses on the importance of collaboration with providers, partners and customers outside of one’s own organization (e.g. [4]).

As a consequence, we look at the IT service system comprised out of provider and supplier and collaboratively try to find suitable contract relationships for the system and its elements. Empirically, this would also entail risk reward schemes as “there is a positive correlation between risk sharing price mechanisms and co-operative contract behavior in IT sourcing relationships” [11, p. 123].

3. A model to analyze risk sharing

In the following, we develop a formal model to analyze risk sharing in IT service contracts. Therefore, we look at an IT client and a potential IT service provider and discuss under which conditions these companies close an IT service outsourcing contract and, thus, form a new service system. Furthermore, we analyze under which conditions these contracts can be advantageous for both, supplier and customer, and thus make the IT service system formed by them more efficient.

3.1. A basic model: forming a service system via an outsourcing decision

We first develop a simple model to look at the outsourcing decision and potential contract specifications. Later on, we will introduce risk and different contract options. The model is described by the following assumptions:

(A1) Enterprises:

We consider an IT customer C and a potential supplier S. Both partners try to maximize their cash flow net present values (NPV). Their relevant discount rates for a time period are $i_C \geq 0$ with $q_C := 1 + i_C$ and $i_S \geq 0$ with $q_S := 1 + i_S$.

(A2) Services:

The IT service in question can be provided over a time period $T = [0;1]$ by the customer himself at cost \( c^C \) or alternatively by the provider at cost \( c^S \). The customer uses the IT services to realize revenue \( r > 0 \) at the end of period T.

(A3) Contract:

The provider could offer a service contract at a fixed price $P > 0$.

We will analyze first, under which conditions a service system (depicted in figure 1) will form, i.e. the provider will be employed by the supplier.
In the absence of risk, the customer can produce the services himself at a net present value (NPV) of
\[ c^C_0 = -c^C_0 + \frac{r}{q_C} \] (1)
or, alternatively, procure it from the provider rendering a NPV of
\[ c^S_0 = \frac{r - p}{q_S} \] (2)
In the first case (1), the customer incurs cost in t=0, whereas he realizes revenue in t=1. In the second case (2), the customer has to pay the provider in t=1. At the same time he realizes his revenue.

Obviously, forming the system (via outsourcing the IT service) is favorable, if the price stays below a threshold determined by the opportunity cost and the discount rate applied by the customer
\[ c^C_0 \geq c^S_0 \iff p \leq c^C_0 \cdot q_C \] (3)

On the other hand, the supplier will only offer the services if his NPV – composed of his cost cash outflow and his discounted proceeds – is positive:
\[ c^S_0 = -c^S_0 + \frac{p}{q_S} \geq 0 \iff p \geq c^S_0 \cdot q_S \] (4)

Thus, an outsourcing of the IT services is reasonable if and only if a price P is selected that puts both parties better off than before: The customer realizes an NPV advantage vs. the “make” alternative, the supplier obtains a positive NPV from entering the business.
\[ P \in [c^C_0 \cdot q_C; c^S_0 \cdot q_S] \] (5)

Selecting a particular price from the interval in (5) then determines the allocation of the outsourcing advantage which can result from cost and/or financing differences to both parties\(^2\): a price at the lower end will leave the supplier indifferent towards outsourcing while the customer gets the full impact of the decision. Vice versa, a price at the high end of the price interval will allocate all additional benefit to the supplier. We will illustrate this simple case with an example that we will systematically extend later on:

**Example 1:** The customer could gain revenues of \( r=200 \) at “make” cost of \( c^C_0 = 70 \) or alternatively employ a provider operating at cost of \( c^S_0 = 40 \). With both parties applying discount rates \( i_C = i_S = 10\% \), the resulting price interval for effective cooperation is \([44;77]\). A price of 65 out of this interval allocates the total (and constant) advantage of forming a service system to both parties as follows: the customer increases his net present value (compared to the “make” decision) from 111.8 by 9.8\% to 122.7, while the provider is realizing a NPV of 19.1 by entering into the system. The system’s effectiveness measured as the sum of both NPVs moves up by 30 (or 26.8\%) to 141.8 – in this simple model the change is entirely caused by the cost saving that can be realized by the provider entering the system.

