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Innovations in containers specially adapted for medical or pharmaceutical purposes: A prospective patent analysis

Amitkumar Patel*[1], Kinjalben Patel[2], Kalp Bhatt[3], Jignesh Patel[4]

[1]Gujarat Technological University, Chandkheda, Ahmedabad, India
[2]Registered Indian Patent Agent (IN/PA/2873), Ahmedabad, India
[3]IGNITE - Incubator & Co-working Space, Ahmedabad, India
[4]Cureill Pharma, Ahmedabad, India

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ABSTRACT

Packaging pharmaceutical products is a wide, encompassing, and multi-faceted assignment. Packaging preserves the quality and stability of the pharmaceutical products and protects them beside all forms of tampering and spoilage. The quality of the packaging for pharmaceutical products plays a very significant role in the quality of such products. There is an ever increasing need to provide individual, tailored packaging solutions, which guarantees the effectiveness of pharmaceutical products administered as medicines. The pharmaceutical packaging market is constantly upgrading. Distribution of products and goods is now more global than ever before. Mass customisation of packaging to allow its use in multiple markets is a subject that needs explanation and discussion. Packaging is an evolving science, a developing engineering branch, and a successful contributor to pharmaceutical industries. The present research paper has analysed several of the recent pharmaceutical packaging innovation trends with the help of patent data, which are impacting the packaging industry.

* Corresponding Author

Name: Amitkumar Patel
Phone: +91-9898801467
Email: amitpatel.in@gmail.com

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INTRODUCTION

It is very important that pharmaceutical product such as medicines, food supplements, cosmetics etc. reaches safely in the hands of the patients for whom they are intended and prescribed in specified physical form. Packaging pharmaceutical products is a wide, encompassing, and multi-faceted assignment. Packaging is defined in simple terms as the gathering of different components which frame the pharmaceutical product from the time of production until its usage by the end consumer. Packaging is accountable for supplying life-saving drugs, medical treatments, medical devices and new products like as to medical nutritional (nutraceuticals) in every possible dosage form to deliver each type of supplement, poultice, solid, liquid, suspension, powder or drop to people around the world. In the present research paper pharmaceutical products, in general, are to be regarded as all forms of medicines, medicinal products, food supplements, cosmetics and all other such relevant products intended for the use of humans and animals. (Organization, 2002, Young, 2004, Majid *et al.,* 2016, Coles and Beharrell, 1990)

In the manufacture of pharmaceutical products, the role of quality assurance is very critical and defined as “the totality of the complete arrangements made with such objects to ensuring that pharmaceutical products are of the standard quality required for their intended use" (Organization, 2002, Zadbuke *et al.,* 2013)

Public or general users are many times of such opinion and consider packaging as unnecessary

and non-essential. However, it must be understood that packaging preserves the quality and stability of the pharmaceutical products and protects them beside all forms of tampering and spoilage. (Organization, 2002, Zadbuke *et al.,* 2013)

All pharmaceutical products are required to be protected and "consequently need to be packaged in such containers that follow to prescribed standards, particularly with regard to the elimination of light and moisture and the prevention of leaching of extractable molecules and substances into the product contents and of chemical interaction with the product contents. However, the limits of tolerability in these various respects largely depend, in part on climatic variables. Recommendations in The international pharmacopoeia are given for the same, and can only be advisory; precise quantitative standards for the same were defined by local food and drug regulating agencies. (Organization, 2002, Sonneveld, 2000, Gobbo and Olsson, 2010, Farmer, 2013)

The complexity for the selection of appropriate packaging materials and the highly technical nature of pharmaceutical products is such that manufacturers are challenged with significant complications. The interaction between product and such packaging is possible due to varied reasons. Few of the major reasons are due to the arrangement of a multiplicity of container components and API (active pharmaceutical ingredients), excipients and solvents used in a variety of dosage forms. (Organization, 2002, Farmer, 2013, Carli Lorenzini *et al.,* 2018)

Containers may be mentioned too as primary, secondary or tertiary containers, depending on whether they are for immediate use after production of the finished product or not. (Zadbuke *et al.,* 2013, Farmer, 2013)

