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Table of Contents

- 4-16 *Economical Efficiency of Geosynthetics Application in Uzbekistan and Prospects of Geosynthetics Market Development*
Damir M. Rozibakiev · Umidbek A. Allabergenov
- 17-28 *Investments into Primorsky Territory*
Evgenia Rubinshteyn
- 29-60 *Applying Platforming Concept in Healthcare Services Development: Comparison, Issues, and Future Research*
Linda L. Zhang
- 61-76 *Comparative Performance of Health Insurance Business of Public and Private General Insurance Companies in India*
Amandeep Kaur Shahi · Harinder Singh

Economical Efficiency of Geosynthetics Application in Uzbekistan and Prospects of Geosynthetics Market Development

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ABSTRACT

At present though the market of geosynthetic materials as that in Uzbekistan also doesn't exist but projects in which it is supposed to use geosynthetic materials already began to appear. Being based on the analysis of world experience, it is possible to argue with confidence that in the next two-three years the situation in a root will change and geosynthetics will gain popularity. In article is carried out research and the analysis of the market of geosynthetic materials and also ways of increase of demand for geosynthetics

Keywords: Economical Efficiency, Geosynthetics Market Development, Geosynthetics Application in Uzbekistan

INTRODUCTION

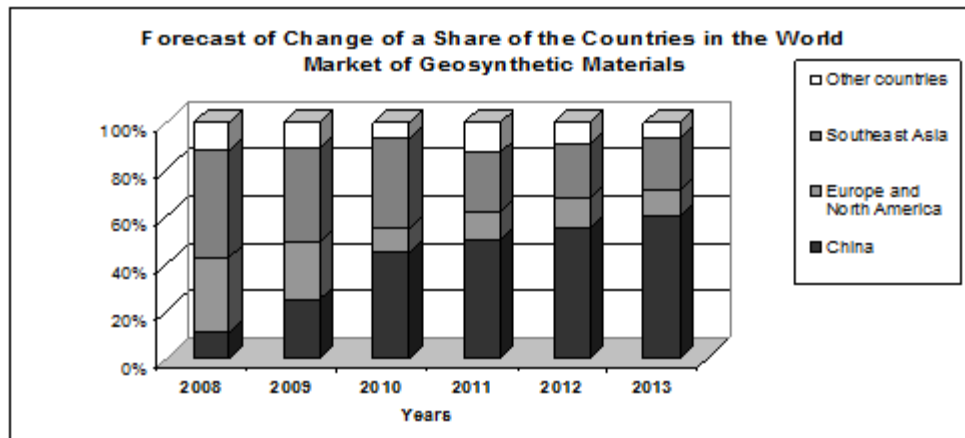
According to a forecast demand on geosynthetics will grow for 5,3 % annually and by 2013 will reach 4,7 billions square meters. The greatest increase in demand is supposed in such countries dynamically developing countries as: China, India and Russia. That has a talk one party with prompt development of infrastructure and with another – need to observe modern ecological and construction norms. Demand for rigid geogrids will grow most of all, it will make only 11 % from the general increase in demand in this area. In spite of the fact that the essential increase in demand on geosynthetics is expected practically in each region, the reasons provoking growth can vary. These and other trends including shares of the market and commodity segmentation are presented in research under the name «World geosynthetics» of company Freedonia Group, Inc (World Geosynthetics) (Aleksandrova et al., 2015; Bekchanov et al., 2014; Raupova, et al., 2014).

The main effect from application of geosynthetic materials is connected with substantial increase of reliability and durability of building units. Geosynthetic materials combine high physical-mechanical characteristics (high durability at dynamic loadings, elasticity) both excellent hydraulic and chemical properties. So, use of geosynthetics reinforcing materials in road building in the USA and the European countries has allowed to increase service life of a road covering at least for 4-5 years. Application in building of geosynthetic materials gives also considerable economic benefit. It is reached at the expense of reduction of cost of building and increase in service life of constructions, decrease in expenses for maintenance service and repair of objects. Building depreciation is caused by that new technologies allow to reduce (in road building – to 50 %) expenses on traditional building materials: sand, rubble, gravel and also the expenses connected with their transportation and packing (Bekchanov et al., 2014; Schoengold & Zilberman, 2014).

The important advantage of geosynthetic materials is their ecological compatibility. Geosynthetics are extremely rack to influence of aggressive chemicals (acid, alkali), organic substances (a fungus, a mold, microorganisms), to extreme environmental conditions (a frost, a heat, high humidity), and also to ultra-violet radiation. Thus geosynthetic materials don't form any by-products, i.e. are absolutely non-polluting materials (Bhaduri & Djanibekov, 2015; Duygun et al., 2014; Harbouze et al., 2014; Theodoridis et al., 2015).

Market of geosynthetic

In 2008 about 45 % were the share of a share of Asia and the Pacific region from world sales of geosynthetics. Advance of the market of this region occurs generally thanks to China which provided three quarters of sales of all region in 2008. Besides according to a forecast between 2008 and 2013 to the People's Republic of China will belong more than 60 % of new world demand on geosynthetics. Such domination of China speaks the market number of the free earth, to proceeding development of infrastructure and need of fight against an erosion. Expected growth in the Indian market too is essential (Jamasb et al., 2014; Jenkins, 2014). As approves Freedonia Group, the percent of annual increase in demand in India will be expressed by two-place numbers (Fig.1).



Source: World Geosynthetics // Study from The Freedonia Group, Inc.

Figure 1. Forecast of Change of the Countries Share In the World Market of Geosynthetics

It is caused by development of transport infrastructure, need of improvement of methods of fight against an erosion and mud landslides during a season of rains and to construction of modern ranges for burial of a waste. However, in many other less developed countries of Asia demand on geosynthetics will be more limited because of a lack of adequate financing, absence of necessary technical norms and existence of cheaper alternatives such as a stone and geotextiles from natural fiber (Karimov, 2015; Karimov & NiÇo-Zarazffla, 2015).

In 2008 North America became the regional market second for the size of geosynthetics, applying almost on a quarter of world sales. Advance in the market of the USA is expected soon thanks to the state projects on construction and repair of roads, bridges and other infrastructure objects stimulating development

of economy. Though the Canadian market of geosynthetics much more smaller than in States, it actively develops thanks to a high level of development and technical norms and as to financing. Western Europe and Japan are comparable from the USA on a market level of development and technical norms.

Table 1. Criteria of an Assessment of the Market of Geosynthetic Materials in Uzbekistan

Criterion	Description	Assessment
1. Market criteria. Need for production	Production will satisfy requirement which isn't satisfied now	Above an average
1.2. Prospects of development of the market	Rather large market. Considering speed of construction in Uzbekistan, consumption of geosynthetic materials will grow.	Above an average
1.3. Degree of competitiveness of production	There are no strong competitors having strong positions. Rather low prime cost of an innovation. Competitors have no favorable possibilities for acceptance of fast counter-measures against new production.	Above an average
1.4. Degree of market stability	The general economic factors poorly influence a market condition. It is possible to assume that demand for production will have constant character. The rate of return above average for a number of years is expected.	Average
1.5. Advertizing	Unique properties of production represent good possibilities for its demonstration, effective advertizing.	Above an average

2. Production criteria 2.1. Equipment and personnel	Production will be orderly in Uzbekistan, equipment purchase abroad and training of specialists however is required.	Average
2.2. Resources	It is possible to use the raw materials made by Shurtan gas-chemical complex and subsequently and Ustyurt gas-chemical complex. Besides it is possible to repeatedly process the used plastic bottles	Above an average
2.3. Technical knowledge and personnel experience	Production will demand personnel training abroad or invitations of foreign experts for training of local staff.	Average
3.1. Quality of production	Production possesses unique properties, considerably reduces costs of construction on already available technologies.	Above an average
3.2. Price	Cost of geosynthetics is slightly higher than at traditional construction materials. However, expenses quickly pay off at the expense of increase in reserve maintenance periods.	Above an average
4.1. Realization	Realization will be provided with a marketing network, however at the initial stage of functioning of production some difficulties are possible in sale adjustment because of novelty of output production.	Average

Economical efficiency of geosynthetics application

In research (on which basis this article is written) was considered an area of 1 million square meters which it was required to cover with geotextiles. According to the spent researches, the layer of a geotextile cloth is capable to replace a 40-centimetric layer of gravel and rubble – a traditional filtering material as it possesses similar filtering and drain properties. The data presented by Representative Office of the "TOKPOL" Ltd in the Republic of Uzbekistan. In the Table 1 are resulted the description of works and an expense for their execution.

Table 2. The comparative analysis of expenses for a covering of an area of 1 million square meters with application of geotextiles and traditional technology

Name	Technology with application of geotextile		Technology with application of traditional materials	
Price	Price of material for covering an area of 1 million m ² - 5 EUR		Price of traditional materials (for 1 m ³)- 5,77 EUR. Consequently, price of 1 m ² is 2,31 EUR	
Material consumption	Necessary volume	Price	Necessary volume	Price
	1 150 000 m ² of geotextile	5 750 000 EUR	400 000 m ³ of traditional filtering materials	2 308 000 EUR
Time of placing	Terms of a covering of an area of 1,0 million m ² by geotextile at a time supply of fast one for parallel covering over geotextiles = 56 days.		Terms of a covering of an area of 1,0 million m ² of two-layer filter by domestic materials (height 40cm) – 165 days	

	Technical equipment for covering	Price	Technical equipment for covering	Price
Technical equipment	Trucks for transportation of geotextile (14 500 m ²)–3units;	173 EUR in a day (with due account taken of all costs)	Trucks for transportation from distance of 70-100 km at volume of loading 10 m ³ and 2rides in a day of each truck on object–121units.	173 EUR in a day (with due account taken of all costs)
	Forklift loader for loading and covering of geotextile (weight of 1 roll of geotextiles –330 kg) – 1 unit	173 EUR in a day (with due account taken of all costs)	Bulldozer and scraper – 4 units;	173 EUR in a day (with due account taken of all costs)
			Crushing and sorting production equipment with personnel – 1 unit.	308 EUR in a day (with due account taken of all costs)
Labor force	Labor force (for unloading and covering of geotextile) – 5 people	10 EUR in a day	Labor for control of uniform covering of the filter of 20 sm on 2 layers– 15 people	10 EUR in a day
TOTAL	5 791 552 EUR		5 951 695 EUR	

Thus, if to use geotextiles as a filtering material at building it is possible to save more than 160 000 EUR. Besides, thanks to simple technology of packing, term of building works decreases

almost in three times. The research of the market of geosynthetic materials conducted by us and also dynamics of development of economy of Uzbekistan convincingly testifies to fast occurrence of considerable demand for these materials, first of all on geolattices, geogrids and geotextiles. Considering possible scopes of application of geosynthetics it is necessary to note first of all a number of the scale projects realized in Uzbekistan. There are projects on building of Ustjurtsky gas and chemical complex on the basis of a Surgil deposit. The President of the Republic of Uzbekistan Islam Karimov reports “All our aspirations and programs – for the sake of the further development of the Homeland and increase of well-being of the people” (21.01.2011.). As a rule, on building of similar objects are widely applied such geosynthetic materials as geomembranes, geotextiles and geogrids. They are used at building of objects on storage and recycling of liquid production wastes (Keller, 2015).

