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Application of Modeling and Internet Technologies in Marine Insurance Business Processes

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Abstract

The paper is devoted to the problems regarding modeling of marine insurance business processes, calculating of tariffs, study and analysis of Internet possibilities for supporting marine insurance information system design.

1. Introduction to Marine Insurance

Banks and insurance companies are among the business partners operating in port areas. Providing effective processing of insurance and financial data and corresponding information exchange between financial and maritime companies in essential.

Marine insurance is one of the types of risk insurance, Fig.1.

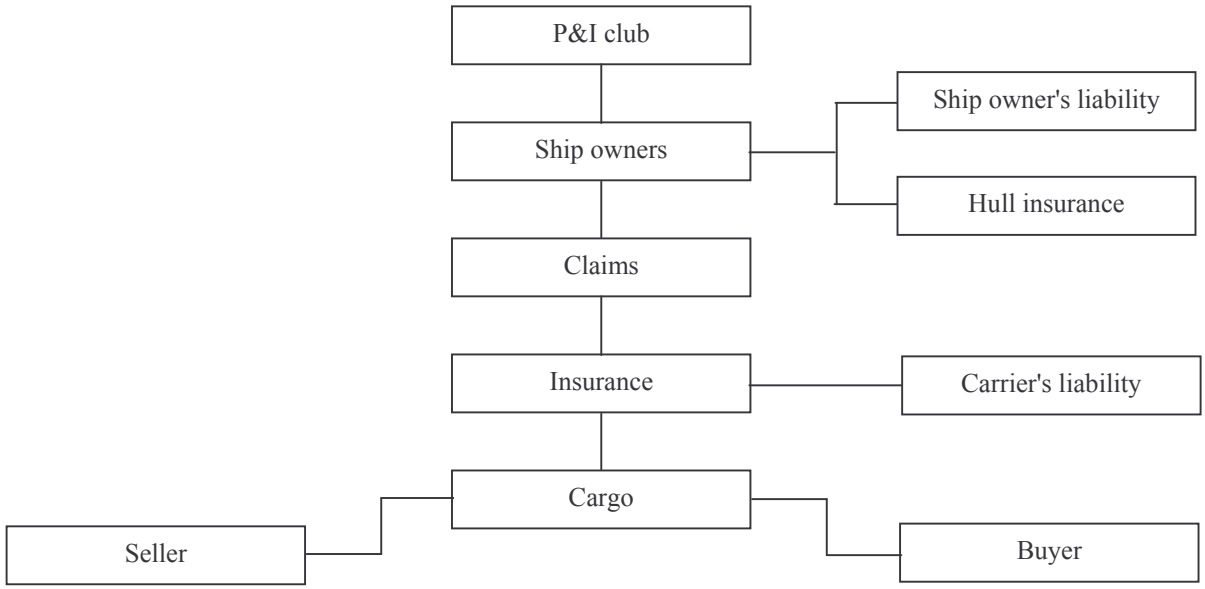

Fig.1: Marine Insurance

As premiums collected by Baltic States companies rapidly increase since 1992 and the number of policies issued rapidly grows, the task of creating modern Insurance Data Processing System (IDPS) assumes great importance. Modeling of insurance business processes is a necessary prerequisite for IDPS development and application.

2. Study and Analysis of Insurance Business Processes

Insurance companies are among the actors that are involved in the whole supply logistic and maritime chain, *Novitsky et al. (2003)*. The Latvian insurance company BALVA was selected for demonstration of marine insurance data processing system design and its integration into Information Management System of the enterprise. BALVA was established in 1992 and devotes much attention to co-operation with foreign partners, while having has nearly 40 branch offices and bureaus in Latvia.

BALVA gave high priority to the project of developing an Insurance Data Processing System. Study, formalization, and analysis of business process is a necessary stage of customization and application of IDPS.