- Primary packaging system is the use of material that first covers the product and holds it, i.e., those package constituents and subcomponents that comes in physical contact with the product, or those that might have a straight effect on the product shelf life, e.g., ampoules and vials, IV containers, prefilled syringes, etc.
- The secondary packaging system is the outer side of the primary packaging and used for grouping primary packages together, e.g., boxes, cartons, injection trays, shipping containers etc.
- The tertiary packaging system is utilized for shipping and bulk handling, e.g., edge protectors, barrel, container, etc.
- Key Functions of Pharmaceutical Packaging (Zadbuke *et al.,* 2013, Carli Lorenzini *et al.,* 2018)
- Containment - The containment of the product is a fundamental function of packaging for pharmaceutical products. The design of high-quality packaging must take into consideration both the manufacturing and distribution system and the needs of the product. This requires packaging: not to leak, nor allow any diffusion and permeation of the product, to be strong enough to hold the contents when exposed to normal handling and not to be changed by the ingredients of the preparation in its final dosage form.
- Protection - The packaging must require to protect the product against all kind of adverse external influences that may affect its potency or quality, such as moisture, light, biological contamination, oxygen, mechanical damage and adulteration/counterfeiting.
- Identification - The printed packs or its subsidiary printed components serves the purposes of providing together information and identity.
- Presentation and information - Packaging is also an important source of information mentioned on medicinal products. Such information is provided by means of package inserts and labels for patients.
- Convenience - The convenience is linked with product administration or, e.g., a unit dose eye drop which together eliminates the need for anti-microbial agents and lowers the risks related with cross infection, by administering only a single dose.
- The quality of the packaging for pharmaceutical products plays a very significant role in the quality of such products. Such packaging must: (Organization, 2002, Sonneveld, 2000)
- protect the product against all adverse external influences, which can change the properties of the product, e.g. light, moisture, oxygen and temperature variations;
- protect the product against biological contamination;
- protect the product against physical damage;
- such packaging carries the correct identification information of the product.
- The kind of packaging and the product materials used must be selected in such a way that: (Organization, 2002, Majid *et al.,* 2016, Coles and Beharrell, 1990)
- the packaging itself does not have a contrary effect on the product (e.g. through leaching of packaging materials, chemical reactions or absorption);

- the product does not have an adverse effect on the packaging, affecting its protective function or changing its properties.

The resulting requirements must be met during the whole of the proposed shelf-life of the product. Given the link between the quality of its packaging, quality of a pharmaceutical product, pharmaceutical packaging materials and in principal systems must be subject to the similar quality assurance requirements as pharmaceutical products. (Organization, 2002, Majid *et al.,* 2016, Coles and Beharrell, 1990)

Materials used for Pharmaceutical Packaging (Zadbuke *et al.,* 2013, Carli Lorenzini *et al.,* 2018)

Various types of containers for pharmaceutical products are available; the appropriate container is selected based on the type of product and dosage form. Types of the container are such as Ampoule, bag, blister, bottle, cartridge, gas cylinder, an injection needle, injection syringe, pressurised container, single-dose container, Strip, Tube, vial etc.

Usually, the majority of medicines (51%) have been consumed orally in the forms of tablets or capsules, which are either fed into plastic pharmaceutical bottles (especially in the USA) or packed in blister packs (very common in Europe and Asia). Liquids, Powders, and pastilles also make up part of the oral medicine consumption. However, other routes for taking medicines are now being more extensively used. These include intravenous or parenteral (29%) route, inhalation (17%) route, and transdermal (3%) administration methods. (Zadbuke *et al.,* 2013, Farmer, 2013, Young, 2004, Carli Lorenzini *et al.,* 2018)

These changes to the route of administration have made a huge impact on the packaging industry, and there is an ever increasing need to provide individual, tailored packaging solutions, which guarantees the effectiveness of pharmaceutical products administered as medicines. (Zadbuke *et al.,* 2013)

The pharmaceutical packaging market is constantly upgrading and has reported annual growth of at least five percent per annum in the past few years. The market is now valued worth over $20 billion a year. As with most other packaged consumables, pharmaceuticals also need reliable and speedy packaging solutions which deliver a combination of quality, product protection, patient comfort, tamper evidence and security needs. Constant innovations in the field of pharmaceuticals themselves such as anti-counterfeit measures, blow fill seal (BFS) vials, snap off ampoules, plasma impulse chemical vapour deposition (PICVD) coating technology, two-in-one prefilled vial design, unit dose vials, child-resistant packs and prefilled syringes have a direct impact on the packaging. (Organization, 2002, Farmer, 2013, Carli Lorenzini *et al.,* 2018)

Distribution of products and goods is now more global than ever before. Mass customisation of packaging to allow its use in multiple markets is a subject that needs explanation and discussion. Environmental issues, including sustainability, will always be a particular dimension to for any packaging design. Packaging is an evolving science, a developing engineering branch, and a successful contributor to pharmaceutical industries. Packaging can reside through research and development (R and D), operations, purchasing, engineering, marketing, or the general administration department of a company. For the majority of products produced in pharmaceutical industries, the packaging is probably one of the largest collective purchase made by a company of materials important for the protection, distribution, and sale of the product. (Zadbuke *et al.,* 2013, Vernuccio *et al.,* 2010, Gobbo and Olsson, 2010)

