American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-8, Issue-10, pp-90-99
www.ajer.org
Research Paper Open Access

The German Automotive Industry as a Driving Force for Innovation

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ABSTRACT : *Innovations are inevitable for the profitability and sustainability of enterprises. The necessity for innovation is pushed by rising competitive pressure, increasing rivalry on the markets and shortened product life cycles. A short introduction into innovation management is given. The research question deals with the innovativeness of the automotive industry, which will be demonstrated with selected figures. The justification of this article is that there are currently strong signals noticeable indicating a radical change accompanied by a downturn in the automotive industry. Especially the German automotive industry seems to slide into big trouble. This article presents the innovative power of the German automotive industry. The importance of the German automotive industry for employment, sustainability and economic wealth in particular as well as for Germany as a location for industry in general will be explained. Methodologically, a theoretical and an analytical approach are used. Latest literature, surveys, statistical data and logical conclusions provide justified arguments. Firstly the success factors of innovation management will be shown on a theoretical basis. Secondly the performance data of the German automotive industry are deployed on a statistical data basis. Thirdly the need for action to support this industry will be derived.It can be summarized that the German automotive industry provides a huge contribution to the economy in terms of investment and employment on the input side and innovation and prosperity on the output side.The contribution to academic discussion is to point out the significance and impact of the automotive industry in terms of input and output factors. The findings provide reasonable results about this special industry in comparison to others as well as effects on economies contributing to the wealth of nations.*

KEYWORDS *automotive industry, innovation management, innovation rate, expenditures, sales figures, open innovation, research and innovation (R&I), patents.*

Date of Submission: 06-10-2019 Date of acceptance:22-10-2019

I. INTRODUCTION

All modern economies need proper innovations to convince customers to buy and to increase profitability as well as to improve competitiveness. The innovation management has the crucial task to meet all requirements from internal and external stakeholders of the enterprise. Some industries are more and others are less innovation driven. The reasoning for innovation is the attractiveness of markets.

There is the fear that the automotive industry is heading into a structural and technological change, which could lead into a severe crisis in Germany. Worldwide sales volume of the automotive industry dropped 5% at mid-year 2019. German car manufacturers lost 20% of export in the two most important markets China and the US [1]. As a consequence suppliers announce layoffs on a large scale.

The current challenges are diesel scandal, strict engine exhaust regulations, electrical and digital revolution and moreover a foreseeable economic downturn. Trade wars, driving bans, insufficient electrification and skepticism of customers about e-mobility worsen the situation additionally on the demand side. These are the reasons, why car manufacturers urgently need money to invest to be able to keep up. Budgets are badly needed for alternative fuel, for optimization of conventional power drives and extension of electrical mobility as well as for the digitalization of the factory and the car up to automated driving.

Furthermore competitors from other industries like google, amazon, apple, uber are going to penetrate the mobility market as a whole. They earned a lot of money in their traditional businesses and are in search of

new business opportunities in other areas. Their advantage is that they have a high capital strength to cover budgets for research and innovation (R&I).

From the year 2015 on the total number of registered cars worldwide exceeded the number of 1 bn units. The highest number of new car registrations was observed in China, followed by USA and Japan. In 2017 70.5 m cars and 25.1 m commercial vehicles were manufactured worldwide. In China 25.71 m cars were produced. The share of Asia in the global automotive market is 49.9 percent. The biggest manufacturer is Toyota with 10.47 m units with a corresponding sales volume of 238.53 bn EUR. The most profitable car manufacturer at these times was BMW with 10% EBIT rate.

Total sales of top 100 global automotive suppliers reached 889 bn EUR in 2017. The worldwide biggest supplier was the German based Bosch company with sales volume of 47.6 bn EUR. The biggest supplier in Asia in terms of sales volume was Denso with 36.4 bn EUR.

The German market moved from the year 2008 with 5.53 m units to 5.12 m units in 2018, with only small ups and downs in between. The peak was in 2011 with 5.87 m units and in 2018 however a considerable amount of 500,000 units less than 2017. The total sales in 2017 was about 422.8 bn EUR, therein exports with a tendency of +6% with a total number of 271.7 bn EUR which equals 64.3% of total sales. The German suppliers in the automotive industry achieved a sales volume of 79.6 bn EUR in 2017, therein 31.6 bn EUR (39.7%) for export.

The number of employees in Germany climbed with 11,500 from 2016 to 2017 and totaled in 819,995 employees. In comparison to 2010 there were more than 118,400 jobs created by all German companies within the automotive industry.