Table I: Business Chart of Insurance Data Processing

Functions	Processes	Actions
1 . Preparation of insurance contract	1.1. Filling in the application form.	1.1.1. Filling in the application form for a one-time insurance policy. 1.1.2. Filling in the application form for an open (long-term) insurance policy.
	1 .2. Drawing up the insurance contract.	1.2.1. Selection of the kind of transportation (ship, railways, truck). 1.2.2. Selection of the policy: long-term, one-time. 1.2.3. Definition of amount insured. 1.2.4. Selection of insurance conditions. 1.2.5. Calculation of insurance premium. 1.2.6. Selection of document language. 1.2.7. Printing of the policy.
	1.3. Drawing up the payment documents.	1.3.1. Writing up of the invoice. 1.3.2. Writing up of the receipt.
2. Reinsurance contract preparation	2.1. Optional reinsurance	2.1.1. Cover note writing. 2.1.2. Receipt of the accepted cover note. 2.1.3. Risk sharing. 2.1.4. Premium sharing.
	2.2.Compulsory reinsurance	2.2.1. Risk sharing. 2.2.2. Premium sharing.
3. Monitoring of insurance contracts execution	3.1. Initial premium monitoring.	3.1.1. Deposit payment. 3.1.2. One-time payment. 3.1.3. Multiple payments.
	3.2. Damages monitoring.	3.2.1. Claims registration. 3.2.2. Damages sharing between re-insurers. 3.2.3. Payment to client. 3.2.4. Receipt of payments from re-insurers.

The following steps for improving business processes by using IT solutions must be undertaken:
- creating the info-logical model which would serve as the basis for improving the business processes,
- developing a pilot version of IDPS, which supports different kinds of risk insurance, including marine insurance,
- formulating the recommendations for improving business processes.

A set of business charts, interface tables and communication diagrams was created in the first phase of process design, *Blumel and Novitsky (2000)*. The results of this phase were used for further development of the software system. The Business System Planning (BSP) method and LIS Technology were used to produce the set of business charts (Functions Processes-Activities) and diagrams "Processes-Executors". Table I presents an example of the business chart. It presents three main functions (writing up the insurance contract, writing up the reinsurance contract and monitoring execution of the insurance contracts) and appropriate processes/actions of their detailed definition. Table II presents business processes sharing among classes of executors (underwriters, experts from reinsurance and claims/damages departments, employees of accounting departments).

Table II: Example Diagram "Processes – Executors"

Executors / Processes	Underwriter	Reinsurance Department	Accounting Department	Claims / Damages Department
1.1 Filling in the application form				
1.2. Drawing up the insurance contract				
1.3. Drawing up the payment documents				
2.1. Optional reinsurance				
2.2. Compulsory reinsurance				
3.1. Initial premium monitoring				
3.2. Damages monitoring				

The next step in IDPS design is to create an info-logical model, which represents information objects and the links between them. Fig.2 presents an example of a communication diagram which describes the processing of insurance information.