Packaging and delivery methods as a differentiator for pharmaceutical and drug products will continue to become more significant, especially in jam-packed therapeutic areas and for solving industry-wide difficulties such as drug-product counterfeiting. The market today is approachable to packaging systems that are providing track-and-trace abilities and product verification throughout the supply channel. Pharmaceutical products seals are an ideal platform for these emerging technologies. The wider use of technologies like as RFID tags embedded in the plastic knob affixed to the seal, or ultraviolet inks applied to seals, providing items additional level security may be seen. The drive for hygiene and purity will no doubt last into the imaginable future. With developments in material science, we can imagine cleaner elastomeric formulations by employing BFS technology for producing primary packaging and delivery system components. Although predicting the upcoming future is problematic, but one expects with confidence that as pharmaceutical research continues to develop advanced life-saving therapies, the methods used to package and administer such therapies will keep pace through advances in innovative design and material science. (Zadbuke *et al.,* 2013, Carli Lorenzini *et al.,* 2018, Majid *et al.,* 2016, Han *et al.,* 2017, Sonneveld, 2000)

The present research paper has analysed several of the recent pharmaceutical packaging trends which are impacting the packaging industry, via analysing relevant patents filing trends worldwide.

Table 1: Data for top fifteen priority country

Sr. No.	Priority Country	Priority Country Code	Total Applications
1	China	CN	31471
2	Japan	JP	9690
3	USA	US	9010
4	Korea	KR	2975
5	Germany	DE	2885
6	Taiwan	TW	1314
7	U.K.	GB	1154
8	Europe	EP	1103
9	France	FR	920
10	Russia	RU	740
11	Italy	IT	429
12	Australia	AU	428
13	Sweden	SE	324
14	Spain	ES	320
15	Brazil	BR	315

Table 2: Current Legal Status of all relevant patents data set

Sr. No.	Current legal status	Total
1	Active - Applied	26169
2	Active - Granted	19999
3	Inactive - Expired	15714
4	Inactive - Nonpayment	9383
5	Inactive - Withdrawn / Surrendered	7314
6	Inactive - Rejected / Refused / Suspended	4849
7	Inactive - Opposition / Revoked	109
8	SPC Active - Granted / Applied	1

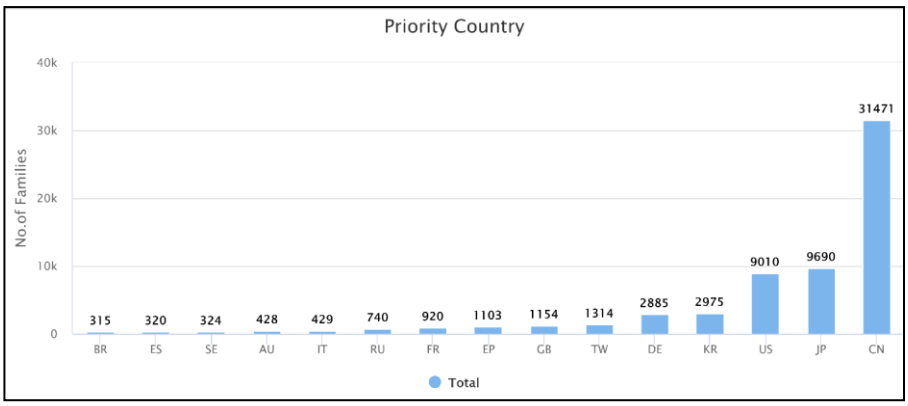

Figure 1: Graph for Top 15 Priority Countries

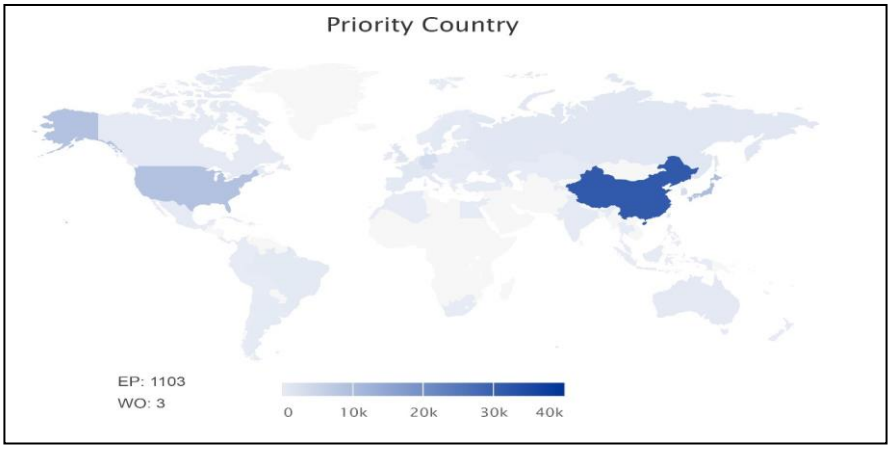

Figure 2: Density for top fifteen priority countries from where maximum innovations for containers specially adapted for medical or pharmaceutical purposes were generated

METHODS

In present work, based on patent analysis we had made an attempt to identify and track the innovations in containers specially adapted for medical or pharmaceutical purposes. As per International Patent Classification (IPC) system and basic patent trend analysis of containers specially adapted for medical or pharmaceutical purposes, we come to know that the most widely used IPC code to cover the majority of innovations in containers for medical or pharmaceutical purposes belongs to A61J IPC Subclass. As per the actual definition of IPC codes, the IPC Subclass A61J is defined as, inventions related to: Human Necessities; Medical or Veterinary Science; Hygiene; containers specially adapted for medical or pharmaceutical purposes; devices or methods specially adapted for bringing pharmaceutical products into particular physical or administering forms; devices for administering food or medicines orally; baby comforters; devices for receiving spittle. (Han *et al.,* 2017).