An important relation can be shown by all generated innovations of the global automotive industry. In 2017 there were 1,223 innovations registered. The share of German automotive companies was 32%, whereas the share in terms of produced cars is only 8%. This is a single, but significant finding about innovativeness [2]. Innovativeness is a mandatory prerequisite for growth and sustainability of companies in competitive markets. Innovations are not only essential for the competitiveness and profitability of companies, but also crucial for the competitiveness of countries and therefore determining the standard of living of the people and wealth of nations.

The reasoning for this article is to present the importance of the automotive industry as a significant industry, especially for German economy. All relevant decision-makers on different levels should be aware of the outstanding performance of the German automotive industry and the significant contribution to innovation, employment, economy and welfare.

The question of research is formulated as: Has the German automotive industry an outstanding innovative power? Quantitative and qualitative arguments will be deployed to answer this question. Statistical figures will show absolute scales and relative comparisons, relative to domestic industries and to competitors abroad. Depending on the result of the analysis the answer will recommend to support this industry or not.

The benefit of this paper is the presentation of the German automotive industry combined with the first systematic matching of innovativeness and impacts of innovation application. The purpose is to identify contributions to economy and sustainability and in the long run to competitiveness and prosperity. These potentials should become purpose of academic discussion as well as evidence for political decision making.

II. INITIAL SITUATION AND PROBLEM FORMULATION

The obstacles of doing successful business in industries are mostly twofold: The first issue is about external impacts like regulation and legislation as well as negative economic influences. The players in a specific industry have only limited possibilities to exert influence, especially when national legislation is transferred to a transnational institution like the EU. Even though the influence is limited and the decision parameters may be contradictive, the responsible deciders should be aware of the consequences. Scientific literature and management know how teach us to detect weak signals and to act before problems arise. Meanwhile there are obvious strong signals to observe.

The second issue is about the internal performance of market participants. In this context, the different companies have to develop competitive strategies and optimize their respective operations. Regarding the performance means mainly the ability to perfectly manage the innovation process. It is in the nature of the matter that innovations are unique and always risky when they are introduced for the first time. But innovations are the decisive prerequisite for growth and sustainability of companies in current and future markets. Therefore the innovation management processes should systematically support R&I and make it happen [3].

Therefor a systematic innovation management process is required [4]. A creative environment generating a plurality of innovative and productive ideas on the one hand and a precisely managed holistic R&I process on the other hand are essential prerequisites for the competitiveness and profitability of companies.

Figure 1 shows that not all German companies are already well prepared. About 28% of analyzed German companies have installed a systematic innovation management yet. A bigger part of 43% have

integrated at least approaches to such process management in their daily business. A small part of 3% currently have none, but plan to change this in the near future. It is remarkable that 26% of all companies do not have any systematic innovation management installed [5].

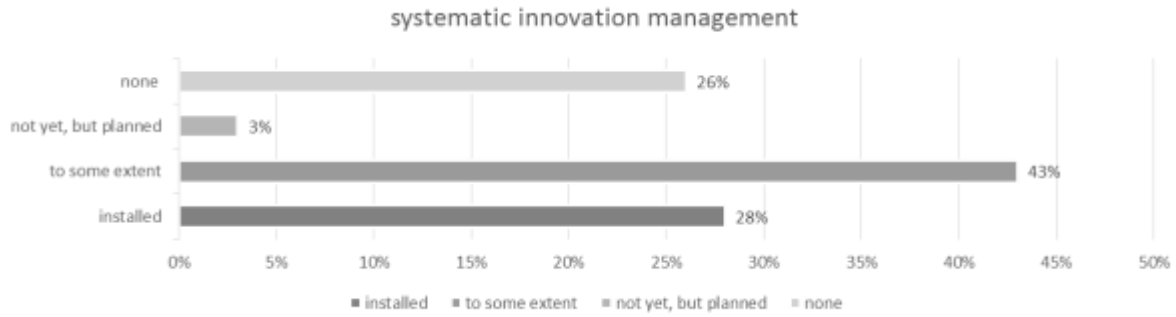

Fig.1. Current status of installed innovation management processes in Germany

Scientific studies of world market leaders show that there are some core elements of success required. Excellent process management is core amongst others. They can be characterized as strategic and operational. These elements appear to be decisive for their outstanding performance [6]:

The strategic issues are:

- Global growth as a strategic corporate goal
- Commitment to active research and innovation

The operational issues are:

- Excellent process management
- Systematic knowledge management
- Scientific cooperation
- Know-how protection through fast patent application

III. LITERATURE REVIEW AND PROBLEM SOLUTION

Innovativeness is inevitable for the sustainability of companies. Thus R&I management is one of the most important entrepreneurial functions. The outcome in terms of new products or applications are essential requirements for prosperous enterprises. An innovative enterprise may be characterized by means of: new product introduction, development of additional benefits, entering new markets, targeting global growth, increase of market share as well as enlargement of sales and profit [3]. Innovations substantiate competitive advantage [7].