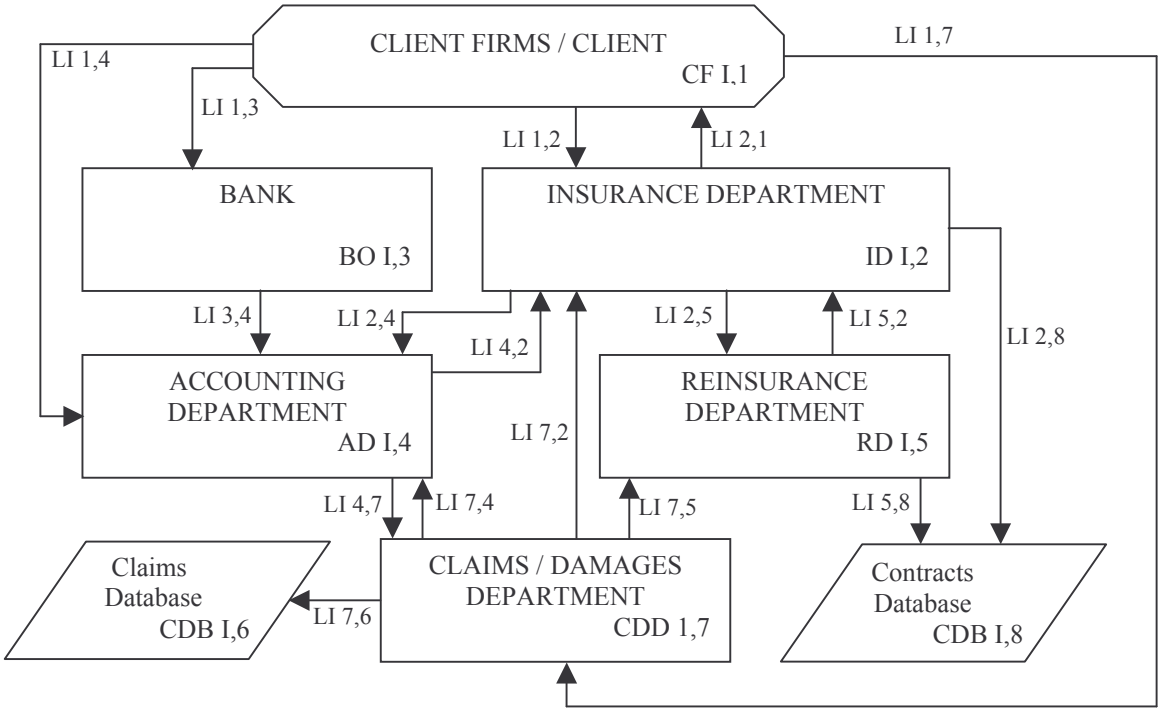

Fig. 2: Example for Communication Diagram

Information links in Fig.2 present the following information:
LI 1,2 - Application Form
LI 1,3 – Payment
LI 1,7 - Claims Application Form
LI 2,1 - Insurance Contract (policy issued)

LI 2,4 - Information on Payments Expected
LI 2,5 - Bordering of Premiums
LI 2,8 - Data on Contracts Issued
LI 3,4 - Information on Payments Received
LI 4,1 -Notice of Payments Expected
LI 4,2 - Information on Client debts
LI 4,7 - Information on Payments Made in Accordance with Claims
LI 5,2 - Information on Risks Reinsured
LI 5,8 - Information on Contracts
LI 7,2 - Information on Claims/Damages
LI 7,4 - Information on Claims/Damages
LI 7,5 - Information on Claims Related to Reinsurers
LI 7,6 - Data on Claims
A set of communication diagrams and interface tables constitute the static info-logical model, which provides a necessary basis for IDPS development.

The IDPS provides multilevel support of business processes associated with the insurance industry, Fig.3. The following functions are carried out on each level:

- Front Office - Policies issuing, input of primary data in real-time regimen.
- Back Office - Insurance data processing without direct contact with customer (accounting, reinsurance, claims processing, etc.).
- Reserve Accounting - Sum of technical reserves includes three main components: unreceived premium reserve, claim reserve and not yet claimed accident reserve.
- Financial Monitoring - Processing of different insurance values with the aim of monitoring the financial stability of a company.
- Financial Information Analysis and Business Processes Forecasting – portfolio premium analysis, definition of profitable insurance, forecasting prospective insurance.

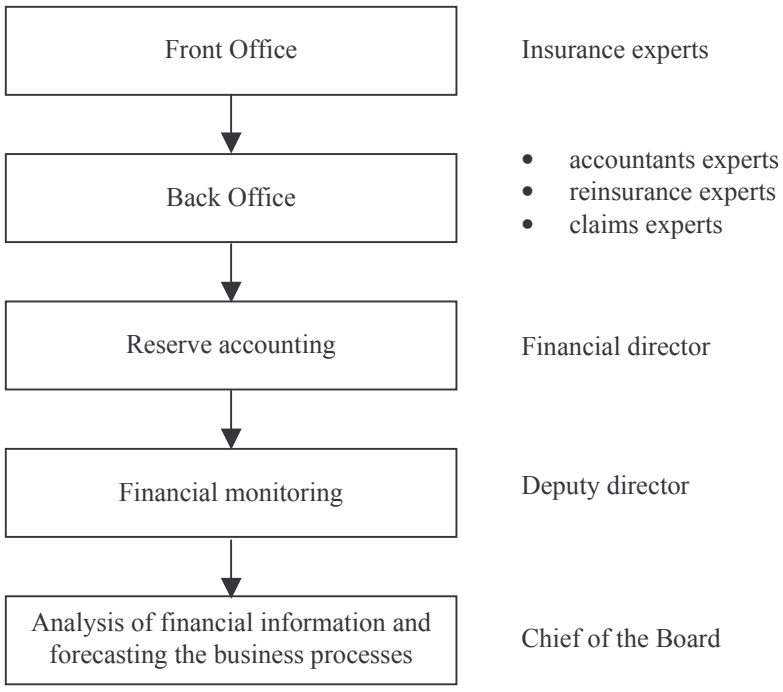

Fig. 3: Multilevel Support of Business Processes

The results of the IDPS design phase were used to develop the system's structural scheme, Fig.4.