3.2. A model extension: risk without integration into the service system relationship

We will now introduce risk, but still keep the potential service contract limited to a fixed price contract.

(A4) Revenue risk:

The revenue \( \bar{r} \) for the customer is now subject to a normal distribution with \( N(\mu; \sigma^2) \).

(A5) Risk preferences:

Both partners judge their utilities according to exponential utility functions with risk aversions \( \alpha_C \geq 0 \) and \( \alpha_S \geq 0 \). They maximize their expected utility (Bernoulli principle) – equivalent with maximizing their certainty equivalents\(^3\) \( \Phi_C \) and \( \Phi_S \).

Similarly to the case above, we can now derive from (1) and (2) those conditions under which both parties would enter into an outsourcing agreement and, thus, form a service system. The customer has to be better off with procuring the service than providing it

\(^2\) Obviously, such an interval does not need to exist. If so, no service relationship will be created – for any price, one of the partners will not enter into it.

\(^3\) Under these assumptions, the certainty equivalent \( \Phi(x) \) for a random variable \( x \sim N(\mu(x); \sigma^2(x)) \) given a risk preference of \( \alpha \geq 0 \) is given by: \( \Phi(x) = \mu(x) - \frac{\alpha}{2} \sigma^2(x) \).
himself, i.e. the certainty equivalent of the “buy” alternative
\[
\phi(\text{\$C}_b^P(p)) = \left[ \frac{\mu - P}{q_c} - \frac{\alpha_c}{2} \cdot \frac{\sigma^2}{q_c^2} \right]
\]
(6)
is to exceed the “make” one:
\[
\phi(\text{\$C}_m^P(p)) = -\frac{\alpha_c}{2} \cdot \frac{\sigma^2}{q_c^2}
\]
(7)

In both equations, the expected value is reduced by the risk weighted with the respective risk aversion of the customer. As can easily be derived, this is still the case if the price charged by the provider is below the financed cost for service “in-house creation” by the customer:
\[
\phi(\text{\$C}_b^P(p)) \geq \phi(\text{\$C}_m^P(p)) \iff p \leq \text{\$C}_b^P(p)
\]
(8)

As the risk does not influence the potential relationship to the provider in this case, it is irrelevant for the customer’s decision to form a service system. Similarly, the decision criterion (4) for the supplier still holds. Thus, we would not expect any impact of the risk to the formation of a system.

Example 2: In addition to example 1, risk aversions of \( \alpha_c = 0.4 \) and \( \alpha_s = 0.8 \) and normally distributed revenues \( \hat{r} \sim N(200; 625) \)\(^4\) are assumed, the resulting price interval remains \([44;77]\) with the same advantages being able to be allocated. However, the customer suffers from the risk as his certainty equivalent is reduced in any case by 103.3; for a price of 65 he is now realizing a certainty equivalent of 19.7 only.

Based on this case, we will now allow the introduction of contract types that enable the parties to share the risk.

3.3. Modeling risk-reward schemes and their impact on service system relationships

We will now analyze whether and under which conditions the service system can be made more effective and yield better results for all parties if we introduce risk sharing. In order to model this, we relax assumption (A3) to

\( (A3') \) Contract:

We assume a service contract with price \( \bar{P} \) as the current situation – i.e. an already existing service system. The provider could offer a service contract for a variable price \( P = \bar{P} + f(\hat{r}) \) with \( f(\hat{r}) : \mathbb{R} \rightarrow \mathbb{R} \) denoting a strictly monotonic increasing function that maps (uncertain) revenue into a price increase within the services contract.