During the last decades innovations were predominantly created in closed research and development departments within the respective company. Nowadays an increasing number of innovations is already generated in innovation networks, where all potential sources inside and outside the organization are used [8].

This leads to a new area of competition for various branches. Companies with the largest R&D departments are not any longer in a preferred position automatically. Those companies will succeed, which use the creative potential, which is available worldwide. Open Innovation and crowdsourcing are suitable to exploit the external know how [9].

The internal R&I mostly focuses on exploitation, whereas the exploration is more and more done by external sources [10]. Companies know that they have to exploit their existing knowledge and resources to achieve competitiveness. In addition to that open innovation [11] is a major opportunity to get beneficial innovations done within a shorter time frame and with a lower budget.

Extending innovative potential through open innovation

The basic idea of open innovation [11] is to open the internal innovation process to integrate innovative ideas, solutions and technologies coming from outside the company. This enables companies to use a huge creative potential from outside, exploit more ideas in a shorter period of time, save money and reduce flop rates. Open innovation is a major opportunity to get new ideas and know how on demand and tasks quickly done.

In light of progressive discontinuity along with steadily more challenging strategies, the requirements to manage innovation processes have changed [3]. Companies have to face them by adapting their business activities to the changed environment in order to remain competitive in an intensive and complex market environment. The Integrated Product Management Process by Hofbauer/Sangl (2018) observes and includes the key points mentioned in chapter 2 and covers the widest range of innovation management, starting with

innovation fields and ending up with accompanying lifecycle management. This basic model can be opened by a modern approach of innovation management in order use external potential. This is known as open innovation [11]. The open innovation approach makes use of internal and external sources for the generation of innovations as well as internal and external ways of utilizing ideas and thus has extensive opportunities to create value for the company [12]. With the opening up of the innovation system, the company is able to cope with increased competition and innovation pressures by sharing the necessary investments and risks.

Figure 2 shows the opened innovation process to use external potential and know-how, which is ought to be used and transformed in the respective phase of the progress of the ongoing process.

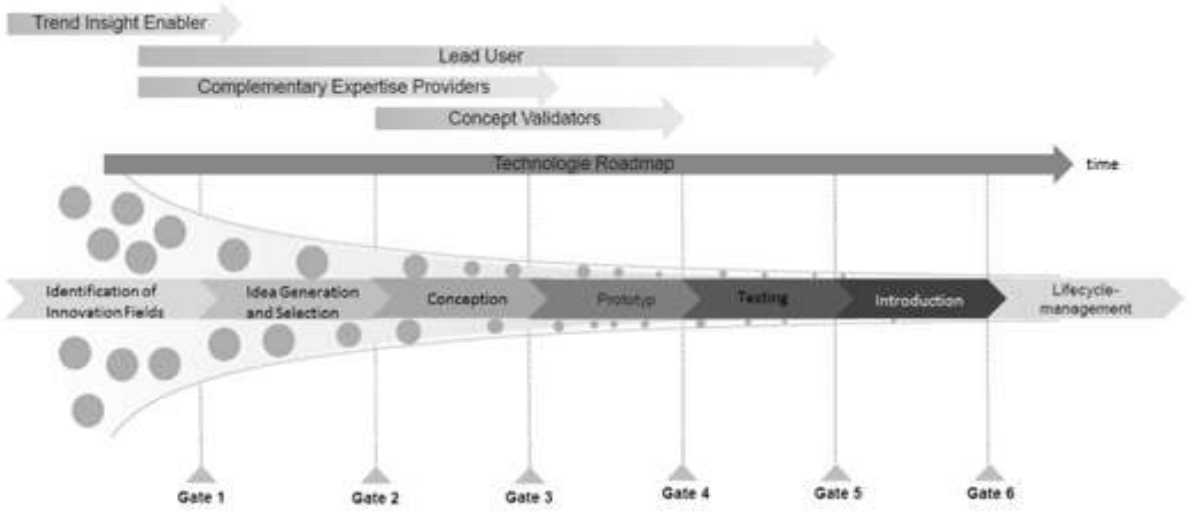

Fig. 2. Opening the innovation process

Arguments for innovation activities

Innovation activities are vital for successful companies and prerequisites for establishing competitive advantage and value added. These principles also apply to the German automotive industry. The empirical data show that innovation activities and corresponding budgets on the input side as well as the outcome of innovation on the sales side have a huge impact on companies and economies. Innovations in terms of products and services are essential to create value for the company and for the customer [13].