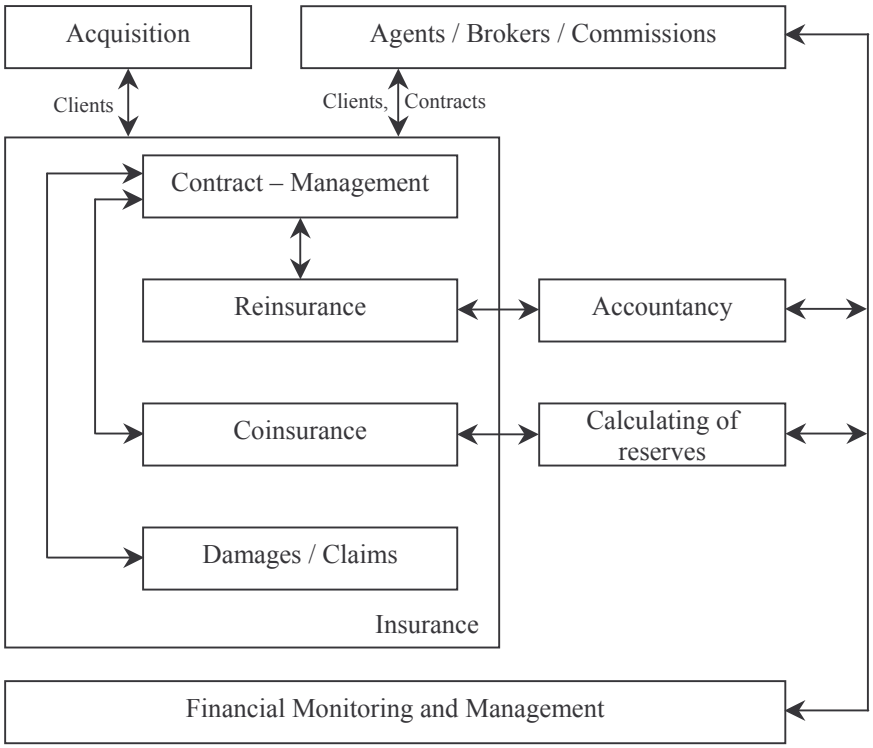

Fig.4: Insurance Data Processing System

Insurance Data Processing System provides the following business functions: contract management, claims management, reinsurance management, coinsurance management, agent and commission management, accounting, calculating of reserves. The main modules of IDPS (Acquisition, Agents / Brokers / Commissions, Contract management, Reinsurance, Coinsurance, Damages / Claims) were integrated with the main modules of Information Management System (Accountancy and Calculating of reserves). It allows to provide through information flows between separate business processes: front office, back office and accountancy.

The IDPS must to provide distributed data processing and transfer to support the wide network of regional offices of BALVA. The software package DiasoftlNSURANCE created by the firm DIASOFT was used as the instrumental tool for the distributed IDPS development of BALVA. This tool has the following competitive advantages:

- integrated solution for all kinds of risks insurance and reinsurance business,
- easy adaptation to the characteristic features of the user by way of introducing new kinds of insurance,
- direct relationships between insurance, reinsurance, accounting, damages / claims and financial management modules,
- user-friendly interface: any user with experience in the insurance business can become familiar with the menus and screens in a short time and is able to start working immediately.

The IDPS provides an interface, the "human-computer", in one of three national languages, which can be chosen at the very start of work with system. The standard version provides an interface in English, Latvian, or Russian. In the customization stage, this set of languages (or one of them) can be changed, thus creating an appropriate dictionary of terms. The IDPS runs using the operating systems Novell Netware / WINDOWS NT with several DBMS: Btrieve, Scalable SQL, Pervasive SQL.

3. Modeling of the characteristics of insurance company business activity

One of the main insurance companies activities indices is reliability. Reliability is solvency of the insurer's fond. It is ability of covering indemnity claims immediately. There are three factors, which threaten the insurance company's reliability:

- Premium rate and reserves insufficiency which are consequences of both inadequate use of statistics and technical information data and changes such as claims specific weight systematic increase and disability of making corrections on time.
- Claims or reserves rate which are not supposed to have an adequate protection. Reinsurance usually provides this protection.
- The loss of invested capital because of specific conditions.