Thus, the customer is able to pass parts of the risk that he incurs onto the provider – in exchange for a certain share of his proceeds. We will now analyze the conditions under which such a contract scheme can improve a fixed price contract \( \bar{P} \) derived from the previous section (see figure 2). Again, we will adopt the approach to look for improvements for both partners.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure2.png}
\caption{The search for optimal contracts within a service system}
\end{figure}

“Figure 2. The search for optimal contracts within a service system”

First, we formulate the condition for the customer. His certainty equivalent is comprised of the expected value of the incurred revenue minus the expected value of the newly created contract function adjusted for the risk incurred:\(^5\)
\[
\phi(\text{\$C}_b^P(p)) = \left[ \frac{\mu - \bar{P} - E(f(\hat{r}))}{q_c} - \frac{\alpha_c}{2} \cdot \frac{\sigma^2}{q_c^2} \right] - \frac{\alpha_c}{2} \cdot \frac{1}{q_c^2} [\sigma^2 + \sigma^2(f(\hat{r})) - 2\alpha \sigma(f(\hat{r}))]
\]
(9)

The certainty equivalent in (9) – applying risk sharing – is to be compared to the one in (6) – which the customer realizes under a fixed price contract, thus bearing all the risk himself. Looking for conditions under which the certainty equivalent in (9) is larger than the one in (6) yields the following condition for the sharing function:

\(^4\) For illustration, this means that 68% probability exists that values are within one standard deviation from the mean, i.e. between 175 and 225.

\(^5\) We note that the random variable \( \hat{r} \) and the function \( f(\hat{r}) \) are perfectly correlated.
\[ E(f(\tilde{f})) < \frac{\alpha_c}{2q_e} \left( 2\sigma f(\tilde{f}) - \sigma^2 \right) \]  

(10)

This can be interpreted as follows: the expected value of the price increase that the customer renders to the supplier must be smaller than the benefit of the avoided risk.

Specifically, for a linear function \( f(\tilde{f}) = \gamma \tilde{f} \) with \( \gamma > 0 \), criterion (10) is

\[ \gamma < 2 - \frac{\mu q_e}{\alpha_c \sigma^2} \]  

(11)

since, in this case, \( E(f(\tilde{f})) = \gamma \cdot E(\tilde{f}) = \gamma \cdot \mu \) and \( \sigma^2 f(\tilde{f}) = \gamma^2 \cdot \sigma^2(\tilde{f}) \).

Similarly, we can compare the certainty equivalent of the supplier

\[ \phi \left( c_0^S(\gamma) \right) = \left[ \frac{P + E(f(\tilde{f}))}{q_s} \right] - \frac{1}{q_s} \left( \frac{\alpha_S}{2} + \frac{1}{q_s} \sigma^2 f(\tilde{f}) \right) \]  

(12)

to the net present value (4) that he incurs from the fixed price scheme. Again, analyzing functions \( f \) putting the supplier better off with variable terms and conditions of the contract (9), we find

\[ E(f(\tilde{f})) > \frac{\alpha_S}{2q_s} \sigma^2 \]  

(13)

Symmetrically, the supplier will endorse a variable contract if the expected proceeds exceed the reduction in utility he is suffering due to the increased risk.

Specifically, for a linear function \( f(\tilde{f}) = \gamma \tilde{f} \); \( \gamma > 0 \), condition (13) holds if and only if

\[ \gamma < 2 \frac{\mu q_e}{\alpha_S \sigma^2} \]  

(14)

Example 3:

a) In addition to example 2, we allow for a linear risk-reward sharing contract vs. an existing outsourcing contract with \( P = 65 \). We find that the customer will enter into a linear contract if \( \gamma < 0.24 \), while the supplier would do this as long as \( \gamma < 0.88 \). In contrast to the situation in example 2, the advantage that can be distributed now is dependent on the parameter chosen. For \( \gamma = 0.24 \) the total gain for the coalition (and the supplier in this case) is 31.7, while at \( \gamma = 0.12 \) the total gain would be only 20.3, but the customer would participate with 1.5 (see also table 1).

b) If the customer in example 2 reduces his risk aversion to \( \alpha_c = 0.3 \), no non-negative parameter \( \gamma \) exists that would make him better off: the price he would pay per “unit of risk” would not be warranted by his increase in utility.