Table 3: Patent Applications Year Wise Filing Trend

Year	Applications Filed
1997	1956
1998	1854
1999	1934
2000	2201
2001	2359
2002	2650
2003	2780
2004	2810
2005	2955
2006	2998
2007	3154
2008	3311
2009	3955
2010	4344
2011	4925
2012	5212
2013	5348
2014	5421
2015	6924
2016	6792
2017	3072

In order to get a quantitative estimation of such patent data, we have analysed the patent data available on Patent research and collaboration platform PatSeer. PatSeer is a one-stop analysis and collaboration platform for Patent and Non-Patent Literature search. PatSeer offers various search, analysis and visualisation tools for effectively looking into the large volume of data. We found that most patents filed, published or granted are captured into the database with a very short period of time after their original release by various publishing authorities. PatSeer includes full-text patent data from 51 countries, and it also includes searchable English translations and bibliographic data from 104+ countries as part of INPADOC data. It includes approximately 74 million full-text records in a database of 115 million+ records. This ensures coverage of required patent data for trend analysis of related technologies on various parameters. (Bach *et al.,* 2017)

To get the relevant dataset, we have defined following query on PatSeer database: IC:(A61J*). The technical meaning of this query is, we instructed database to filter such patent records for which the assigned IPC Subclass is A61J, such records will be related to containers specially adapted for medical or pharmaceutical purposes; devices or methods specially adapted for bringing pharmaceutical products into particular physical or administering forms; devices for administering food or medicines orally; baby comforters; devices for receiving spittle.

Further, this data was analysed and sorted based on patent application date from a period of 1997 to 2017 (APD: 1997-2017), so as to look for most relevant and latest technologies developed during a period of last 20 years in the domain.

Based on this strategy the available data was further analyzed on various parameters such as: Priority Country, Current Legal Status, Patent Application Year Wise Filing Trend, Major Current Owner of Technologies, Assignee Type, International Patent Classification (IPC) Group Data, Technology Topics related to containers specially adapted for medical or pharmaceutical purposes to get some major insights out of the same data pool.

RESULTS AND DISCUSSION

With the Search Query: IC:(A61J*), initially, we found 191244 total patent records from the database. To remove the multiple patent family for the similar invention, we had applied the deduplicate results based on the simple family parameter, and we found the total 96243 unique results for patents related to this domain. Then to focus for most relevant and latest technologies in the containers specially adapted for medical or pharmaceutical purpose, the result set was further analyzed for last 20 years' patent records based on application date of patents, from a period of 1997 to 2017 (APD: 1997-2017), to which the total number of results reached to 66285 records. All these records are deduplicated based on simple family members' parameter available on PatSeer database, so as to eliminate multiple repetitive records from same patent family and only one record per patent family will come into the final dataset.

Table 4: Top Fifty Current Owners for Pharmaceutical Patents, Outside Indian Territory

Sr. No.	Current owner	Total
1	HUNAN CHINA SUN PHARM MACHINERY	621
2	TERUMO CORP	562
3	YUYAMA MFG CO LTD	453
4	BECTON DICKINSON & CO	439
5	CHINA MOBILE COMMUNICATION CORP	378
6	OTSUKA HOLDING CO LTD	377
7	SICHUAN KELUN PHARMA	362
8	TOSHO CORP	309
9	BAXTER INTERNATIONAL INC	289
10	NIPRO CORP	279
11	PANASONIC CORP	257
12	MITSUBISHI GROUP	256
13	TAKAZONO SANGYO CO LTD	251
14	JOHNSON & JOHNSON	239
15	JVM CO LTD	224
16	CHONGQING LUMMY PHARMA	212
17	GLAXOSMITHKLINE PLC	212
18	JMS CO LTD	199
19	PFIZER INC	198
20	SANOFI SA	198
21	FRESENIUS SE & CO KGAA	193
22	KROLEVETS ALEKSANDR ALEKSANDROVICH	187
23	HUNAN NOVOL MED CHARTERS MAT	182
24	CANON INC	152
25	CH BOEHRINGER SOHN AG & CO KG	152
26	DAINIPPON PRINTING CO LTD	152
27	NOVARTIS AG	148
28	YOSHINO KOGYOSHO CO LTD	144
29	ABBOTT LAB	139
30	BAYER AG	135
31	AJINOMOTO CO INC	124
32	COVIDIEN PLC	115
33	GUANGDONG ALPHA ANIMATION & CULTURE CO LTD	114
34	MATERIAL ENG TECH LAB INC	111
35	CHONGZHOU JUNJIAN PLASTIC CO	109
36	WANG LI	102
37	B BRAUN MELSUNGEN AG	101
38	ASTRAZENECA PLC	100
39	NOVO NORDISK AS	98
40	TOPPAN PRINTING CO LTD	98
41	YUYAMA SEISHAKUSHO CO LTD	97
42	ROCHE HOLDING AG	96
43	TAKAZONO TECHNOLOGY INC	92
44	CHENGDU HENGRUI PHARMA	91
45	KONINKLIJKE PHILIPS NV	91
46	WEST PHARMA SERVICE INC	90
47	HITACHI LTD	89
48	CHINESE PLA GENERAL HOSPITAL	87
49	TAKEDA PHARMA CO LTD	84
50	ROBERT BOSCH GMBH	82