In most cases insufficient insurance premium rate calculation causes company's instability and reserves insufficiency. Hence, the main problem is to calculate premium rate accordingly the risk. To solve this problem different factors must be taken into account e.g. claims probability and their rate. Mutual ratio between demand and supply concerning insurance risk on the insurance services market.

Information Management System was used in the insurance company BALVA as the instrumental tool for investigation of different models of insurance tariff rate calculation, *Novitsky (2001)*. Insurance tariff is the premium rate of one insurance unit. The main premium rate calculation methods policy are the following:

- to guarantee insurance activities profitability;
- tariff must be relevant to the costs probability;
- tariff's availability.

To calculate tariff it is necessary to calculate the net rate and then to add the second tariff's part (additional costs). Additional costs are provided for:

- covering office-work expenses;
- gaining profit;
- money transfer into the fund of preventive measures.

Additional costs present the smallest tariff's part, its value makes up 9-40%, and it is chosen by the insurer himself. To calculate the tariff rate the statistics data of the previous analysis are used.

One of the problems is that Baltic insurance companies rather often store statistic data only for a short proceeding time period, which brings about different problems in the course of analysis and simulating. The net tariff given in percentage is the insurance case probability which calculation is based on the previous experience. The tariff can be calculated as a ratio between indemnities paid and insurance premiums. Having calculated indemnity average value and estimated this ratio change dynamics it is possible to use these data to calculate the net tariff. This ratio is called the insurance premium non-profitability. The added cost for risk to this ratio equals the net tariff. To prevent insurance company bankruptcy in case of costs and insurance subjects amount changes the added cost is calculated. There are different methods to calculate the added cost for the risk. To calculate its rate it is possible to use costs total sum dispersion or the insurance premium non-profitability. Information about insurance policies in 2002 in the first half a year in company *BALVA* was collected and analyzed. The following data were selected to check the premium rate calculation model: the date of insurance policy signing, insurance premium factual costs. This information was used to calculate the premium rate and the results were checked taking into account policies signed later. It is one of the models, which can be used in practice to calculate the premium rate. The premium rate is calculated according to the tariff added extra cost for the risk. Consequently, if the tariff (t) is equal to probable costs for one insurance premium unit then:

$$t = \frac{E\sum_{i=1}^{N} X_i}{\sum_{i=1}^{N} O_i} = \frac{\sum_{i=1}^{N} X_i}{\sum_{i=1}^{N} O_i}, \qquad (1)$$

where $E\Sigma X_i$ – probable costs rate,
X_i – cost rate of the police number *i,*
O_i – insured amount of the police number *i,*
N – number of policies.

Hence the premium of one policy (p_i) equals:

$$p_i = O_i\, t + h_i\,, \tag{2}$$

where h_i – extra cost for the risk.

From this follows that if insurance company concludes N agreements, then its reserves are equivalent:

$$u = \sum_{i=1}^{N} p_i = \sum_{i=1}^{N} (O_i \cdot t + h_i) = t\sum_{i=1}^{N} O_i + h = \frac{\sum_{i=1}^{N} EX_i}{\sum_{i=1}^{N} O_i} \cdot \sum_{i=1}^{N} O_i + h = \sum_{i=1}^{N} EX_i + h = ES + h \tag{3}$$

where ES expected sum of all losses,
h - total additional costs for risk.

Then bankruptcy probability R is equal to

$$R = P(S > u) = P(S > ES+h). \tag{4}$$

where S – expected sum of losses.

Using Central Limit Theorem of the probability theory it is possible to prove that

$$R \approx 1 - \Phi\left(\frac{h}{\sqrt{VarS}}\right) \tag{5}$$

where Φ is standard normal cumulative distribution function,
$VarS$ – is dispersion of the loss sum.

Thus, if we want, that the company nonbankruptcy probability is equal to α, than additional cost for risk h should be equal to:

$$h = \chi_\alpha \cdot \sqrt{VarS}\,, \tag{6}$$

where $\Phi(\chi_\alpha) = \alpha$.

The calculated added cost h is to be divided by all policies. There are different division methods. One of these methods is based on the proportional probable costs of the additional cost division, but according to other methods the additional cost h is divided proportionally to costs dispersion.