“Table 1. Potential risk-reward schemes in example 3a and their impact on the partners in the system”

<table>
<thead>
<tr>
<th>Certainty equivalents in example 3a for a contract with</th>
<th>Cust.</th>
<th>Suppl.</th>
<th>Syst.</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \gamma = 0.00 )</td>
<td>19.4</td>
<td>19.1</td>
<td>38.5</td>
</tr>
<tr>
<td>( \gamma = 0.12 )</td>
<td>20.9</td>
<td>37.9</td>
<td>58.8</td>
</tr>
<tr>
<td>( \gamma = 0.24 )</td>
<td>19.4</td>
<td>50.8</td>
<td>70.2</td>
</tr>
<tr>
<td>( \gamma = 0.33 )</td>
<td>16.4</td>
<td>56.6</td>
<td>73.0</td>
</tr>
<tr>
<td>( \gamma = 0.44 )</td>
<td>10.3</td>
<td>59.1</td>
<td>69.4</td>
</tr>
<tr>
<td>( \gamma = 0.88 )</td>
<td>-38.8</td>
<td>19.1</td>
<td>-19.7</td>
</tr>
</tbody>
</table>

For the linear payment scheme, it is illustrative to analyze the certainty equivalents as a function of the parameter \( \gamma \). Using \( f(\tilde{f}) = \gamma \tilde{f} \) and setting the first derivation of (9) and (12) to zero, the optimality criterion for the parameter \( \gamma \), therefore, are

\[ \gamma_c < 1 - \frac{\mu q_e}{\alpha_c \sigma^2} \]  

(15)

\[ \gamma_S < \frac{\mu q_s}{\alpha_S \sigma^2} \]  

(16)

In both cases, second derivatives are positive, so \( \gamma_c \) and \( \gamma_S \) both denote optimal risk sharing parameters for the individual partners in the service system. Therefore, both parties benefit from choosing parameters \( \gamma \in (0; 2 \cdot \min \{ \gamma_S; \gamma_c \}) \). However, the benefits\(^a\) accruing to them individually and as a system

\(^a\) As benefit we denote the improvement of the partners’ certainty equivalents via a risk sharing contract vs. the fixed price contract. E.g., for the supplier, this is the difference of the certainty equivalents (12) – applying risk sharing with \( \gamma > 0 \) – and certainty equivalent (4) – not basing the on the risk, i.e. \( \gamma = 0 \).
are subject to negotiation of this parameter – as figure 3 illustrates.

It becomes evident, though, that the choice of any parameter from this interval leads to an improvement in comparison to the fixed price solution, but may only accidentally hit the coalition optimum (in the above example realized at $\gamma_{co} = 0.33$ outside of the agreement interval). Relaxing our reward function to function types $f(\bar{F}) = \vartheta + \gamma \bar{F}$, with $\vartheta \in \mathbb{R}$, however, enables us to shift the benefit curves depicted in figure 3 such that (at the system optimum $\gamma_{co}^* = 0.33$) both parties realize a solution superior to a fixed price contract at price $\bar{P}$, the “reference solution”: In the above example, a price reduction $\vartheta < 0$ does not change the system view, but re-allocates part of the provider’s advantage to the customer to at least offset his disadvantage vs. the (fixed price) reference solution. Choosing $\gamma_{co}^*$ to maximize coalition advantage, the agreement interval can then be formulated depending on $\vartheta$ denoting contracts that put both parties better off than a fixed price $\bar{P}$.

This may be illustrated by our example: The maximum system certainty equivalent is reached at the parameter value $\gamma_{co}^* = 0.33$. In this case, the customer, however, would not enter into a risk-reward sharing contract unless the supplier agrees to (at least) compensate him for his certainty equivalent decrease in relation to the fixed price reference solution, which is 3.1 monetary units at $\gamma_{co}^* = 0.33$. The system benefit at this parameter value compared to the fixed price solution is 34.4 monetary units. The distribution of this advantage among both partners is subject to negotiation.

Thus, introducing risk sharing (i.e. the selection of $\gamma$) opens up an additional degree of freedom compared to the reference case (fixed price, $\gamma=0$), which can also be regarded as “degenerated” risk sharing. As we allow for costless application of risk sharing (i.e. without incurring contracting/governance cost), usage of this additional option can only improve the outcome.
4. Application to business scenarios

We would now like to interpret some of the results obtained in the previous section in light of real-world IT service transactions. While there is no general rule that risk sharing contracts can be constructed that put both partners better off than a fixed price contract, we showed favourable risk sharing contracts do exist in many cases: As long as the expected value of the “risk premium” (E(f(R)) or specifically E(yR)) for the customer is still lower than its valuation of the avoided risk, while the provider values the additional gain more than the additional risk taken on, both partners benefit from a risk sharing contract.