The information collected was further analysed on various parameters: Priority Country, Current Legal Status, Patent Application Year Wise Filing Trend, Major Current Owner of Technologies, Assignee Type, International Patent Classification (IPC) Group Data, Technology Topics related to pharmaceutical patents and results were found as following

Priority Country: To analyse the countries, wherein the major innovations were

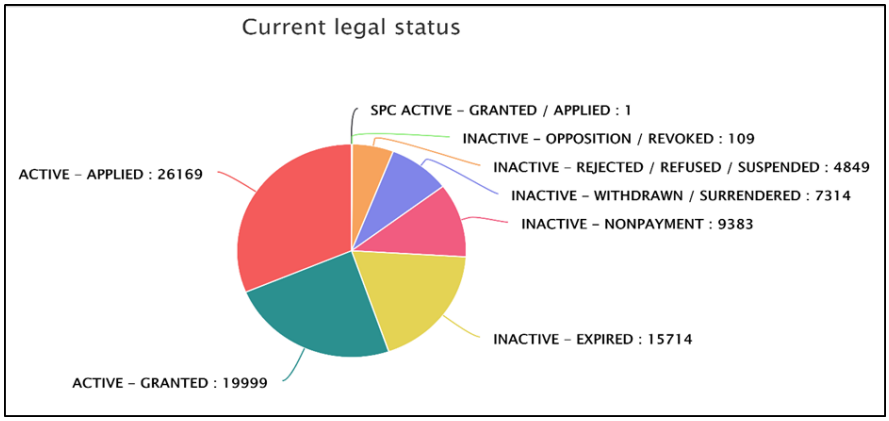

Figure 3: Graphical representation for Current Legal Status of all relevant patents data set

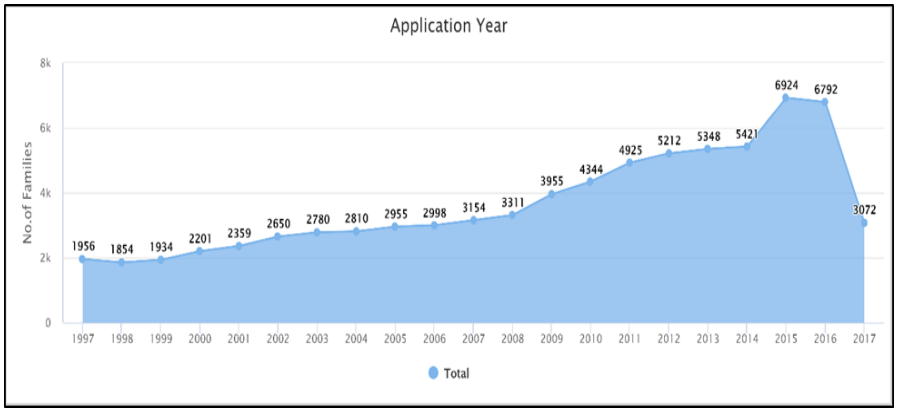

Figure 4: Graphical Representation for Patent Application Year Wise Filing Trend

developed in these areas, in the present study we had analyzed the top countries from where the relevant innovations are first generated, the priority country. This represents the key countries wherein maximum R&D was carried out for the development of new technologies in the said domain of containers specially adapted for medical or pharmaceutical purposes. Data was analyzed to sort top fifteen innovator countries.

In Table 1 data for the top fifteen priority country is provided, in descending order of total filled patent applications. Figure 1 represents a Graph for top fifteen priority countries. Figure 2 represents density for top fifteen priority countries from where innovations related to containers specially adapted for medical or pharmaceutical purposes were generated.

Current Legal Status

To analyze the current legal status of an available large number of patent documents which are related to containers for medical or pharmaceutical products and which were filled across the world by various applicants. They were further analyzed to check how many patents were in force, how many were expired, and expired for what reasons, how many were withdrawn etc. at their respective filing offices.