If we want to divide h proportionally to probable costs, then:

$$h_i = k \cdot O_i \cdot t \tag{7}$$

where k – is coefficient of proportionality,

$$h = \sum_{i=1}^{N} h_i = k \cdot t \cdot \sum_{i=1}^{N} O_i = k \cdot \frac{\sum_{i=1}^{N} EX_i}{\sum_{i=1}^{N} O_i} \sum_{i=1}^{N} O_i = k \sum_{i=1}^{N} EX_i\,, \tag{8}$$

from formulae (7) and (8) follows that:

$$k \sum_{i=1}^{N} EX_i = x_\alpha \cdot \sqrt{VarS}\,. \tag{9}$$

Thereby,

$$k = \frac{h}{\sum_{i=1}^{N} EX_i} = \frac{h}{ES} = \frac{x_\alpha \cdot \sqrt{VarS}}{ES}. \tag{10}$$

In this case, the premium for one contract should be equal

$$p_i = O_i t + h_i = O_i t + \frac{x_\alpha \cdot \sqrt{VarS}}{ES} O_i t = O_i t \left(1 + \frac{x_\alpha \cdot \sqrt{VarS}}{ES} \right). \tag{11}$$

So, if we want to divide h proportionally probable costs, then the following formula can be used for premium rate estimation:

$$p_i = O_i t \left(1 + \frac{x_\alpha \cdot \sqrt{VarS}}{ES} \right), \tag{12}$$

where ES – all costs probable total.

The diagram shows that tariff rate depends on the bankruptcy probability, Fig.5. The increase of tariff brings about reduction of bankruptcy risk, as well as drop of competitiveness. Thus, the choice of the acceptable correspondence depends on company. Moreover, as it seen in the diagram, reduction of bankruptcy probability to half of a percent, requires a slight increase of tariff, whereas the following reduction of bankruptcy leads to sharp increase of tariff rate.

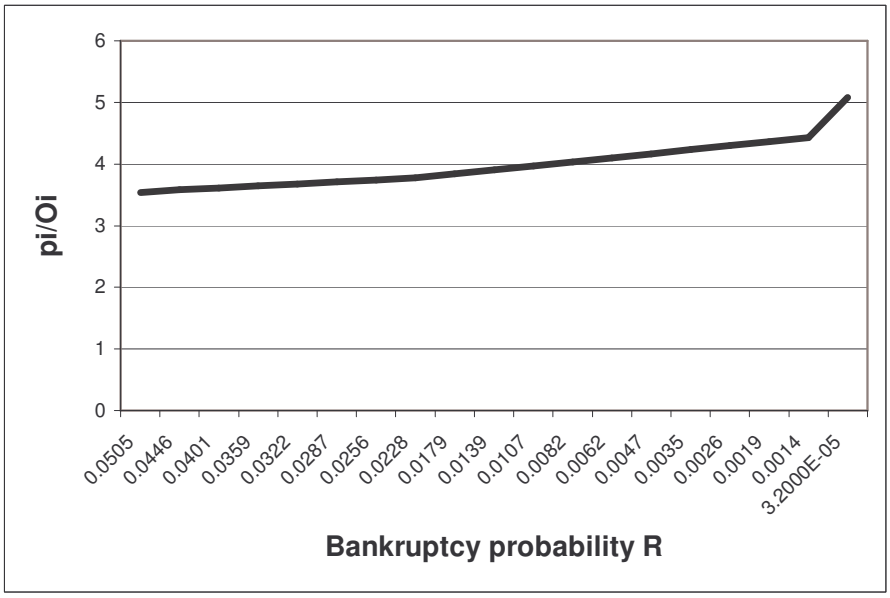

Fig.5: Tariff and bankruptcy profitability dependence

The collected statistics data processing showed that this model can be used in practice to correct the premium rate. This premium rate calculation method guaranties company reserves formation to pay indemnities, but having calculated the gross premium it is necessary to add the additional cost what can guarantee the insurer the possibility to cover the office work and the profit. The model described is the simplest of the models which were used to improve the integrated insurance informative system possibilities.