The most important advantages of open innovation are reduction of time-to-market and cost-to-market and an enhancement of fit-to-market and new-to-market. The first two issues referring to time and cost are related to improved access to information about solutions of problems [14]. This information is about technical knowledge how to solve specific problems. Further on how to use efficiently existing resources while finding solutions. Fit and new refer to the access of information about needs and wants of customers. The knowledge about the preferences of customers is essential to meet their needs. This helps to improve the effectivity, because the products will meet the needs of the customers and thus the flop rate will be reduced.

This article pays attention to the research question under consideration of above mentioned key points. In case of provided evidence of innovativeness, a strong recommendation will be given to protect a leading innovation position in times of radical change, discontinuities, downturn and rising competition.

IV. REASONING FOR INNOVATIVENESS OF GERMAN AUTOMOTIVE INDUSTRY

In this chapter the argumentation for the research question will be provided with selected facts and figures including comparisons with German industry on average or on detailed basis with other industries.

Regarding quantitative reasoning about output factors (innovative products, sales and share of sales, patents) and input factors (investment, intensity of innovation) as well as treading new paths with opening the innovation process the outstanding performance of the German automotive industry will be justified.

One of the most convincing facts is that the sales structure of the German automotive industry accounts for nearly 50% of innovative products. Exactly 49.6% of total sales with roundabout 423 bn EUR is achieved with innovations. This is a considerable output of invested innovation input. In Germany sales is generated with 84.5% on industry average with established products, 15.5% with innovations.Figure 3 shows the noteworthy relations on sales volume [15].

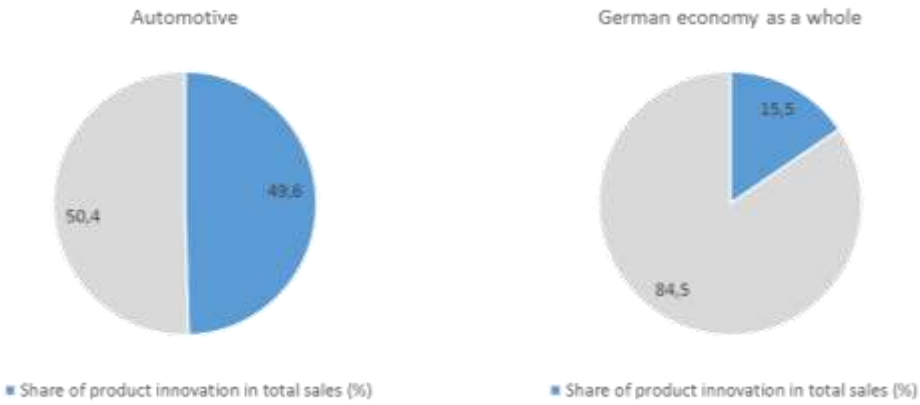

Fig. 3. Share of product innovation

Figure 4 shows significant indicators in comparison to other industries in Germany. The innovation rate displays the percentage of innovative companies within the respective industry. One can see, that the automotive industry is among the three leading innovative industries, namely automotive, chemicals/pharmaceuticals and electrical industry. The next comparison shows the share of sales with innovative products. As already depicted the automotive industry has a share of nearly 50%. Here the automotive industry is in the lead with a big gap to the second one. The intensity of innovation shows the portion of sales allocated for innovation activities.

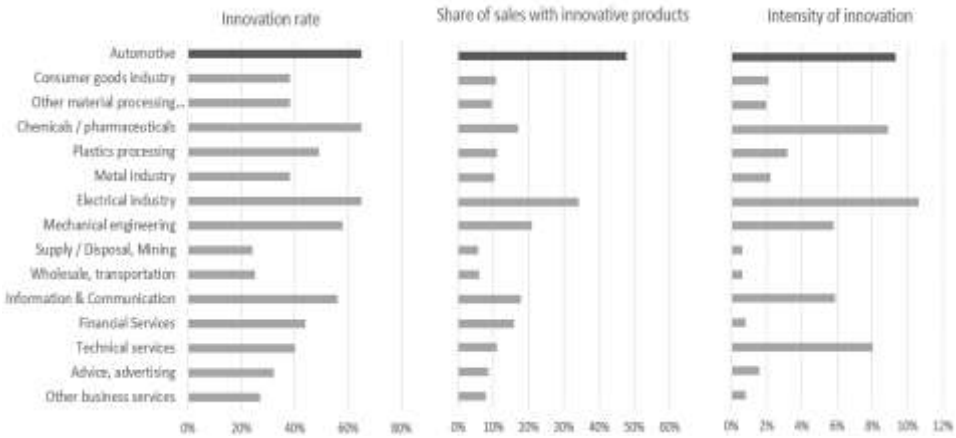

Fig. 4. Comparison of innovation indicators across different industries [16]

The comparison pinpoints that there is a wide range between the different sectors, but this is quite normal and the innovation intensity represents the degree of competition and even the profitability of the business.