Prospects of development of geosynthetics market

The research of the market of geosynthetic materials conducted by us and also dynamic of development of Uzbekistan's economy convincingly testifies to fast emergence of considerable demand for these materials, first of all on geolattices, geogrids and geotextiles. Considering possible scopes of geosynthetics it should be noted that a number of the large-scale projects realized in Uzbekistan. There are projects on construction of Ustyurtsky gas-chemical complex on the basis of a field Surgil. As a rule, on building of similar objects are widely applied such geosynthetic materials as geomembranes, geotextiles and geogrids. They are used when building objects on storage and utilization of liquid production wastes. The following, not less important project – construction of the two-acceptable electrified railway line Djizzak-Yangiyer and the single-line electrified railway line Yangiyer-

Farkhad. At last one of the largest and major projects for economy of our country – construction of the Uzbek National Highway. Within this Program intended for 2009-2014 will be provided a reconstruction and construction of four sites of highways on Beyneu-Kungrad-Bukhara-Samarkand-Tashkent-Andijan routes, Bukhara-Alat, Bukhara-Karshi-Guzar-Termez and Samarkand-Guzar in the general extent over 1,5 thousand km.

In 2012 on these purposes is provided to direct over 600 million dollars of capital investments that in 1,3 times more than in 2011 with commissioning of 302 kilometers of the highways meeting the international requirements and standards. According to the Program the National Highway will be equipped with the necessary infrastructure including construction of motels, campings, stations technical and service, etc. It is necessary to emphasize that in our country under the direction of President Islam Karimov is carried out a creative work which has not only great value for our country but also for all Central Asian region as a whole and development of the Uzbek National Highway – an example obvious to those. Construction and high-grade functioning of the route will allow to create tens of thousands of new workplaces and will give a new impulse to development of mutually advantageous commercial relations with the world countries, will protect economic interests of Uzbekistan (Lamb, 2014; Maksutina, 2014; Markovits, 2014).

By our estimates only implementation of aforementioned projects will need not less than 100 million square meters of various geosynthetic materials. It is enormous volume which will demand building of own production geosynthetics. These requirements of production could be satisfied by the Shurtan gas-chemical complex and again created objects of the chemical industry. In particular is conducted work on construction of new

modern gas-chemical complexes on production of polyethylene and polypropylene production. Creation of similar objects will allow to receive and use local raw materials for production of national geosynthetic materials that will essentially reduce production expenses and will allow to increase competitiveness of future production as on local and world markets.

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Investments into Primorsky Territory

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ABSTRACT

In the balanced economy the investments are the basic condition of economic development, and in the economy captured by crisis, investment activity acts as the main condition of economic revival. This thesis is axiomatic enough and was repeatedly proved by world economic practice. Russian economists as their foreign colleagues consider investments as long-term capital investments to various spheres of economy, social programs, protection of environment as within the country, and abroad for the purpose of development of manufacture, social sphere, business, and profit increase. Situation in the Russian economy now such is that investments are extremely necessary for it. Therefore the subject of this article is extremely important.

Keywords: *Balanced Economy, Economic Development, Long-term Capital Investments, Russian Economy*

INTRODUCTION

The major element in economic activity of any country with market economy is investments. The problem of a choice of the investment decision always is difficult, and the assessment of

investment appeal of the territory is the most important part of making any economic decision. Thus, the situation in the region is more difficult, the more experience and intuition of the investor have to rely on results of an expert assessment of investment climate (Pogosian, 2012; Sills & Abt, 2013).

The testimony of complexity of a situation in economy is decline in production, weakening of scientific and technical potential, non - reasonable use of national wealth of the country. However, at competent investment policy after all improvement of economic welfare, both Russia, and her citizens is possible. In a present situation if it won't be possible to attract an investment, gradual dying of productions, economy degradation, an edge impoverishment, social explosions and the other accompanying phenomena become reality Increase of investment appeal of the territory will give the additional resources, allowing to promote to recovery from the crisis. It is feasible only with proper management of investment process and increasing investment appeal (Persson & Wiberg, 2012; Postiglione, 2015).

DIVERSE INFRASTRUCTURE OF DEVELOPMENT AND SUPPORT OF ECONOMY

To attract potential investors on the territory, it is necessary to provide conditions for the maximum return from investments, and it is possible only with the development and implementation of effective investment policy. The investment strategy will have real results in the presence of the organizational preconditions most important of which has to be existence of diverse infrastructure of development and support of economy. For this purpose it is necessary to have infrastructure, namely: infrastructure of financial and non-bank investment institutions, consulting, and also the organizations solving specific and socially

significant problems, infrastructure for support of and investment into small business, infrastructure of transport, communications, infrastructure for scientific and technological and innovative spheres; market and trade (Bakitzhatov & Filin, 2004; Bollinger, 2014; Snieska & Simkunaite, 2015).

All these components traditionally are considered as the basic necessary elements of the investment infrastructure creating favorable conditions for the organization, provision, support and development of investment process. We need to add one more essential component - the infrastructure of public administration responsible for formation, regulation and implementation of regional investment policy, and also for the organization, provision and development of competitive infrastructure of investment process itself.

At regional level management of investment activity includes (Economy, 2012):

- development of annual analytical reports on region economic and social situation (Identification of tendencies, contradictions, problems; defining problems, assigning them priorities and assessment of necessary investment resources for their solutions);
- development and administrative maintenance of strategy of investment development of Primorsky Territory (formation of general "philosophy" of preparation and making administrative decisions by various participants of investment process - on approaches to understanding the essence of arising problems, a choice of priorities under conditions of limited investment resources, necessity of their concentration on the key directions, which provide stability of economy development);

- assessment of a stage and dynamics of the regional investment market and development of programs of involvement of local savings in regional production process;
- assessment of investment potential of industry branches and territories of the region;
- the current monitoring of regional investment risks and development of actions for their decrease (the analysis of sources, definition of necessary resources and their concentration on most "dangerous" the directions);
- creating the list of regional economic partners, who are "investment reliable";
- development of organizational and economic mechanisms of assistance to direct investors in order to ensure access to management of joint business, safety and return of investments;
- monitoring of investment resources with the lowering comparative efficiency, attracted to the Primorsky Territory economy from foreign markets;
- assessment of social and budgetary efficiency of investment projects and their selection for organizational and financial support by regional and territorial authorities.

Successful investment activity in the region sufficiently depends on its administration and, therefore, has to be traced, be estimated and be analyzed for the purpose of more effective management of its results (Topsakhalova, 2010).

One of criteria of an assessment is a gross domestic product (GDP) indicator (Gleditsch, 2002; Goossens & Mäkipää, 2007; Lakštutienė, 2015). The possible criterion could be a maximum of the gross domestic product per capita for the region. Such criterion can be written down in the following look:

$$F/U \rightarrow \max, (1)$$

where

F - a gross internal product of the region in unit of time (year);

U - an average annual population in the region.

In an ideal situation the administration of the region has to trace permanently changes which happen to the most important social indicators of development of the population in order to have an opportunity to watch a trajectory of their movement. Such indicators are:

- employment of able-bodied population;
- average cumulative income per capita;
- average total and living space per capita;
- average annual infantile mortality;
- average life expectancy of men and women;
- price index of consumer basket;
- number of operating phones on a family;
- portion of food expenses in total income of the population;
- quantity of new workplaces;
- growth of officially recorded monetary savings per capita;
- commodity turnover growth per capita;
- changes in a population standard of living;
- changes in system of ecological factors.

This list doesn't settle all possible social indicators of development of the population which the administration of the region will constantly define and trace, creating the favorable environment for more effective management of investments. Only such situation will make possible to speak about high and effective policy of the administration towards to significant improvement of living standard of the population, when results of

decisions made by territory administration will become measured quantitatively (Ivanov, 2002).

PRIMORSKY TERRITORY CASE

In Primorsky Territory (Bakalin, 2008; Doudkin & Volkova, 2013; Ivashintsova & Voronin, 2014; Vainshtein & Beglyarov, 1971), the legislative base on creating favorable conditions for investors, including foreign investors is created:

1) The law of Primorsky Territory of May 10, 2006 No. 354-KZ "About the state support of investment activity in Primorsky Territory". Law is directed to stimulation of investment activity on territories of Primorsky Territory and attraction of investments on the basis of most favored conditions to the Russian and foreign investors, and also ensuring equal protection of the rights, interests and property of participants of investment activity regardless of organizational and legal forms of investors and forms of ownership.

2) The regional target program "Improvement of Investment Climate in Primorsky Territory " for 2011-2015 (it is approved as the resolution of Administration of Primorsky Territory of June 30, 2011 No. 177-па). Main objectives and Program tasks: creating favorable conditions for attraction of investments and the effective tools providing increase of investment appeal of Primorsky Territory, improvement of the legislation of Primorsky Territory in the field of the investment relations, attraction of additional investment resources, the organization of work on elimination of administrative barriers at implementation of private projects and projects of state-private partnership, building and promotion of positive investment image of Primorsky Territory.