The available patent data set was further analyzed to obtain details related to current legal status of said patent documents in all jurisdictions where ever they had filled patent application. All patients were grouped based on their status of applied, active, inactive, expired, withdrawn, surrendered, granted, revoked, refused, SPC etc. Here SPC is to be considered as patent term extension. Table 2 below represents the statistics for Current Legal Status of all relevant patents data set, which related to containers specially adapted for medical or pharmaceutical purposes. Figure 3 below represent the graphical representation for Current Legal Status of all relevant patents data set.

Patent Application Year Wise Filing Trend

Further analysis was made to check for the most recent patent filing trend in these domains for data available on PatSeer from the period of 1st January 1997 till 31st December 2017. To this, we have analyzed the data for how many total patent families were filed in total, on a yearly basis during the said period from all countries worldwide. Cumulative data for filing from all countries across the world, available on PatSeer database was analyzed.

Table 3 below represents the Patent Applications year wise filing trend, data for a total number of patent applications filed on a yearly basis by all

Table 5: Assignee Type

Sr. No.	Assignee Type	Number of Patent Applications
1	Firm	42429
2	Individual	28450
3	University	3330
4	Hospital	1445
5	Government	229
6	Institutes	7
7	Other	17627

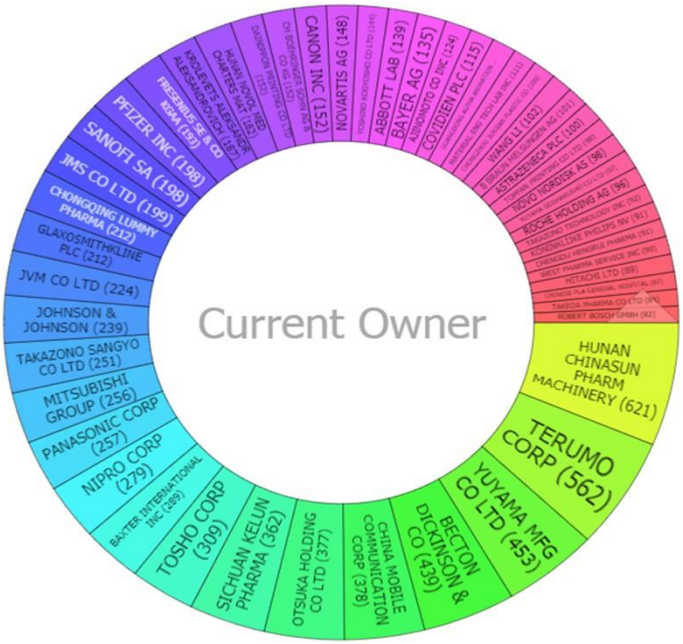

Figure 5: Top Fifty Current Owners for patents in the domain of containers for medical or pharmaceutical purposes

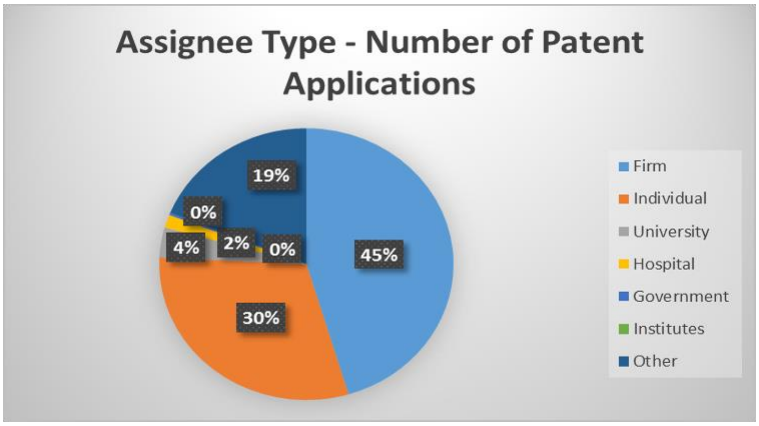

Figure 6: Total patents held by each type of assignee

jurisdictions in a cumulative manner. Figure 4 represents the graphical representation of the Patent.

Applications year wise filing trend, data for a total number of patent applications filed.

Current owner (Assignee)

From the initial screening of records related to top priority countries, the current legal status of filed patent applications, patent filing trend now further analysis was made to identify the major current owner of technologies in this domain. It was analyzed to identify who holds the maximum number of patents in the said area of containers specially adapted for medical or pharmaceutical purposes.

The patent data set was analyzed further to check for the top assignee/current owner of maximum patents in this area. The top assignees had been finding out based on the maximum number of patent applications filed and granted, and holds by any assignees from all relevant patents data set.