Table 1 illustrates exemplarily the range between the automotive industry and the average of all sectors.

Tab. 1. Range of innovation measures for automotive sector and average of all sectors in Germany [16]

	share of innovative companies	intensity of innovation as expenses in % of sales	share of sales with innovative products
Automotive industry	62.3%	9.39%	49.6%
Average all industries	36.0%	3.14%	15.5%

The empirical data show that innovation activities and corresponding budgets on the input side as well as sales figures of innovation on the output side have a huge impact on companies and economies. Innovations in terms of products and services are essential for competitiveness and profitability.

The overall expenditures of the German automotive industry for innovation is displayed in figure 5. On the left scale we see the absolute figures of the German automotive industry and on the right scale the absolute figures of the overall economy in bn EUR. After the crisis in 2009 one can see a steady increase of the

expenditures. After 2011 the progression of the automotive industry (bars) was higher than the German industry on average (line).

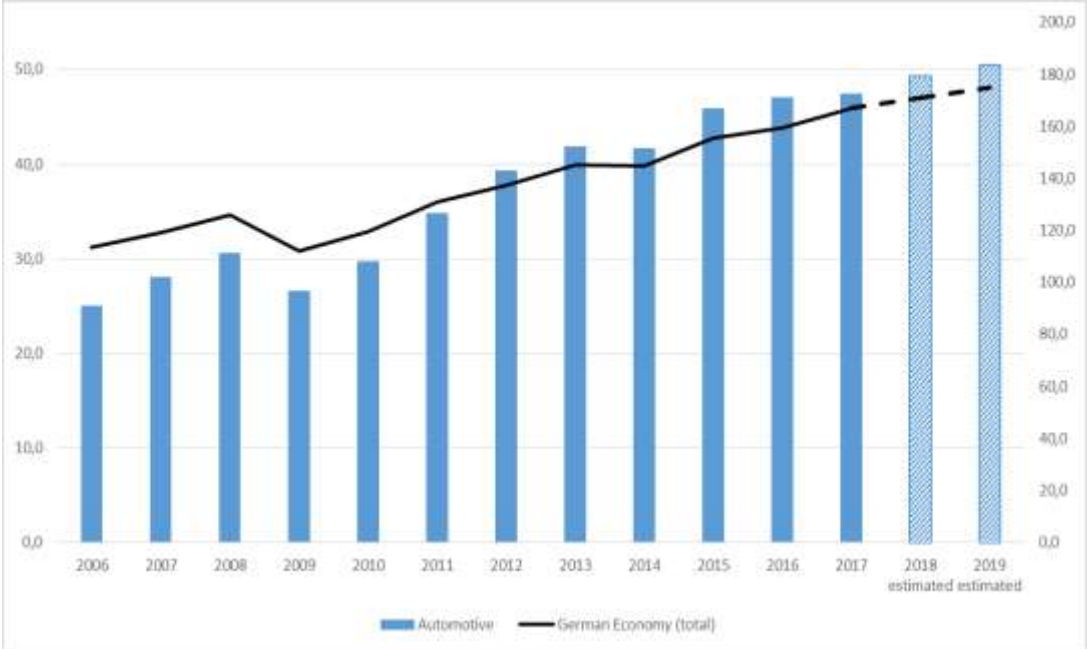

Fig. 5. Innovation expenditure in € billion [15]

All companies have to watch out for their cost position in order to stay competitive. Figure 6 shows the comparison of the proportions of German automotive industry versus German economy on average with process innovation-related cost reductions over time. This means that innovation activities are not only important for new products, but also to impact the cost position of a company. In this context the German automotive industry has also a leading position far above average in process related innovation.