3) The regional long-term target program "Development of Small and Medium Size Business in Primorsky Territory " for 2011 - 2013 (No. 328-III is approved by the resolution of Administration of Primorsky Territory of 24.09.2010). Main objectives and program tasks are creating favorable conditions for steady functioning and development of small and medium size businesses, assistance to development of small size businesses in production and innovative spheres; expansion of ways for businessmen to access to financial resources, development of the directions of regional policy for support of small and medium size businesses providing development, improvement of regulatory legal base and legal support of business activity, increase of competitiveness of small and medium size businesses in domestic and foreign markets, expansion of ways of access for of small and medium size businesses to financial resources, including rendering financial support by non-profit organization "Guarantee Fund of Primorsky Territory", improvement of starting conditions for business activity (grant support to beginning businessmen), development of infrastructure of support for small and medium size businesses.

Each Territory of the Russian Federation tries to involve as much as possible capital investments into the economy, but not each territory has equal appeal to the investor, including the foreign. Appeal depends on a number of factors: advantages of the economical geographical position, favorable investment climate in the specific region, level of infrastructure. All these factors find the reflection in dynamics of investment appeal and ability to use it.

Infrastructure has considerable influence on efficiency of private investment, therefore, good infrastructure attracts investors to the region. Opportunity to use buildings and the land (the right to dispose them often belongs to regional or municipal

administrations) also are a considerable decisive factor for attraction of foreign investments.

Acceptance in June, 1999 and signing by the president in July of the same year, the new law "About Foreign Investments in Russian Federation" No. 160-FZ was a significant event for investment process in Russia concerning foreign investments. The law defines the main guarantees of the rights of foreign investors on an investment both gained income, and profit, and also conditions of business activity in the territory of Russian Federation.

The law of Russian Federation "About Foreign Investments in Russian Federation" defines a foreign investment as "an investment of the foreign capital in object of business activity located on the territories of Russian Federation in the form of objects of the civil rights belonging to the foreign investor if such objects of the civil rights aren't withdrawn from a economic circulation or aren't limited in an economic circulation of Russian Federation according to federal laws, including money, securities (in foreign currency and currency of Russian Federation), other property, the property rights having a monetary assessment, exclusive rights for results of intellectual activity (intellectual property), and also services and information". This law gave to foreign investors favorable conditions for the business activity, conterminous to the international standards.

According to the law, privileges are given to the investors who implement the priority investment projects determined by the government of the Russian Federation on the basis of a set of criteria including investment the size and their orientation. These measures are directed, first of all to fight against abuses of privileges. Despite the favorable conditions provided to foreign investors, there still are many factors constraining inflow of the foreign capital. Among them it should be noted such, as high cost

of the credit, lack of guarantees of safety, economy criminalization, arbitrariness of local authorities, corruption of officials. In aggregate it significantly raises risk that doesn't allow to fully involve the potential of investment cooperation [4].

Primorsky Territory is one of most actively developing regions of Russia, the leader of economic growth among Far East regions. Primorsky Territory wins first place among of Far East regions on the volume of investment, directed to development of economy and the social sphere. Over the last 10 years investments into the region grew by 7,8 times in the comparable prices (Department of economy, support of business, development of the competition, investments and control of preparation for the APEC summit of Primorsky Territory. The report is on improvement of investment climate in Primorsky Territory.

The large Russian investors, more than 2 thousand foreign companies and the companies with foreign participation conduct businesses in Primorsky Territory. The foreign trade turnover of Territory made 8 bln. US dollars in 2011, that made growth by 1,2 times. 90% of a foreign trade turnover are the share of ATR countries. The greatest portion among which occupy China – a share of 58,5%, the Republic of Korea – a share of 16,3%, Japan – 10,0%. Thus, the major countries investors are China, the Republic of Korea, and Japan. About 700 mln. dollars of the USA of foreign investments work in economy of Primorsky Territory. Strategy of social and economic development of Primorsky Territory for the period till 2025 defined 6 priority directions of development for the Territory:

1. Transportation and deep processing of hydrocarbon raw materials
2. Development of transportation system
3. Modernization of industry branches of traditional specialization

4. Development of the Vladivostok agglomeration
5. Development and introduction of innovations, global education
6. Shipbuilding, mechanical engineering, development of local airlines

CONCLUDING REMARKS

Building of comfortable conditions for business and favorable investment climate is a key problem of Primorsky Territory. During preparation for the APEC summit in short terms modern infrastructure objects in the field of power, transport, municipal services were created. The state program of the Russian Federation "Social and economic development of the Far East and the Baikal region for the period till 2025" provided implementation 69 priority investment projects with total cost more than 3 trillion rubles in Primorsky Territory.

The following branches: the agriculture, processing manufacture, wholesale and retail trade, transport and communication are the most interesting branches to foreign investors. They are the most profitable branches of region economy. The stable investors to the economy of Primorsky Territory are the Asian countries which are the very next neighbors – China, the Republic of Korea, Japan.

According to Administration of Primorsky Territory, region annually receives not more than 1% of foreign investments in the total amount invested in regions of the Far East. Despite interest to Primorsky Territory from foreign investors, streams of foreign investments were reduced after 2008, which is negative tendency. Thus, for the last years the attention to the Primorsky Territory is traced, both from the foreign capital, and from the state. But, streams of foreign investments, were considerably reduced as

because of world financial crisis and its consequences, and because of the objective social and economic problems of the region. At the same time implementation of strategic projects of the state and international level in the Far East, implementation of strategy for social and economic development of Far East and the Baikal region till 2025 gives hope of the state investment of realized projects and revival of investment activity.

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Applying Platforming Concept in Healthcare Services Development: Comparison, Issues, and Future Research

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ABSTRACT

While developing product platforms for designing product families is effectively applied in the manufacturing industry, this platforming concept is rarely employed in the healthcare industry, hospitals in particular. In view of the lack of structured approaches to developing healthcare services, this study proposes the adaptation of the platforming concept to develop healthcare platforms for designing healthcare families in hospitals, in hopes of improving hospitals' business performance. It first examines make-to-order (MTO) firms, where platforms are developed for designing product families, and hospitals with respect to work environments and performance requirements. Based on the many similarities between MTO firms and hospitals, it concludes that developing healthcare platforms and designing the corresponding healthcare service families in hospitals is promising. As initial efforts, this study also provides some general guidelines for planning healthcare platforms and discusses the related issues in detail. In accordance with the characteristics of delivering

healthcare services in hospitals and the application of the platforming concept in MTO firms, it identifies a number of potential future research issues and topics pertaining to developing healthcare platforms for designing healthcare service families.

Keywords: Product Platform, Healthcare Platform, Healthcare Service Design, Healthcare Service Family

INTRODUCTION

The healthcare industry plays a critical role in ensuring a country's continuous development as its function is to provide the healthcare needs to communities and individuals and impacts the life of every person. Moreover, as one of the largest and fast-growing industries, the healthcare industry, together with several other service industries (e.g., transportation, financial services, and data processing), accounts for more than half of all projected job growth over the coming decade (Meyer & DeTore, 2001). However, the healthcare providers in general, hospitals in particular, are facing several intense pressures. Most governments in developed economies are cutting down the public healthcare spending (Dutta & Heda, 2000; Warring & Bishop, 2010); the healthcare costs are rising as a result of, e.g., the advancement in medical technologies, the change of healthcare cost structures (Lim & Tang, 2000); the incidents, such as deaths and injuries in hospitals, and other healthcare service quality problems are often reported (Joosten et al., 2009). All of these pressures force hospitals to develop (or redesign) the healthcare services such that the expected healthcare can be delivered with the available resources.

In view of the above need to develop quality healthcare services, in recent years scholars start to pay attention to service development and delivery in hospitals. More specifically, they investigate the application of several well-known design and management techniques and methodologies, which have been used in effectively developing products in the manufacturing industry, in hospitals. These techniques and methodologies include quality function deployment (Dijkstra and van der Bij, 2002), total quality management (Lim & Tang, 2000), and lean thinking (Holden, 2011; Kim et al., 2006; Radnor et al., 2012; Womack & Jones, 2003). Some application cases have been reported to show the improved healthcare services based on the adaption of these techniques and methodologies (Spear, 2005). While the healthcare industry lags behind the manufacturing industry in the adaption of these techniques and methodologies (Walley, 2003), the available studies demonstrate that if implemented carefully, they can contribute to the improved patient care and efficient resource utilization.

In the recent two decades, customers in the manufacturing industry increasingly impose diverse individualized requirements on the products that they want. As a result, instead of developing products “one at a time”, firms strive to timely develop a family of customized products at affordable costs, in hopes of surviving (Meyer et al., 1997). A concept of platforming (i.e., developing product platforms) has been recognized as an effective means to develop product families while utilizing the existing manufacturing resources and competences (Meyer & Lehnerd, 1997; Zhang, 2015). In practice, many product platforms and the corresponding product families have been developed (Simpson, 2004). The benefits for developing product platforms have been frequently reported, including the improved customer satisfaction,

the reduced product development time and cost, the reuse of product development knowledge, to name but a few.

While the platforming concept has been well applied in the manufacturing industry, especially make-to-order (MTO) firms, its application in the service industry is limited. To my best knowledge, there are three articles introducing the application of platforming concept in the service industry. In one study, Menor et al. (2002) discuss the critical substantive and research design issues pertaining to service development (e.g., new service definition and unit of analysis specification) and point out the need to develop service platforms for service development. In the other two studies, the authors explicitly address the development of service families based on service platforms in the banking industry (Moon et al., 2011) and in the reinsurance industry (Meyer & DeTore, 2001), respectively. As with hospitals, customers in both industries have their unique profiles, thus demanding diverse individualized services. While Moon and his group treat the design of the service platform as an essential step in developing the banking service family (Moon et al., 2011), Meyer and DeTore (2001) shed light on the definition and development of the service platform for the reinsurance service family provided by Lincoln Re. As initial studies, their work demonstrates the feasibility of applying platforming concept in developing banking and reinsurance service families.