Example 3 showed this with the customer being less risk averse than the supplier (\( \alpha_C = 0.4 < \alpha_S = 0.8 \)): we could imagine this to be a situation where a small IT provider serves a large corporation with the latter having a broad latitude to diversify project risks. However, we can also look at scenarios where risk sharing contracts are advantageous with the supplier being more risk averse than the customer – as in the following example:

**Example 4:**

a) Did the supplier from example 3a demonstrate a risk aversion of \( \alpha_S = 0.2 \) and thus below the customer’s risk aversion of \( \alpha_C = 0.4 \), risk-reward sharing would still be advisable for both parties with \( y \in (0; 0.24) \).

b) Regardless of the risk aversion of the provider, the customer with \( \alpha_C = 0.3 \) (as in example 3b) would not enter into a (linear) risk-reward scheme.

This in turn could describe a situation where a large IT provider is serving smaller customers (e.g. a large company like IBM or HP/EDS offering outsourcing to small and medium businesses). Also here risk sharing may be advisable. Therefore, a thorough analysis of the parameters is required when deciding upon contract schemes. Table 2 summarizes the scenarios covered.

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**Table 2. Possible scenarios demonstrating that decision criteria need to be applied to each case**

<table>
<thead>
<tr>
<th>Risk sharing contract can be constructed according to the criteria in the previous section</th>
<th>Supplier more risk averse</th>
<th>Customer more risk averse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 3a</td>
<td>Example 4a</td>
<td></td>
</tr>
<tr>
<td>No risk sharing contract exists putting both partners better off</td>
<td>Example 3b</td>
<td>Example 4b</td>
</tr>
</tbody>
</table>

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5. Conclusion, limitations and application

The contribution of this paper is threefold. First, we developed a basic model to analyze contractual relationships between an IT client and a potential IT service provider. Based on this model we discussed under which conditions these companies enter into a fixed-price contract and, thus, form a service system.

Second, we extended our model by introducing revenue risk, which is taken on by a client. Thus, we could show that customers’ revenue risk does not influence the potential relationship to the provider, i.e. it is irrelevant for the customer’s decision to form a service system.

Third, we modified the assumptions of our model allowing for contract types that enable the parties to share customer’s revenue risk. We analyzed for typical situations, with IT providers being more or less risk averse than their customers, whether revenue risk sharing is advisable, i.e. is advantageous for both supplier and customer (compared to an existing fixed-price contract). We identified Pareto optimal constellations that constitute efficient contracts between the partners.

Having put forward a simple model to explain the existence and to design contractual relationships in IT service systems, we are fully aware of a number of limitations in the setup and application of the model:

- First of all, we oversimplified the situation with just one risk-laden external factor (revenue) influencing the service system. In further works we will expand the model and take into account other factors, like e.g. clients’ lock-in risk (due to service specificity) or vendors’ risk of their clients not renewing the contract, as well.

- Moreover, we neglected the impacts of individual effort on the outcome (as usually is done in agency theoretical approaches) – and thus deliberately excluded one of the mainly cited reasons to share risk. The assumptions on the utility curves and risk distributions are – while common in economics – still very special. We did not further expand on the selection of possible risk sharing functions, but just showed the general conditions and illustrated them for linear functions.

- Furthermore, we ignored costs arising from creating and managing a provider-customer relationship to form a service system like transaction fees and/or governance costs.

- For practical application of results, the biggest issue may be the lack of suitable measurements for risks (e.g. the knowledge about risk distribution), the
application of exponential utility concepts and the specification of risk preferences as well as the isolation of risk variables (like revenues) from a more aggregated output. In addition, the disclosure of the partners’ characteristics to find Pareto optimal solutions may be an additional hurdle to take.

Still, we are convinced – not just since the recent global financial crisis – that dealing with risk is a key issue also for the design of service systems. Our model should help to explain the formation of observable IT service systems and hopefully make decision makers think about options to share risk to augment the instruments available in contracting for mutual benefit. At the same time, the limitations and application issues above leave a broad field for further research.

REFERENCES