Table 6: Top IPC Sub Group with Definition

Sr. No.	IPC Sub Group/Full Class	Total Patents
1	A61J3/00 - Devices or methods specially adapted for bringing pharmaceutical products into particular physical or administering forms	10904
2	A61J1/14 - Details; Accessories therefor	7906
3	A61J1/00 - Containers specially adapted for medical or pharmaceutical purposes	7723
4	A61J1/05 - For collecting; storing or administering blood; plasma or medical fluids	7443
5	A61J7/00 - Devices for administering medicines orally	5678
6	A61J1/10 - Bag-type containers	5211
7	A61J9/00 - Feeding-bottles in general	4388
8	A61J1/20 - Arrangements for transferring fluids	3977
9	A61J1/03 - For pills or tablets	3842
10	A61J7/04 - Arrangements for time indication or reminder for taking medicine	3808
11	A61J3/07 - Into the form of capsules or similar small containers for oral use	3780
12	A61J15/00 - Feeding-tubes for therapeutic purposes	3212
13	A61J3/06 - Into the form of pills; lozenges or dragees	2233
14	A61M5/14 - Infusion devices	1952
15	B65D83/04 - For dispensing annular; disc-shaped; or spherical or like small articles	1700
16	A61J1/06 - Ampoules or cartridges	1493
17	A61J1/16 - Holders for containers	1368
18	A61J17/00 - Baby comforters; Teething rings	1264
19	A61K9/20 - Pills; lozenges or tablets	1256
20	A61K9/00 - Medicinal preparations characterised by a special physical form	1247
21	A61J11/00 - Teats	1229
22	A61J9/02 - With thermometers	1072
23	A61J3/10 - Into the form of compressed tablets	1062
24	A61K9/48 - Preparations in capsules	983
25	A61M5/00 - Devices for bringing media into the body in a subcutaneous; intravascular or intramuscular way; Accessories therefor	981
26	A61J3/02 - Into the form of powders	963
27	B65B1/30 - Devices or methods for controlling or determining the quantity or quality of the material fed or filled	956
28	A61M35/00 - Devices for applying media	945
29	A61J19/00 - Devices for receiving spittle	931
30	A61J - Containers specially adapted for medical or pharmaceutical purposes; Devices or methods specially adapted for bringing pharmaceutical products into particular physical or administering forms; Devices for administering food or medicines orally; Baby comforters; Devices for receiving spittle	907
31	B65D81/32 - For packaging two or more different materials which must be maintained separately prior to use in admixture	849
32	G06F19/00 - Digital computing or data processing equipment or methods; specially adapted for specific applications	814
33	A61K47/36 - Polysaccharides; Derivatives thereof	810
34	A61M31/00 - Devices for introducing or retaining media	775
35	A61K9/14 - Particulate form	772
36	A61G12/00 - Accommodation for nursing	754
37	A61M1/00 - Suction or pumping devices for medical purposes; Devices for carrying-off; for treatment of; or for carrying-over; body-liquids; Drainage systems	738
38	A61K9/16 - Agglomerates; Granulates; Microbeadlets	736
39	A61J9/04 - With means for supplying air	729
40	A61K47/38 - Cellulose; Derivatives thereof	699
41	A61M15/00 - Inhalators	678
42	A61K9/08 - Solutions	667
43	G06Q50/22 - Health care	662

Table 6: Top IPC Sub Group with Definition (Contd...)

Sr.No.	IPC Sub Group/Full Class	Total Patents
44	A61J9/06 - Holders for bottles	660
46	A61K47/10 - Alcohols; Phenols; Salts thereof	606
47	A61J7/02 - Pill counting devices	604
48	A61M5/31 - Details	598
49	A61F9/00 - Methods or devices for treatment of the eyes; Devices for putting in contact-lenses; Devices to correct squinting; Apparatus to guide the blind; Protective devices for the eyes; carried on the body or in the hand	590
50	A61K47/32 - Macromolecular compounds obtained by reactions only involving carbon-to-carbon unsaturated bonds	576

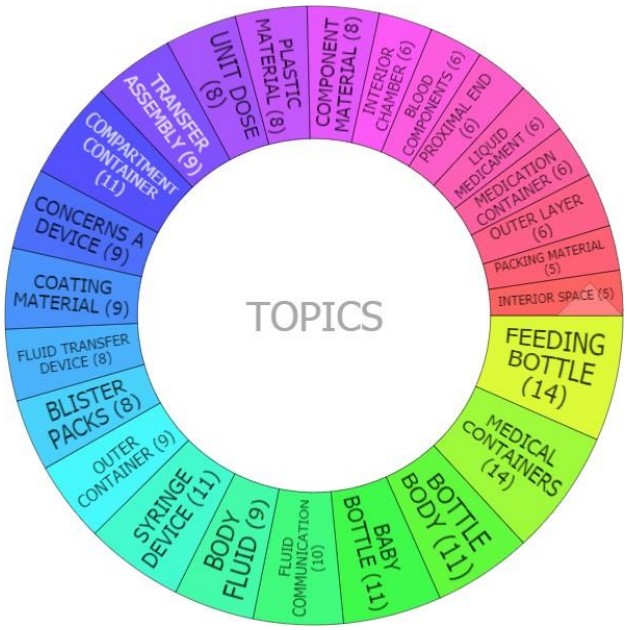

Figure 7: Technology Topics Related to containers specially adapted for medical or pharmaceutical purposes