MTO firms and hospitals possess a very similar nature in the production/service delivery caused by the fact that both MTO firms and hospitals strive to meet the expectations of customers, each of which has his unique requirements (Walley, 2003). As a matter of fact, Forgionne & Kohli (1996) view hospitals as MTO enterprises and the healthcare delivery process as an MTO process. In addition, as with MTO firms, quality, time, and cost are recognized as necessary characteristics to embed in the

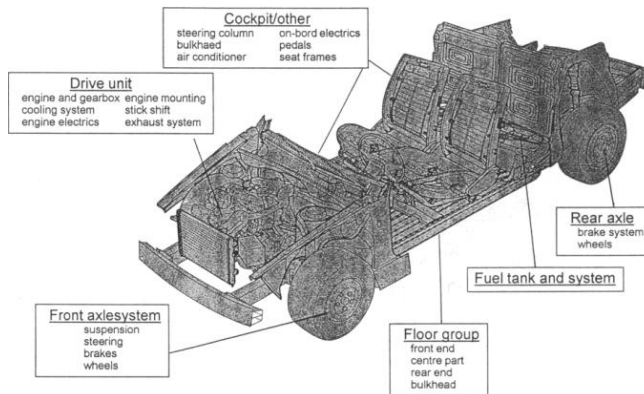
healthcare services in hospitals (Walley, 2003). To summarize, there are diverse similarities in production/service delivery and in performance requirements between hospitals and MTO firms.

The purpose of this study is to investigate the adaption of platforming concept in developing healthcare service families in hospitals. It is motivated by (i) the similarities between hospitals and MTO firms, (ii) the application of platforming concept in the banking and reinsurance industries, and (iii) the adaption of several design and management techniques and methodologies from the manufacturing industry to hospitals. This study promotes adapting the platforming concept in hospitals, instead of adopting the available product platform-related solutions. This is because hospitals have certain unique characteristics (e.g., the involvement of patients in the most part of the care delivery process), which do not appear in MTO firms. Due to these unique characteristics, hospitals can adapt the platforming concept in developing healthcare services, instead of adopting the product platform-related solutions, which are suitable to use in MTO firms.

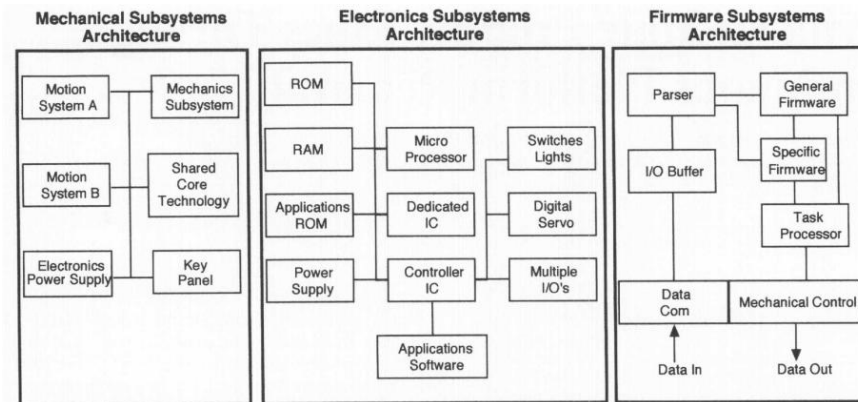
In the rest of the paper, a brief review is dedicated to the platforming concept in Section 2. The adaption of platforming concept in hospitals is investigated by first comparing MTO firms and hospitals with respect to the production/service delivery and performance requirements in Section 3. Subsequently, Sections 4 sheds light on the issues in planning healthcare platforms. Future research is highlighted in Section 5. The paper is ended with some conclusions in Section 6.

PLATFORMING REVISIT

The literature review suggests that product platforms have been defined from different perspectives ranging from being general and abstract (e.g., Meyer & Lehner, 1997; Robertson & Ulrich, 1998) to being industry and product specific (e.g., Ericsson et al., 1996; Wilhelm, 1997). In addition, the meaning of product platforms differs in the scope. Some definitions focus on the physical product/components (Meyer and Utterack, 1993), whilst others explore the platform concept in terms of a firm's value chain (Meyer & DeTore, 2001; Sawhney, 1998). In spite of the diversities in the definitions and descriptions of product platforms, the consensus is that a product platform is either a physical element or an abstract system. A physical product platform refers to the group of common components (such as modules, parts, assemblies), which is shared by a number of related products. A typical example of physical product platforms is a car platform at Volkswagen (Wilhelm, 1997). It consists of a floor group, drive system, running gear, and cockpit, as shown in Fig 1(a). An abstract product platform is viewed as a set of subsystems and interfaces that form a common structure, from which a series of derivative products can be developed. An example of abstract product platforms is the inkjet printer platform from Hewlett-Packards (Meyer, 1997). It includes several key subsystems, including mechanical subsystems, electronics subsystems, and firmware subsystems, and interfaces among these subsystems, as shown in Fig 1(b).



(a) Volkswagen’s product platform (Wilhelm, 1997)



(b) Hewlett-Packard’s product platform (Meyer, 1997)

Figure 1. Product platform examples

Based on product platforms, be they physical or abstract, families of related products (i.e., product families) can be effectively developed. While the product family as a whole targets a market segment, the members address the needs of individual

customers or market niches. Assuming a common product structure, the product family members perform the same basic functions characterizing the market segment and unique functions pertaining to individual customers (Fan & Liu, 1999). There are two prominent approaches to developing product families based on product platforms, including module-based product family development and scale-based product family development (Simpson, 2004). In module-based product family development, product family members are developed by adding, substituting, and/or removing one or more modules from the product platform. (A module is a group of components which collectively perform certain function. For example, the drive unit is one module in the car platform in Fig 1(a).) A frequently quoted example of module-based product family development is the development of more than 250 Sony Walkmans in the 1980s (Sanderson & Uzumeri, 1997). Using the second approach, product family members are developed by scaling one or more variables (e.g., length, width) to “stretch” or “shrink” the product platform. A well-known example is the Boeing case where Boeing developed many of its commercial airplanes by “stretching” the platform to accommodate more passengers, carry more cargo, or increase flight range (Sabbagh, 1996). To summarize, the key assumption of developing product families based on product platforms is that despite their unique requirements, customers often have similar/same requirements associated with the basic product functions.

COMPARISONS OF MTO FIRMS AND HOSPITALS

Make-to-order firms

Firms differ in the way how they meet the market demand. Some firms produce products by anticipating customer orders, thus

delivering standard products to customers from finished goods inventory, i.e., make-to-stock; some, however, start their production and/or design activities after receiving customer orders, i.e., MTO. While different criteria are used to classify MTO firms (Amaro et al., 1999; Gunasekaran & Ngai, 2005; Hendry, 1998; Olhager & Ostlund, 1990), the same manufacturing characteristics of MTO firms are recognized in the literature. First, the market demand of MTO firms is volatile and can rarely be predicted as each customer has his specific needs, which are different with these from others. In addition, customers have demanding requirements for the delivery lead time and do not accept the delayed delivery, as explicitly pointed out in (Kingsman et al., 1993). In accordance with the individualized customer requirements, MTO firms develop a variety of customized products while ensuring that lead time promises are kept. To produce different product options, MTO firms employ highly skilled staff (e.g., operators, engineers) in the daily operations activities (Hendry & Kingsman, 1989; Muda & Hendry, 2002). In recent years, MTO firms have been capitalizing on the platforming concept to develop product variety while meeting the specific needs of individual customers. As a result, there is a generic product structure assumed by a family of customized products, leading to design similarities, such as similar product structures and same components (Babu, 1999; Muda & Hendry, 2002). Thanks to the similarities in design, similarities in production, such as common routings, process flows, and machines, exist on shop floors for producing the customized products (Zhang & Rodriguez, 2012).

Hospitals

Scholars have pointed out that hospitals have a variety of customers, including patients, patients' families, insurance

companies, and local, provincial and national regulators (Dijkstra & van der Bij, 2002; Kollberg et al., 2007; Radnor et al., 2012). This study assumes the patients as the primary customers because the main mission of hospitals is to treat and cure patients, who are the end-consumers of the healthcare services. The basic input of a care process is a patient in terms of his demographic, diagnostic, and therapeutic information. Thus, the type and level of healthcare services that a patient receives is determined by his demographic, diagnostic, and therapeutic characteristics. The output (or product) is the healthcare service delivered. Same as in MTO firms, the healthcare activities in hospitals, such as test, diagnostics, and treatment, must be performed on time to avoid death and other unwanted consequences (Holden, 2011). In spite of the fact that each patient is unique, he has certain demographic, diagnostic, and therapeutic attributes in common with other patients. Consequently, patients can be classified into groups and receive similar healthcare services (Fetter et al., 1980; Van der Bij et al., 1999; Wally, 2003). Moreover, in practice similar healthcare pathways for patients belonging to same groups can be identified in hospitals (Walley, 2003). The resources, such as physicians, nurses, and test, diagnostic and treatment equipment possess very high level skills for performing their tasks. Such high skills are necessary to deliver a healthcare service, which can turn a patient with diseases into a satisfied, healthy patient.

Unlike in MTO firms, there are no structured approaches in hospitals for developing and designing healthcare services (Alam & Perry, 2002; Smith et al., 2007). Due to the inappropriate service design and management, low capacity utilization, poor flexibility, delayed care, and other quality problems are often seen in hospitals (Kim et al., 2006). However, facing the competition from other healthcare providers, the rising of

healthcare costs, and government regulations, hospitals must be able to deliver high quality, low cost and fast healthcare services (Guerriero & Guido, 2011; Walley, 2003). In this regard, hospitals must develop new services and systems such that quality, low cost and fast responsiveness can be achieved in the healthcare delivery process.

Comparison of MTO firms and hospitals

In accordance with the characteristics of MTO firms and hospitals described above, Table 1 presents a summary of comparisons of MTO firms and hospitals with respect to the environment characteristics and performance requirements.