4. Internet Technologies in Insurance

4.1. IDPS structure and benefits

While developing IDPS, it should be taken into account that agreement registration technologies may sharply differ in different companies as concerns the agreement numeration types and documents' forms, *Uhanova (2003)*. Consequently, IDPS systems should at most precisely, flexibly and rapidly record and process variety of information flow between insurance and reinsurance members. The system must be able to perform the most varied tasks connected with drawing up and registration of documents, as well as their parameters calculation. The system should also take into account such terms as payments, insurance cases, appearance of supplementary agreements, premium receipt, agreement suspension. The system should calculate such agreement parameters as insurance sum, reinsurance premium and other factors which may help to define the insurance agreement terms at a maximum accuracy. It is also necessary to store up information about risks, protection from which provides each of the insurance agreements. The system should also support link between reinsurers and direct insurers. This possibility may be secured by means of Internet technologies as well as those intended for distributed application development. Special attention should be also paid to security problems.

Using Internet technologies it is possible to create a valuable company's virtual office where clients can get insurance policies. Virtual office must meet the following requirements:

- virtual office must give a client a full information about company's financial situation;
- it must give a client information about company's services;
- it must give an opportunity to calculate the insurance premium rate and to determine payment conditions according to each insurance type depending on concrete parameters;
- it must offer a client to fill in a policy application form;
- it must offer a client policy ordering and paying for it though the Internet;
- it must provide a client policies certified with the insurer's e-signature and policy's delivery through the Internet;
- it must provide an exchange of information between the two parties within the policy's validity time;
- it must provide an exchange of information between the insurer and the insured person in case there is the subject of insurance;
- it must guarantee the indemnity in the case of the subject of insurance exists;
- it must offer a client other services e.g. insurance terms glossary, currency exchange rates, consulting.

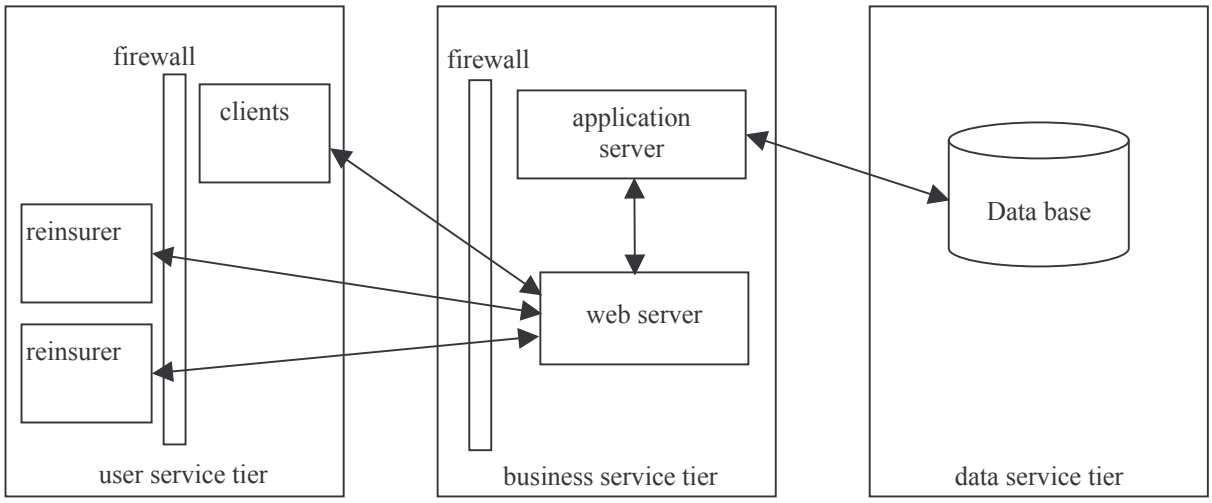

Fig.6: IDPS structure

Creating virtual office the company get the following benefits. Virtual office maintenance costs are lower than an ordinary office maintenance. The main advantage is that Internet representative offices establishment gives the insurance company the opportunity of offering its services in any geographical area. The practice of information system development proved that difficulties are connected with the fact that qualitative result is impossible without correct choice of tools. Therefore while developing a new system, it is important to decide what will be the structure of the system, how the system components will be located and how they will be connected with each other. Today the most powerful distributed application development technologies are CORBA, J2EE and .NET. Among these technologies, particular role belong to the technology CORBA, which as distinct from .NET is solution of heterogeneous environments and unlike J2EE allows integration of programs which are developed in different languages. If one of these technologies is used for IDPS system development, then the structure will be as in Fig.6. Table III shows which functions should be performed by each system tier.