From the whole patents, data set attempt was made to identify top fifty assignees in the domain of containers for medical or pharmaceutical purposes. Table 4 below represents the top fifty current owners for innovations in the domain of containers for medical or pharmaceutical purposes, who holds the maximum number of patents in this domain. Figure 5 is a graphical representation to show the top fifty current owners for innovations in the domain of containers for medical or pharmaceutical purposes, who holds the maximum number of patents in this domain along with a total number of patents held by each owner.

Assignee Type

After analyzing the patent data set for current top owners of patents, to check the share of patents holding by various broad categories of assignees, further analysis of patent data set was made based on the basis of assignee type. The patents were grouped into following groups of assignees: Firm, Individual, University, Government, Hospital, Institutes and Others.

Table 5 below represents a total number of patents held by each type of the assignee, for containers specially adapted for medical or pharmaceutical purposes. Figure 6 below represents a graphical representation to show the total number of patents held by each type of the assignee, for containers specially adapted for medical or pharmaceutical purposes.

Key IPC Classes

Further to analyze the micro areas of innovations for innovations related to containers specially adapted for medical or pharmaceutical purposes, the patent data were further analyzed based on the International Patent Classification (IPC) system. IPC analysis of the data set was performed on the basis of IPC Sub Group Data to define the micro technical domains of each innovation protected by patents. An attempt was made to identify the total number of patent applications filed in particular technology domains.

All patents are systematically classified according to their specific technical field. Though various existing national classification systems, the Inter-

national Patent Classification (IPC) system is a common system shared by all patent offices. Further information on the IPC, including how to use keywords to find the right classification, is available at, http://www.wipo.int/classifications/ipc. To present research study, a further attempt was made to analyze the micro areas of technologies, based on the IPC subgroup code assigned to each patent by respective authorities. Based on the aspect and scope of each patent application, respective authorities may assign one or more IPC subgroup codes to each of these patients. This will reflect the major core domains in the field of containers specially adapted for medical or pharmaceutical purposes, wherein maximum research is carried out, and innovations were developed. A definition for each of those IPC subgroup codes was provided in below-mentioned Table 6. An attempt was made to identify top fifty such IPC subgroups which have a maximum number of patents classified with said such IPC codes.

Technology Topics: After analysing the full patent data set to find out top fifty IPC groups to identify the micro areas of research, a further attempt was made to define a macro level area of all

these patent documents. To see the macro areas of research, the patent documents data set was further being grouped into various groups of Technology Topics, the total area of records related to particular technology topics were shown based on the total number of patent documents pertaining to said domain in present study dataset, which is shown in below Figure 7.

CONCLUSION

The present analysis of patent documents between 1997 and 2017 in the area of containers specially adapted for medical or pharmaceutical purposes was carried out by means of patent information analysis using PatSeer paid patent database. This study represents patent trends analysis on the basis of top Priority Country, Current Legal Status, Patent Application Year Wise Filing Trend, Major Current Owner of Technologies, Assignee Type, International Patent Classification (IPC) Group Data, Technology Topics and results were found as: From the initial screening of records it was found that from the priority country data analysis of all patent documents it was evident that maximum patents were generated from China, Japan, USA, Korea and Germany followed by other countries. China is the market leader in respect of innovation creation and patent filling numbers. It was also concluded that apart from patent applications and granted patents in this domain, a large number of patents are in inactive phase due to the reason either of withdrawal, surrender, expired, nonpayment of fees, rejected, refused or suspended. From patent application year wise patent trend data analysis, it can be observed that patent filings related to containers specially adapted for medical or pharmaceutical purposes are showing a continuous rise on a yearly basis during a period of 1997 to 2016. A slight decrease in total patents filing was observed in the year 2017.

Further analysis was made to identify current major owners of technologies in this domain, and top 50 assignees had been determined with a total number of patents they are holding in areas of containers specially adapted for medical or pharmaceutical purposes. Hunan Chinasun Pharm Machinery, Terumo Corp, Yuyama Mfg Co Ltd, Becton Dickinson & Co and China Mobile Communication Corp are the top five assignees who hold the maximum patents in the areas of containers specially adapted for medical or pharmaceutical purposes. Further analysis was made to categorize the patent applications and patents, based on the type of assignee. From this it was evident that the majority of patents were hold by firms, followed by individual and university as assignees. Further, the innovations were grouped and analyzed based on the micro level in various technical fields, based on various IPC subgroup codes; this was analyzed to identify to which areas, maximum patent applications were being filed. Further patent data was also grouped in various broad technology topics, to identify an area of research topics on macro levels.

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