Table 1. Comparison of MTO firms and hospitals

Characteristics	MTO firms	Hospitals
Demand predictability	Very low	Very low
Customer requirements	Diverse; Groups can be identified	Diverse; Groups can be identified
Delivery time	On time as requested	On time as requested
Output	Products	Healthcare services
Design	Customized products are designed based on product platforms	No structured approaches for healthcare service design
Production/Delivery	Variations with common routings, process flows, etc	Variations with similar healthcare treatment pathways
Resource skills	High	High
Performance requirements	High quality; Low cost; Fast delivery	High quality; Low cost; Fast delivery

In spite of the difference in output (i.e., MTO firms produce products and hospitals deliver healthcare services), MTO firms

and hospitals have a number of similar characteristics in their business environments. Both MTO firms and hospitals cannot make an accurate forecast of market demand, which results in low demand predictability. This is caused by the profiles of customers, who have specific needs and unique requirements for the products/healthcare services that are suitable for them. While customers from MTO firms/hospitals have different requirements on the products/healthcare services, they do possess a requirement in common, that is, products and healthcare services have to be delivered on time as requested. Moreover, despite the requirement diversities, customers of both MTO firms and hospitals have certain common characteristics (e.g., needs/requirements, diseases). With these common characteristics, customers can be classified into different groups. While in MTO firms, product platforms are used to develop customized products for customer groups, the platforming concept is not utilized in hospitals to develop healthcare services. As a matter of fact, structured approaches do not exist in hospitals for developing healthcare services. This gives the opportunities to investigate effective approaches to develop healthcare services.

To materialize diverse customized products, production variations, such as the change to machines, operations, and tools, must be introduced on shop floors of MTO firms. This is the same for the healthcare delivery in hospitals. For each customer (i.e., patient), each healthcare service package is unique. Nevertheless, common routings, process flows, operations, etc. exist on shop floors of MTO firms for producing customized products; similar healthcare treatment pathways are often seen for customers who have similar demographic, diagnostic, and therapeutic information characteristics attributes. In both MTO firms and hospitals, the skills of resources (especially the human resources) are very high. Such high skills are necessary to ensure the

production/delivery of diverse products/healthcare services. At last, to survive, both MTO firms and hospitals need to embed quality, flexibility and responsiveness in the product production and healthcare service delivery (Walley, 2003).

Based on the above similarities between MTO firms and hospitals, the application of platforming concept in the banking and reinsurance industries, and the adaptation of other design techniques and methodologies from the manufacturing industries to hospitals, this study proposes that the platforming concept can be adapted to develop healthcare service families in hospitals. More specifically, healthcare platforms can be planned and developed for designed healthcare service families. In the next section, some issues in and guidelines for planning healthcare platforms are discussed.

PLANNING HEALTHCARE PLATFORMS

Being intangible, healthcare services are processes and activities performed by human resources (e.g., physicians, nurses, administrators), hardware resources (e.g., medical equipment), software resources (e.g., test programmes), and information systems. By considering this nature of services, this study purports that a healthcare platform takes the form of an abstract system, instead of a physical component. This confirms to Meyer & DeTore's view on service platforms: *service platforms are best considered from the flow of knowledge and information between the service provider and the service user* (Meyer & DeTore, 2001, p. 196). Based on the belief that principles of design and development for products and services are common (Meyer & DeTore, 2001), the first step in planning a healthcare platform is to clearly segment customer groups and understand user needs

and requirements in the targeted segment. With the identified user needs and requirements, the second step is to develop healthcare architecture, which acts as the backbone of the healthcare platform. In the third step, in accordance with the common healthcare service functions in the healthcare architecture, common healthcare service processes and activities are determined. Also determined are the relationships among them. In the last step, optional healthcare service processes and activities are identified to fulfill optional healthcare service functions available in the healthcare service family in relation to a market segment. While the process of planning healthcare platforms is summarized in Figure 2, some issues and guidelines are discussed below.

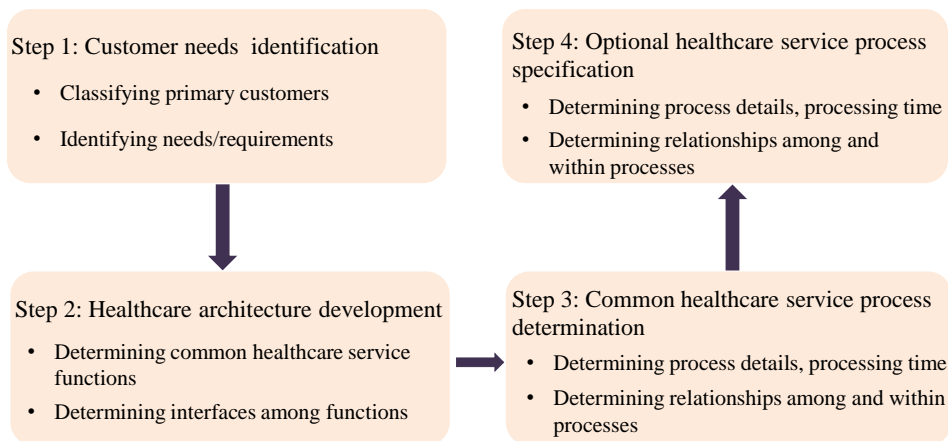


Figure 2. Healthcare platform planning process

Customer needs identification. In a service process, a customer consumes the service at the same time that the service is being delivered. Customer's such direct involvement in the

service delivery highlights the important role of customer needs and requirements in developing services. This is particularly true for developing healthcare services in hospitals (Dijkstra & van der Bij, 2001). The available literature recognizes that hospitals have several different types of customers (e.g., Dijkstra & van der Bij, 2001; Radnor et al., 2012; van der Bij et al., 1999). Consistent with the available literature and the practice, this study identifies patients as primary customers as healthcare services are delivered to cure patients; the other interested customer groups include patients' families, insurance companies, local, provincial, and national regulators, and hospital management and staff.

As pointed out in (Walley, 2003), the healthcare service processes designed for each individual patient do not contribute to the efficient utilization of medical resources and the delivery of quality healthcare services; healthcare services should be designed for handling groups of patients with similar treatment pathways. Fetter et al. (1980) show that customer groups can be formed with respect to patients' demographic, diagnostic and therapeutic characteristics. Thus, in planning healthcare platforms, the patients possessing similar demographic, diagnostic and therapeutic characteristics should be classified into groups, forming different market segments. The other interested customer groups are attached to each segment as they possess equal importance for each market segment. This implies that when planning a healthcare platform and the corresponding healthcare service family for each market segment, the needs and requirements of these interested customer groups must be considered. For each market segment, the needs and requirements of patients can be determined based on their demographic, diagnostic and therapeutic information. For examples, the needs of a patient with serious fracture include "a

bone operation”, “staying in the hospital for certain days after the operation”, and others. In view of the fact that there are a large number of patient records in a hospital’s databases and file systems, data mining techniques (e.g., association rule mining) might be employed to determine these needs. It has been well recognized that data mining techniques excel in discovering useful information, pattern, and knowledge hidden in large volumes raw data (Zhang, 2012). For identifying the needs and requirements of other interested customer groups, several approaches might be adopted, such as interviewing representatives and using questionnaire survey. Some examples of these needs and requirements include “excellent information flow in the healthcare service process (the requirements of hospital management and staff)” and “correct and on time diagnosis (the requirements of patients’ families)”.

Healthcare architecture development. In developing product platforms, product architecture exists to determine product functions in accordance with customer needs (Halman et al., 2003). The adoption of architecture concept is to reduce problem solving complexity by analyzing problems at different granularity levels. In this regard, this concept can be employed in planning healthcare platforms for healthcare service family development. More specifically, healthcare architecture can be developed to facilitate the planning of healthcare platforms. The above identified needs and requirements, especially these from patients, can be used to develop the healthcare architecture. Being the backbone of the healthcare platform, this architecture should consist of common healthcare service functions and interfaces among these functions. These healthcare service functions are used to meet the common customer needs and requirements identified in a market segment. One healthcare function example is “To perform an eye operation”, which is for meeting the

customer requirement: “A double eyelid”. It may be ideal if one function can be developed to meet one customer need or requirement as this can reduce problem solving complexity. However, it is more practical that one or more healthcare service functions are developed to meet one customer requirements. This is because not all of the needs and requirements, especially these of the interested customer groups, can be met by a single healthcare service function. Moreover, these functions must be determined in the way such that all customer needs, especially these related to patients’ diagnosis and treatment, are fulfilled while existing medical resources can be optimally utilized. The interface between two healthcare service functions should be clearly specified for defining the information/data flow between them. It should specify the sender, the receiver, the data/information to be transferred from the sender to the receiver, the allowable time window for data/information transfer. The allowable time window is to ensure that all the functions can be fulfilled on time. In this regard, it should indicate the time period where the data/information from the sender must be passed to the receiver. Essentially, the architecture interprets, at a higher functional level, the family of healthcare services for patients with similar demographic, diagnostic and therapeutic characteristics.

Besides the common healthcare service functions, the optional functions of several (including one) patients need to be determined. These functions are used to fulfill the needs and requirements of several, instead of all, patients belonging to a market segment. Along with these optional functions, the interface among them and with the common ones should be determined as well. These interfaces contain the same type of information with these among the common healthcare service functions. The determination of these optional functions and

interfaces can ensure that all patient needs and requirements can be satisfied by developing the healthcare service family.

Common healthcare service process determination. In product development, components are designed to fulfill product functions, whilst in the service industry, service processes are designed to fulfill service functions (Moon et al., 2011). Thus, healthcare service processes and activities should be determined to fulfill the common healthcare service functions. In a same fashion, data mining techniques can be employed to identify the suitable service processes for the related functions. In addition, experts' opinions can be utilized to specify the service processes. For each healthcare service process, the details, including activities, input, output, human, hardware and software resources, must be specified. Moreover, it is very important to set standard processing time for each healthcare service process to ensure the healthcare services to be delivered on time, as pointed out in (van der Bij et al., 1999). Thus, along with the other details, the processing time needs to be specified for each healthcare service process. These processing times can be determined based on similar cases from the past and/or industrial standard. For each healthcare service process, it is equally important to determine the relationships among process details. These relationships specify the role of each element in performing a service process. For example, the relationship between a physician and a service activity clarifies that it is the physician who carries out the activity. The relationships among healthcare service processes also need to be determined. These relationships, on one hand, specify the precedence between any two processes, and, on the other hand, determine the information (or data, object) which are exchanged between two processes. (An object example is a patient under treatment.) The common healthcare service processes and process details, relationships form the healthcare

platform. In this regard, the healthcare platform for a market segment contains the healthcare service functions, processes, activities, resources that are shared by all the healthcare service family members, which will be designed for each patient.