Table III: Distribution of system functions according to tiers

Tier	**Functions to be performed**
User service tier	Provides service for various type of clients
Business service tier	Ensuring links between system's clients, authorization of clients, documents preparation
Data service tier	Data storage

4.2. Technologies solutions of the system development

While developing IDPS system, it is possible to use Internet browser as client application. Thus, a system client may be "thin" in order to simplify the further system modifying. As basis for data tier may serve various data base management systems, for example Microsoft SQL Server, MySQL, Pervasive SQL, Oracle etc., but business tier structure depends to a great extent on the chosen technologies. In the predetermined time several tools were developed which support CORBA technologies and function on different platforms. CORBA support tools are integrated into different program products, for example, data base management system Oracle, document management system Lotus Domino, windows manager X Windows etc. Thus, in order to ensure business tier functions, for CORBA components development may be used various languages and environment. But if for system development are used .NET or J2EE technologies, then for business ties component development should be used technological solutions, Table IV.

Table IV: Technological solutions for business tier component development

System function	Technology J2EE	Technology .NET
Creation of dynamic WEB pages for exchange of information between clients, direct insurers and reinsurers	client side: JavaScript Java applet server side: JavaServer Pages Java Servlets	client side: VB Script JavaScript server side: ASP.NET
Components of the system logic (calculations, document preparations etc)	JavaBeans	COM+, ActiveX
Link support with data base	JDBC	ADO.NET

5. Conclusions

Providing effective processing of insurance and financial data and corresponding information exchange between financial and maritime companies in essential. Study, formalization and analysis of business process is a necessary stage of customization and application of Insurance Data Processing System.

The following steps for improving business processes by using IT solutions must be undertaken:

- creating the info-logical model which would serve as the basis for improving the business processes,
- developing a pilot version of IDPS, which supports different kinds of risk insurance, including marine insurance,
- formulating the recommendations for improving business processes.

The Business System Planning (BSP) method and LIS Technology were used to produce the set of business charts (Functions Processes-Activities) and diagrams "Processes-Executors". A set of business charts, interface tables and communication diagrams was created in the first phase of process design. The results of this phase were used for further development of the software system. The main goal of IDPS is to provide an integrated solution that supports insurance business process at different levels. Therefore, study and analysis of mathematical models for insurance tariff rate estimation has been performed. The collected statistics data processing showed that described model can be used in practice to correct the premium rate. This premium rate calculation method guaranties company reserves formation to pay indemnities, but having calculated the gross premium it is necessary to add the additional cost what can guarantee the insurer the possibility to cover the office work and the profit.

The model described was used to improve IDPS possibilities. The modern Internet technologies were analyzed from the point of view of their possible use in marine insurance data processing system. The results of this analysis allow to conclude that Internet technologies offer already now wide possibilities for insurance business, they also can be widely used in reinsurance because Internet and distributed application technologies may simplify cooperation between direct insurer and reinsurer as well as accelerate information exchange between them.

While choosing technologies, it is necessary to take into account such factors as necessity to transfer program to other platforms, project size and complexity. For example, CORBA offers unique possibilities for program integration, this technology is very convenient to use in the heterogeneous environment. Microsoft .NET technology is too young at present moment and therefore should be used with precaution. But at the same time, .NET is especially suitable for Windows environment.

References

NOVITSKY, L; UHANOVA, M.; VIKTOROVA, E.; RAGOZIN, V. (2003), *Modelling of Marine Insurance Business Processes*, The International Workshop on Harbour, Maritime and Multimodal Logistics Modelling & Simulation HMS 2003, Riga, pp.345-350

BLUMEL, E.; NOVITSKY, L. (Eds.) (2000), *Simulation and Information Systems Design: Applications in Latvian Ports*, JUMI, Riga, p.155.

NOVITSKY, L.; UHANOVA, M.; JACKIV, I. (2001) *Analysis and Modeling of the characteristics of insurance company business activity*, Scientific Proceeding of Riga Technical University, Computer Science, volume 8, “RTU”, Riga pp.163-170 (in Latvian)

UHANOVA, M. (2003), *Information Technologies in Reinsurance Activities*, Scientific Proceeding of Riga Technical University, Computer Science, volume 17, “RTU”, Riga pp.185-193 (in Latvian)