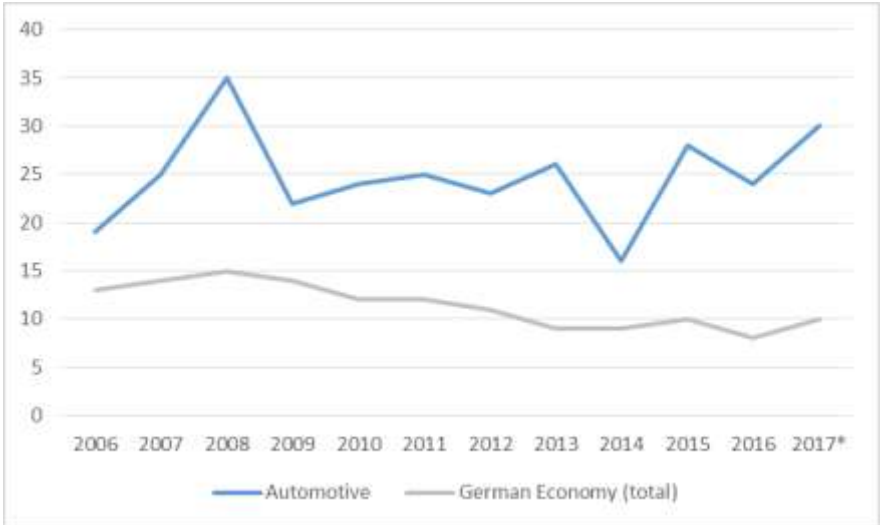

Fig. 6. Proportions of process innovation-related cost reductions (in %) [15]

With regard on innovativeness it is also important to analyze the openness of companies or industries in general. This is an important issue to take advantage in competitive markets. Increasing competition face companies with pressure to innovate and force them to push innovation activities with higher budgets. Innovations are drivers for profitable growth, competitiveness and sustainability. New technologies as well as cost and time pressure have changed the practice of innovation activities. Closed innovation has changed into open innovation. The basic idea of open innovation is to open the internal innovation process to integrate innovative ideas, solutions and technologies coming from outside. Open innovation [11] is a major opportunity

to get new ideas and know how on demand and tasks quickly done, without limitations in thinking and problems coming up with a slow-acting and sometimes calcified internal organizations.

Figure 7 shows the way of operating product innovations within the automotive industry, answering the question who is involved in the process. The figures display that there are as much innovation projects done together with third parties as on a stand-alone basis (multiple choices possible). In comparison to total industry on average the automotive industry in Germany is about one third ahead of the other sectors with regard to open innovation.

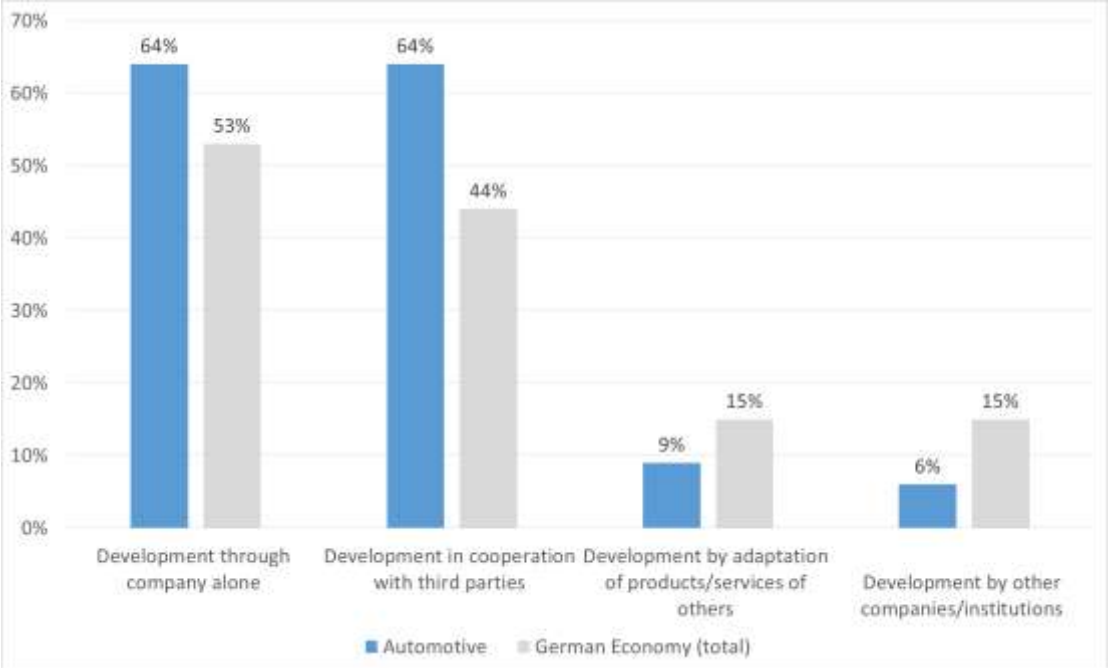

Fig. 7. Developers of Product Innovations 2014-2016 [17]

With regard to open innovation and inclusion of ideas from outside there are many ways to execute. Figure 8 shows four different ways to collect ideas. Workshops with experts from own industry, experts from other industries, joint ventures and online/crowd based generation. From that figure can be derived that the automotive industry is one third ahead of German industry on average.