Optional healthcare service process specification. In a similar fashion, the optional healthcare service processes, the details, and the relationships should be determined to fulfill the optional service functions. The relationships among these optional processes and the common ones need to be specified as well. Based on the healthcare platform and these optional elements, specific healthcare service can be designed for individual patient and the healthcare service family can be developed for the market segment.

FUTURE RESEARCH

Adapting the platforming concept to develop healthcare services calls for dedicated efforts from both academics and practitioners. This study identifies several research issues and specific topics. This identification is based on the characteristics of hospitals and the application of product platforms in manufacturing industries.

Determining the optimal number of healthcare platforms. In most hospitals, the patients can be classified into many groups based on their demographic, diagnostic and therapeutic characteristics (Fetter et al., 1980). The large number of patient groups raises an issue of the optimal number of healthcare platforms to be developed. If one healthcare platform is developed for one patient group, many healthcare platforms need to be developed. Hospitals may not receive expected benefits from developing too many healthcare platforms. This is because the common healthcare service functions, processes, activities, and resources among different patient groups may not be captured by

the healthcare platforms, thus not being utilized. In addition, it will be very costly to develop many healthcare platforms as the development involves the limited human resources, especially domain experts (e.g., physicians), who are already busy with their own tasks. If one healthcare platform is developed for multiple patient groups, only a few platforms will be developed. A few platforms may reduce platform development time and cost; they, however, may not contribute to the efficient design of specific healthcare services for the related patient groups. This is because the few platforms may only contain a very small portion of common healthcare service functions, processes, activities, and resources shared by the individual healthcare services to be designed for a large number of patients. Thus, the direct result of designing healthcare services based on a few platforms is that there would be too many differences and too little commonality among individual healthcare services. If commonality is too less and differentiation is too much, designing healthcare services based on the platforms may not be beneficial.

In this regard, determining the optimal number of healthcare platforms for a hospital suggests itself as an interesting research topic. In determining the optimal number, it is necessary to make trade-off decisions regarding commonality and differentiation among the healthcare service family to be designed based on a healthcare platform. Making these decisions may need the development of certain performance indicators. Thus, performance indicators need to be developed for supporting trade-off decision making in determining the optimal number of healthcare platforms.

Modeling healthcare platform development and healthcare service family design. As a starting point, this study provides some general guidelines for planning healthcare platforms. It does not shed light on the specific methods and approaches to

develop a healthcare platform and to design the corresponding healthcare service family. In this regard, investigations of healthcare platform development and healthcare service family design pave a potential avenue for future research. There is a number of interesting research questions to be answered in developing a healthcare platform and designing the corresponding healthcare service family. Some example questions are given below. What are the healthcare platform constituent elements, and their relationships? How can these elements and relationships be rigorously modeled? How can a healthcare service family be developed based on a healthcare platform: develop the healthcare platform in the first step and then design the healthcare service family in the second step, or design the healthcare platform and the corresponding family together in one step? In product platform-based product family design, many mathematical models are developed to address this issue. If mathematical models are to be developed to deal with healthcare platform development and healthcare service family design, how are the above questions to be addressed? In addition, what are the problem solving techniques and algorithms?

While the above investigations deal with the development of healthcare platforms and the design of the corresponding healthcare service family, they are not able to explain healthcare platforms from the structural perspective, i.e., the syntax of a healthcare platform. Understanding healthcare platform syntax is conducive to tackling many issues involved in designing healthcare service families based on healthcare platforms (e.g., healthcare platform implementation in computer systems). This can be accomplished by referring to healthcare platform structural models when analyzing the requirements and characteristics of the problems in concern. Thus, representing a healthcare platform from the structural perspective (i.e.,

healthcare platform structural representation) deserves future research. Healthcare platform structural representation is to represent diverse constitute elements and complex relationships among them. Among the available representation languages, the Unified Modeling Language and System Modeling Language excel in representing internal structures of large, complex systems. They have been applied to represent the structures of a variety of large systems (Felfernig et al., 2000; Friedenthal et al., 2011). They might be adopted to represent a healthcare platform from the structural perspective.

While a healthcare platform structural model visualizes the structure of a healthcare platform, it is not able to model the dynamics of a healthcare platform, i.e., how healthcare service family is designed based on a healthcare platform and the reasoning mechanism. As pointed out in (Arora & Kumar, 2000), structure representation and dynamical modeling of large, complex systems are equally important and necessary for the efficient system development. Thus, it is necessary to develop dynamic models of healthcare platforms (i.e., dynamic modeling of healthcare platforms). Dynamic modeling of healthcare platforms is to model the dynamic process of designing a healthcare service family based on a healthcare platform. It can capture the reasoning mechanism fundamental to the healthcare service family design. As a graphical and mathematical modeling technique, Petri nets (PNs) have emerged as a promising approach for modeling, simulating and analyzing various systems. Thanks to their executability, graphical representation, and mathematical support, PNs have been well recognized as a powerful tool for modeling complex processes and flows (Peterson, 1981). They have been widely applied to model the dynamics of different type of large, complex systems (e.g., Cortes et al., 2003;

Zhang et al., 2009). In this regard, it might be interesting to develop healthcare platforms' dynamic models based on PNs.

Issues relevant to healthcare platform application. The introduction of healthcare platform development and healthcare service family design may change the business processes within a hospital as currently healthcare services are not designed based on structured approaches. In this regard, it might be interesting to develop the new business models where healthcare platform-based healthcare service family design is pursued. Such a business process model can help a hospital understand, from a holistic view, its major business processes, their interrelationships, and the contribution of different functional units to these processes. Such an understanding enables the hospital to develop activities to improve its healthcare services.

Developing healthcare platforms and designing the corresponding healthcare service families are aimed at improving hospitals' business performance. In this regard, designing healthcare service family based on a healthcare platform is not the end of a project. Efforts must be made to evaluate the business performance resulting from designing healthcare service families based on healthcare platforms. With the evaluation results, hospitals can analyze problems, trace reasons, and develop improvement activities. This is especially true when the evaluation results are negative. The key of performance evaluation lies in the development of suitable performance indicators. As hospitals strive to achieve high quality, lost cost, and on time healthcare service delivery, the performance indicators should be developed to capture the impacts of designing healthcare service families based on healthcare platforms on quality, cost, and time. The available literature reports a variety of performance indicators measuring healthcare service quality, time, and cost, such as patient's waiting time for

diagnosis, the number of injuries/death per day, cost per patient-day, the volume of work done within the existing level of resources (Fetter et al., 1980; Francis & Alley, 1996; Radnor et al., 2012; Thakur et al., 2012), to name but a few. In practice, hospitals need to develop appropriate performance indicators based on their own business environments.

As with the advancement in design and manufacturing technologies in the manufacturing industry, medical technologies and healthcare delivery mechanisms in hospitals keep evolving (Lim & Tang, 2000). As a consequence, hospitals frequently update their medical equipment and other facilities, which introduce new service functions, processes and activities. As a result, some service functions, processes, activities, and resources of the existing healthcare platforms get obsolete. Healthcare platforms can function well only in the condition that they consist of all up-to-date healthcare service functions, processes, activities, resources, and relationships. This, in turn, raises an issue of healthcare platform renewal. Future research efforts, thus, need to be made in developing approaches to efficiently renew healthcare platforms in response to the development of medical technologies and medical delivery mechanisms.

CONCLUSIONS

While a myriad of methods and methodologies are available to assist manufacturing companies to develop their products, formal processes and structured approaches are not seen to assist hospitals to design healthcare services. However, hospitals need to develop (or redesign) healthcare services in response to the rising healthcare costs, the advancement in medical technologies, the cut down of government's healthcare spending, and the industrial competition. The platforming concept (i.e., developing

product platforms for designing product families) has been well applied in diverse manufacturing industries; a few studies have also reported recently to show the adaption of this concept in the banking industry (Moon et al., 2011) and in the reinsurance industry (Meyer & DeTore, 2001). This study, thus, purported the adaption of the platforming concept to develop healthcare service family in hospitals, in hopes of improving hospitals' business performance.

By nature, hospitals are make-to-order enterprises (Forgionne & Kohli, 1996). It, thus, identified the similarities between hospitals and make-to-order manufacturing companies, where diverse customized products are developed based on product platforms. These similarities lie in a number of aspects, such as the diverse customer needs and requirements, the existence of customer groups, the resources with high skills, the requirement for on time delivery, and business performance target. With these similarities, adapting the platforming concept (i.e., developing healthcare platforms) to design healthcare service families in hospitals is promising.

As a starting point, this study proposed several general guidelines for planning healthcare platforms. Healthcare platform planning may include four steps. They include (i) identifying customer needs in the targeted market segment, (ii) developing the healthcare architecture, which determines healthcare service functions to be delivered to meet customer needs and requirements, (iii) determining common healthcare processes, activities, resources, processing times, and their relationships for fulfilling common healthcare service functions, and (iv) determining the optional healthcare processes, activities, resources, processing times, and their relationships for fulfilling the optional healthcare service functions in relation to several (or one), instead of all, patients. As these are general guidelines,

hospitals may implement and modify them based on their unique situations.

Based on the characteristics of hospitals and the application of product platforms in the manufacturing industries, this study discussed in detail a number of interesting research issues, including (i) determining the optimal number of healthcare platforms to be developed, (ii) modeling healthcare platform development and healthcare service family design, and (iii) healthcare platform application. More specific topics pertaining to each issue were also discussed. These issues/topics are not exhaustive; along with the increase of the understanding of healthcare service development, I believe that more research topics will be identified in the future.

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Comparative Performance of Health Insurance Business of Public and Private General Insurance Companies in India

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ABSTRACT

The study is an endeavour to analyse the comparative performance of health insurance business of public and private general insurance companies for the period from 2006-07 to 2011-12 using the Mann-Whitney Test. The comparative performance of the health insurance business of 4 public, 8 private general insurance companies and 2 standalone health insurance companies has been examined using the Claim Ratio and Net Retention Ratio. These ratios have been analysed and interpreted by calculating mean, median, standard deviation and coefficient of variation. It has been found that the mean of claim ratio was -2.82 ($p > 0.05$) and mean of net retention ratio was -1.98 ($p > 0.05$) which showed significant difference between the claim ratio and net retention ratio of health insurance business of public and

private general insurance companies.

Keywords: Claim Ratio, Comparison, Health insurance, Net Retention Ratio, Performance

INTRODUCTION

In recent years, health insurance sector has become the fastest growing sector in the non-life insurance industry in India and also emerging as significant business for non-life insurance sector. Increasing awareness of health insurance, rising healthcare costs and the recent de-tariffing of the general insurance industry (which has increased emphasis and efforts by general insurance companies towards health insurance and other personal lines of business) has become the key drivers for health insurance in the last few years. In the absence of health protection, the financial impact of hospitalization can be more in the case of low income people. The absence of health protection causes economic loss and it is one of the leading causes of impoverishment in the country (PHFI, 2011). Looking at the changing face and the participation of public and private general insurance companies' deals in health insurance, there is a need to examine the comparative analysis of health insurance sector in India.

The health insurance is used to describe a form of insurance that pays for medical expenses (Rajan & Dhunna, 2002). The reduction or elimination of the uncertain risk of loss for the individual or household by combining a larger number of similarly exposed individuals or households who are included in a common fund that makes good the loss caused to any one member (ILO). Health insurance is a tool to minimise uncertainty –the

uncertainty of illness, the uncertainty of the cost of treatment (IPH, 2006).

The study focuses on health insurance business of four public, eight private general insurance companies and two standalone health insurance companies for evaluating the performance of health insurance sector in India. In this context the basic objective of the present study is to examine the comparative analysis of health insurance business of public and private general insurance companies in India. Attempt has also been made to determine the performance of health insurance business of public and private general insurers. In India, some studies such as Bhat and Babu (2003), Segal (2004), Bishnoi and Saharan (2007), Devadasan et al., (2010), Dutta (2012), Thakur and Kumar (2013), Verma et al., (2013) have tried to analyse the performance of health insurance in India. However, scanty of literature is available on comparative analysis of Indian health insurance sector. The present study is an endeavour in this direction and tries to fill the existing void in the literature on analysing of comparative performance of health insurance business of public and private general insurance companies.

To accomplish this objective, the paper has been divided into five broad sections. Section I introduces the health insurance in India. Section II deals with review of the empirical work done on performance of health insurance business in India. Section III presents a methodological framework to analyse the comparative performance of health insurance business of public and private general insurance companies in India. Section IV compares the performance of health insurance business of public and private general insurance companies. The last section concludes the discussion.

EVIDENCE FROM LITERATURE

Bhat and Babu (2003) found that with the growth of private voluntary insurance in the unregulated healthcare market, costs of healthcare are likely to go up. In India, the Insurance Regulatory and Development Authority (IRDA) has paved the way for insurance intermediaries such as third party administrators (TPAs), who are expected to play a pivotal role in setting up managed care systems. Segal (2004) found that to meet the burgeoning need for health insurance in the country, private sector participation is a must and also suggested steps to remove the market barriers for the players. Private health insurance covers 3.5-5.5 percent of population. The study suggested six steps for increasing private health insurance, these are-lower threshold capital limit, curb cross subsidization, increase foreign equity, exclusive regulatory provisions, underwriting issues, incentives for employers. Bishnoi and Saharan (2007) found that market trend, penetration level of health insurance business, the premium level and index of growth of health insurance business is continuously rising up in India. The study found that market share in health portfolio of private sector players are on the rise in their contribution level than the public sector and the study seems that up to year 2010, the private sector players will overrule the public sector players and will grab the maximum share. Devadasan et al., (2010) stated that health insurance is considered as a protective measure against the harmful effects of out-of-pocket payment. Most of the people in India (and especially the poor) are not covered by health insurance. Dutta (2012) found that any 12-13 percent of Indians are covered under any form of health insurance (private insurance coverage is approximately three to four percent only. However, Indian healthcare expenditure is still amongst the lowest globally and there are

significant challenges to be addressed both in terms of accessibility of healthcare services and quality of patient care. This will complement Government's efforts towards strengthening public healthcare delivery system through initiatives like National Rural Health Mission, free medicines etc. However, to make this a reality, Government will have to take a decision regarding making health insurance mandatory in phased manner. Thakur and Kumar (2013) outlined that there is low penetration in the Indian health insurance industry. It has been found that India spends only 4-5 percent of GDP on health care. The study compared health care spending patterns between India and developed countries, as only 15 percent Indians avail the health insurance. The study suggested that the marketers in health insurance industry need to understand the major barriers in health insurance industry and try to adopt societal marketing philosophy along with holistic vision as it will go a long way in brand building apart from assured success in penetration. Verma et al., (2013) explained that health insurance is the reduction or elimination of the uncertain risk of loss for the individual or household. Around 24 percent of all people hospitalized in India in a single year fall below the poverty line due to hospitalization. The study analysed that financing on hospitalization shows a large proportion of people either borrow money or sell assets to pay for hospitalization especially among below poverty line population. In India, there is need to take some steps and these shortcomings need to be addressed so that every poor or rich, urban or rural person should take advantage health insurance scheme.

METHODOLOGY

Mann-Whitney test has been used for comparative analysis of health insurance business of public and private general insurance companies. Four public general insurance companies, namely, Oriental Insurance Company Limited, New India Assurance Company Limited, National Insurance Company Limited, and United India Insurance Company Limited and ten private general insurance companies deals with health insurance namely, Royal Sundram Alliance Insurance Company Limited, Tata AIG General Insurance Company Limited, Reliance General Insurance Company Limited, IFFCO Tokio General Insurance Company Limited, ICICI Lombard General Insurance Company Limited, Bajaj Allianz General Insurance Company Limited, HDFC Ergo General Insurance Company Limited, Cholamandalam MS General Insurance Company Limited of which two are standalone health insurance players (deals only in health insurance business) i.e. Star Health & Allied Insurance Company Limited and Apollo Munich Health Insurance Company Limited were taken up for the study. The period of the study was 2006-07 to 2011-12. The basic reason behind the selection of base year as 2006-07 lies in the fact that, this is the exclusive year in which maximum general insurance companies deal with health insurance.

Parameters Used to Assess Comparative Performance

Comparative performance of the health insurance business of public and private general insurance companies has been examined using the following ratios (expressed in percentage).

1. Claim Ratio (Net claim incurred to net written premium)

2. Net Retention Ratio (Net written premium to gross-direct premium).

To have a better view of the comparative performance of health insurance business of general insurance companies, these ratios have been analysed and interpreted by calculating mean, median, standard deviation and coefficient of variation.

RESULTS AND DISCUSSIONS

In this section effort has been made to study the comparative analysis of health insurance business of public and private general insurance companies. The comparative analysis was on the basis of (i) Incurred Claim Ratio and (ii) Net Retention Ratio.

Comparative Analysis of the Health Insurance Business of Public and Private General Insurance Companies - Claim Ratio

Claims incurred ratio is defined as total net incurred claims divided by net written premium (NWP). This indicator is a good complement of the picture of economies, client value and service quality of the various health insurance schemes. The acceptable level for this indicator cannot be determined, but generally, the higher it is, the better it would be.

Table: 4.1 Claim Ratio of Health Insurance Business of Public and Private General Insurance Companies (2006-07 to 2011-12)(in Percentage)

Company	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	Mean	Median	S.D.	C.V.
Public General Insurance Companies										
New India Assurance	212.81	67.35	107.40	113.05	102.53	92.74	116.73	104.97	49.70	42.58
Oriental Insurance	132.51	181.75	136.95	128.91	102.69	102.83	130.94	130.71	29.03	22.17
National Insurance	131.47	107.37	111.72	108.52	105.52	105.09	111.54	107.95	10.02	8.98
United India Insurance	160.05	135.35	121.26	131.56	114.86	97.68	126.80	126.42	21.08	16.63
Mean	159.21	122.95	119.22	120.51	106.40	100.71	121.50			
Median	146.28	121.36	116.27	120.98	104.11	100.26	121.76			
S.D.	38.10	48.11	13.18	11.42	5.80	3.87	8.92			
C.V.	23.93	39.13	11.05	9.47	5.45	3.84	7.34			
Private General Insurance Companies										
Royal Sundram	46.98	44.78	43.57	48.89	51.46	50.86	47.76	47.94	3.21	6.73
Tata AIG	61.70	74.92	46.71	59.08	53.107	49.65	57.53	56.10	10.21	17.74
Reliance	113.02	112.13	91.74	115.83	123.65	85.77	107.03	112.58	14.84	13.87
IFFCO-Tokio	152.89	121.14	122.22	109.30	102.63	85.79	115.67	115.22	22.64	19.57
ICICI Lombard	118.69	98.79	86.07	90.05	92.41	86.19	95.37	91.23	12.36	12.96
Bajaj Allianz	78.64	85.19	78.02	69.35	65.66	66.52	73.90	73.69	7.87	10.66
HDFC-Ergo	87.	142.	100	118.	71.	67.	97.	93.8	28.7	29.