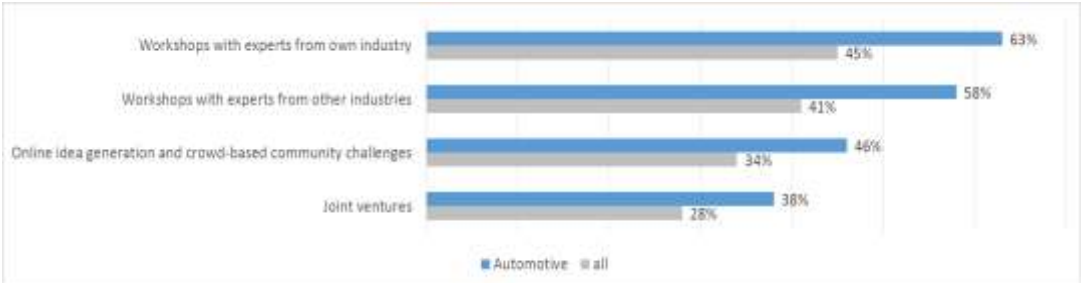

Fig. 8. Innovation sources from outside the company [18]

Figure 9 shows various cooperation partners from outside for automotive industry versus German economy in total. One can derive that the German automotive industry has already opened to external sources of innovation.

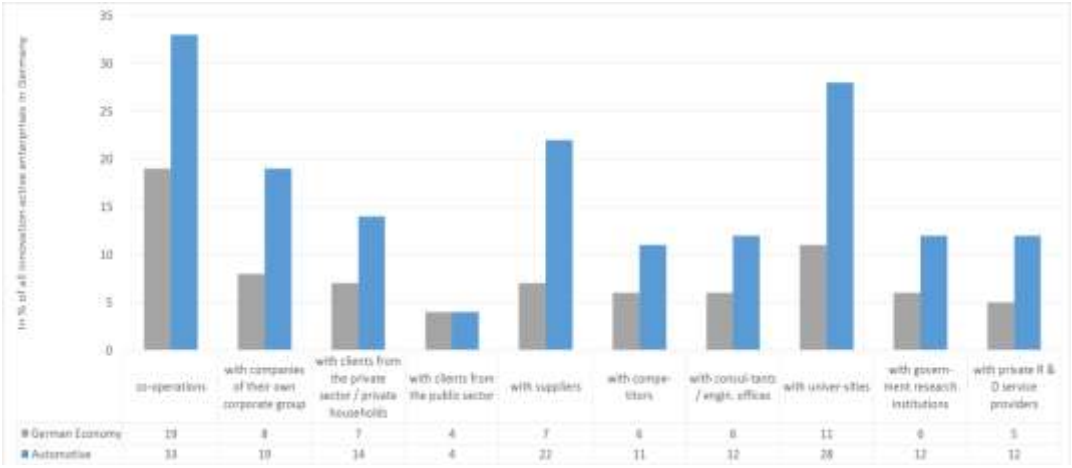

Fig. 9. Cooperation in R&D in Germany 2014-2016 [19]

Figure 10 provides information about the geographical distribution of innovation partners. This gives strong advice that the German automotive industry is ahead also in this respect.