	20	49	.52	05	455	53	88	6	7	39
Cholamandalam	79. 52	93. 05	108 .98	117. 44	68. 249	76. 51	90. 63	86. 29	19. 42	21. 43
Star Health & Allied*	30. 67	76. 21	85. 74	87.1 0	91. 18	95. 76	77. 78	86. 42	23.9 8	30. 83
Apollo Munich*	N.A .	87. 91	114 .27	85.3 9	61. 95	58. 20	81. 55	85. 39	22. 67	27. 80
Mean	85. 48	93. 66	87. 78	90.0 5	78. 17	72. 28	84. 51			
Median	79. 52	90. 48	88. 90	88.5 8	69. 85	72. 02	86. 09			
S.D.	37. 98	27. 19	26. 37	25.1 2	23. 43	16. 17	21. 23			
C.V.	44. 43	29. 03	30. 04	27.9 0	29. 98	22. 37	25. 12			

Note: The results computed from data obtained from Insurance Regulatory and Development Authority.

* : Standalone health insurance companies.

N.A.: Data not available.

Test of Significance

Test	Ratio	Z-value	Asymp. Sig.
Mann- whitney Test	Claim Ratio	-2.828	0.19

Table 4.1 exhibits the ratio of claim incurred as a percentage of net written premium of the health insurance business of public and private general insurance companies on a year to year basis during the period 2006-07 to 2011-12. The table also reveals the mean, median, standard deviation and coefficient of variation for each insurance company from the years 2006-07 to 2011-12 and also for each year across the 14 companies. The sector-wise analysis showed that the claim incurred ratio of the public general insurance companies was higher than that of the private general insurance companies throughout the study period.

Among the public general insurance companies, Oriental Insurance Company showed a maximum average claim ratio of 130.94 percent followed by United India Insurance Company and New India Insurance Company with percentages of 126.80 percent and 116.73 percent respectively. However, among the private insurers, IFFCO Tokio General Insurance Company showed maximum average claim ratio of 115.67 percent followed by Reliance General Insurance Company and HDFC Ergo General Insurance Company with the respective percentages of 107.03 percent and 97.78 percent. Royal Sundram Alliance Insurance Company, the private general insurer showed the least average claim ratio of 47.76 percent followed by Tata AIG General Insurance Company with the ratio of 57.73 percent.

The standard deviation values of the public and private general insurance companies were 8.92 percent and 21.23 percent respectively and coefficient of variation of public and private general insurers was 7.33 percent and 25.12 percent respectively which exhibit that public general insurers were more consistent than the private general insurers in paying claim to the customers. The average claim ratio of health insurance business of all the public general insurers was 121.50 percent and that of private general insurers was 84.51 per cent, which clearly indicates that there was a huge difference between the public and private insurers' claim ratio. Year-wise analysis indicated that the average claim ratio of health insurance business of the public general insurance companies was the highest, i.e., 159.21 percent in the year 2006-07 followed by 122.95 percent in the year 2007-08. The private general insurers' average claim ratio was 93.66 percent as highest in the year 2007-08 followed by the year 2009-10 with average claim ratio of 90.05 percent. A closer investigation of the product portfolio revealed that it was mainly due to the fact that the public general insurance companies were

concentrating more on the creamy business. Further investigation reveals that private general insurance companies did not get much of their business reinsured in contrast to the public general insurance companies. Mann-whitney test has been used for comparative analysis of health insurance business of public and private general insurance companies. The mean of claim ratio was -2.82 ($p>0.05$). It has been found that there was significant difference between the claim ratio of health insurance business of the public and private general insurance companies.

Comparative Analysis of Health Insurance Business of the Public and Private General Insurance Companies - Net Retention Ratio

Net Retention ratio is defined as net written premium divided by gross-direct premium. Table 4.2 presents the trends of net retention ratio of health insurance business of all the public and private general insurance companies from the years 2006-07 to 2011-12. The average net retention ratio of health insurance business of the public general insurers during the period of study was 78.82 percent, whereas it was 66.31 percent in the case of private general insurers. It is evident that the average net retention ratio of the public general insurers was 12.51 percent higher than that of the private general insurers.

Among the public general insurers, National Insurance Company exhibited the highest average net retention ratio of 83.10 percent followed by Oriental Insurance Company with a percentage of 81.05, United India with 77.64 percent and New India with 73.50 percent. Among the private general insurers, Royal Sundram Alliance Insurance Company exhibited the highest average net retention ratio of 81.11 percent followed by Tata AIG General Insurance Company with a percentage of 77.37 percent, Bajaj Allianz General Insurance Company with 77.65 percent, IFFCO Tokio General Insurance Company with 73.73

percent, Reliance General Insurance Company with 73.94 percent, Star Allied & Health Insurance Company with 61.25 percent, ICICI Lombard General Insurance Company with 63.96 percent, HDFC Ergo General Insurance Company with 59.46 percent, Apollo Munich Health Insurance Company with 48.86 percent, Cholamandlam MS General insurance Company 45.20 percent.

Table: 4.2. Net Retention Ratio of Health Insurance Business of Public and Private General Insurance Companies (2006-07 to 2011-12) (in Percentage)

Company Name	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	Mean	Median	S.D.	C.V.
Public General Insurance Companies										
New India Assurance	40.00	67.81	86.22	81.74	80.86	84.39	73.50	81.30	17.65	24.01
Oriental Insurance	72.98	74.17	76.50	75.95	88.60	98.09	81.05	76.22	10.07	12.42
National Insurance	107.34	68.36	79.62	82.53	84.65	76.12	83.10	81.07	13.18	15.86
United India Insurance	75.89	69.28	77.73	77.38	79.36	86.19	77.64	77.55	5.46	7.03
Mean	74.05	69.90	80.01	79.40	83.36	86.20	78.82			
Median	74.43	68.82	78.67	79.56	82.75	85.29	79.34			
S.D.	27.52	2.90	4.33	3.22	4.14	9.06	4.20			
CV	37.16	4.14	5.41	4.05	4.96	10.51	5.33			
Private General Insurance Companies										
Royal Sundram	56.31	76.47	85.61	83.12	104.58	84.19	81.71	83.65	15.62	19.11
Tata AIG	65.58	53.81	111.36	78.31	83.72	71.45	77.37	74.88	19.63	25.37
Reliance	44.57	49.40	89.09	92.88	81.39	86.27	73.94	83.83	21.26	28.76
IFFCO-Tokio	64.77	63.35	78.41	75.20	82.98	71.66	73.73	76.43	7.92	10.74
ICICI Lombard	41.58	45.97	66.37	82.44	74.08	73.31	63.96	69.84	16.50	25.79
Bajaj Allianz	67.22	73.21	69.64	87.52	86.01	82.27	77.65	77.74	8.73	11.25
HDFC-Ergo	49.12	60.21	79.89	61.03	47.07	47.68	59.46	54.66	12.62	21.22
Cholamandalam	22.90	27.13	33.26	41.44	72.98	73.48	45.20	37.35	22.59	49.98

Star Health & Allied*	44.25	57.69	61.43	64.45	87.79	76.22	61.25	62.94	9.70	15.84
Apollo Munich*	N.A.	9.44	48.68	65.73	54.92	65.54	48.86	54.92	23.20	47.48
Mean	50.70	51.66	72.37	73.21	77.55	73.41	66.31			
Median	49.12	55.75	74.02	76.75	82.18	73.40	68.84			
S.D.	14.41	20.41	21.91	15.25	16.54	11.09	12.60			
C.V.	28.42	39.50	30.27	20.83	21.32	15.10	19.00			

Note: The results computed from data obtained from Insurance Regulatory and Development Authority.

* : Standalone health insurance companies.

N.A.: Data not available.

Test of Significance

Test	Ratio	Z-value	Asymp. Sig.
Mann- whitney Test	Net Retention Ratio	-1.98	0.48

The average net retention ratio of public general insurers in the year 2006-07 was 74.05 percent which increased to 86.20 per cent in the year 2011-12. Similarly, the private insurers also reported an upward trend. Their average net retention ratio in the year 2006-07 was 50.70 percent which increased to 73.41 percent in the year 2011-12. The standard deviation values of the net retention ratio of health insurance business of public and private general insurers were 4.20 percent and 12.60 percent respectively and coefficients of variation of public and private general insurers were 5.33 percent and 12.60 percent respectively, indicating higher consistency of the public general insurers regarding net retention. Mann-whitney test has been used for

comparative analysis of net retention ratio of health insurance business of public and private general insurance companies. The mean of net retention ratio was -1.98 ($p>0.05$). The result shows significant gap between the net retention ratio of health insurance business of public and private general insurance companies.

CONCLUSION

The efforts have been made to compute mean, standard deviation and coefficient variation of the health insurance business of public and private general insurance companies and it has been found that standard deviation of public and private general insurance companies were 8.92 percent and 21.23 percent respectively and coefficients of variation of public and private general insurance companies were 7.33 percent and 25.12 percent respectively which exhibited that public general insurers were more consistent than the private general insurers in paying claim to the customers. Year-wise analysis indicated that the average claim ratio of the public general insurance companies was highest, i.e., 159.21 percent in the year 2006-07 followed by 122.95 percent in the year 2007-08. The private general insurers' average claim ratio was 93.66 percent as highest in the year 2007-08 followed by the year 2009-10 with average claim ratio of 90.05 percent. The standard deviation values of the net retention ratio of health insurance business of public and private general insurance companies were 4.20 percent and 12.60 percent respectively and coefficients of variation of public and private general insurance companies were 5.33 percent and 12.60 percent respectively, indicating higher consistency of the public general insurance companies regarding net retention. Mann-whitney test has been used for comparative analysis of claim ratio and net retention

ratio of health insurance business of public and private general insurance companies. The mean of claim ratio was -2.82 ($p>0.05$) and mean of net retention ratio was -1.98 ($p>0.05$). The result showed significant difference between the claim ratio and net retention ratio of health insurance business of public and private general insurance companies

Health insurance business is one of the prominent segments of general insurance sector, which has grown phenomenally due to increasing awareness about health insurance and escalating health care costs. An analysis of growth and market share brings out the fact that role of private general insurance companies has been greater than public general insurance companies due to adopting the innovative products and effective services to their health insurance basket. It is ironic to note that the role of public general insurance companies was greater in the initial stages of the growth of health insurance business but, with the passage of time, the number of private general insurers and their clients has increased considerably. Public general insurance companies must gear itself to meet the increasing challenge from the private general insurance companies and evolve value added health insurance products, lest it should be totally supported by the private general insurance companies.

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