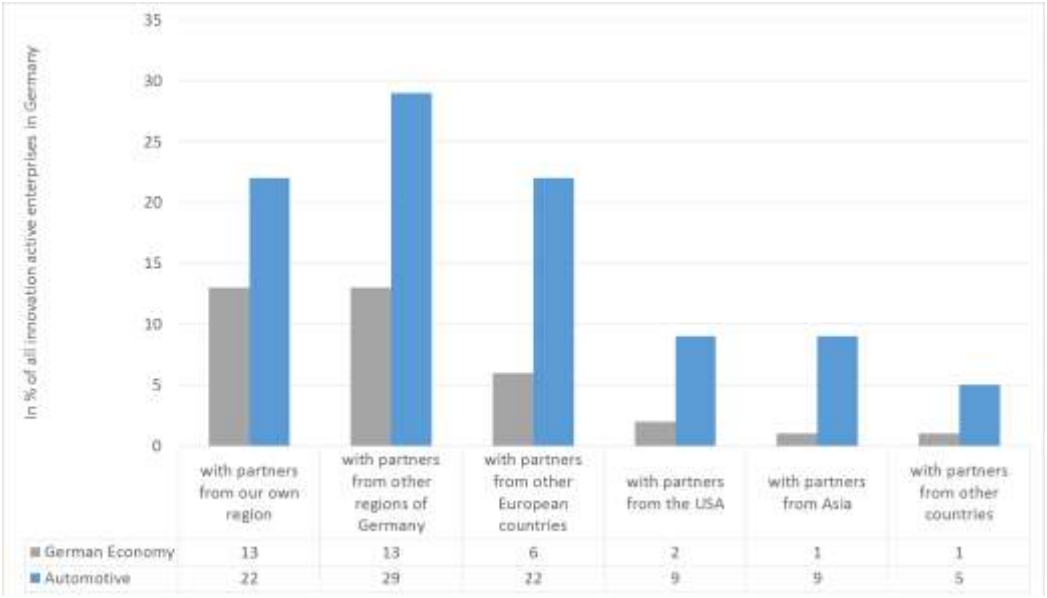

Fig. 10. Cooperation in R&D in Germany 2014-2016 [19]

An interesting output of investment in innovation is the volume of patents in order to protect intellectual property and secure competitive advantage. In 2018 the number of patent applications totalled 67,895 patents, thereof 12,273 from the transport sector, which was a plus of 5.8% in comparison to 2017. The top 3 applicants were [20]:

- Robert Bosch GmbH: 4,230
- Schaeffler Technologies AG & Co. KG: 2,417
- Ford Global Technologies, LLC: 1,921

Figure 11 shows the innovation index of the top 5 automotive companies worldwide. The index value is a composite of degree of innovation, originality, customer value and level of maturity.

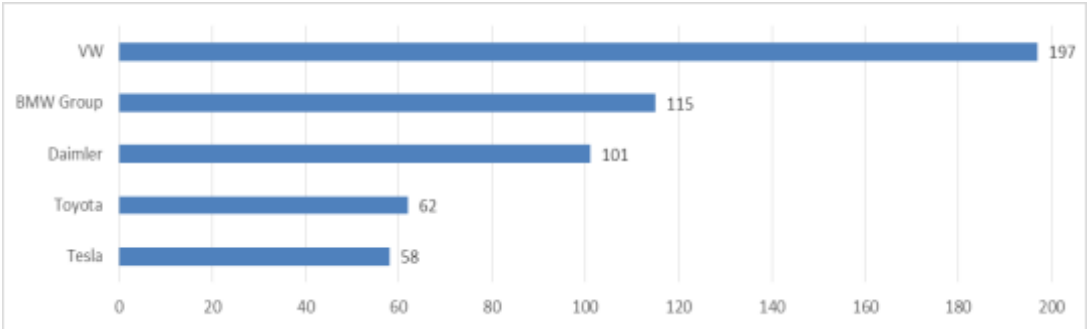

Fig. 11. Innovation Index of selected automotive companies in 2017 [21]

All the qualitative and quantitative arguments demonstrate a high degree of innovativeness for the German automotive industry, far ahead of all other industry sectors in Germany. The reasoning also presents that the German automotive is prepared for global growth and definitely committed to active research and innovation. The key point of success are perfectly managed innovation processes, executed in cooperation with external innovation partners and to apply immediately for patents to protect intellectual property.

V. SUMMARY AND CONCLUSIONS

This paper deals with the significance of innovation in general and the accomplishment of the German automotive industry in particular. The indication of a disruptive change especially for the German automotive industry is in evidence. A variety of influencing factors merge to a situation of radical change. Big trouble seems to be inescapable.

The factors of success of innovation management have been outlined on a theoretical basis. These factors also apply to the German automotive industry. Remarkable issues are a strictly managed innovation process and the targeted appliance of open innovation techniques. The evaluation indicates that the German automotive industry is well positioned.

In the empirical part the current situation of the German automotive industry was pointed out in several dimensions. Statistical evidence was given with absolute and relative figures. The overall assessment shows an outstanding performance of the German automotive industry, in comparison to domestic industries as well as in comparison to car manufacturers abroad.

The key points are the excellence in executing process management, including internal and external knowledge management with the support of cooperations and protecting quickly the outcome in terms of intellectual property.

In consideration of the formulated research question and careful assessment of arguments, it can be stated that the German automotive industry has an outstanding innovation power. Thus it can be concluded that this innovation power is key for the German economy in regard to innovation, employment, prosperity, competitiveness and in the end for the welfare of the nation. So it can easily be derived that there is a huge and instant need for action to support this industry.

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Günter Hofbauer" The German Automotive Industry as a Driving Force for Innovation" American Journal of Engineering Research (AJER), vol. 8, no. 10, 2019, pp 90-99