Automotive Industry Response to its Global QMS Standard ISO/TS-16949

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9 November 2013

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Abstract: With increasing globalization, the intense competition and customer-pressure have spurred many producers from developing/ emerging countries to adopt the best management and organizational practices. The quality issues are paramount for automotive manufacturing. The multiplicity of Quality Management System (QMS) Standards prevalent till the 1990s finally gave way to development of a harmonized automotive industry-specific QMS, namely ISO/TS-16949. This paper analyzes the major factors motivating firms to adopt this Standard: its quality signaling function, especially in international business, and facilitative role in moving up the supply chain. We investigate the inter-national and inter-regional concentration of ISO/TS-16949 certificates and relate those changes to the automotive industry dynamics. Among the top certifying nations – China, India and Brazil included – these certificates and 'cars and commercial vehicles' produced are highly correlated. A moderate-to-high worldwide growth of this certification is probable in near future with its gaining popularity among Tier-2 suppliers and for two/ three-wheeler automotive production. The Indian evidence indicates a sizeable proportion of car and commercial vehicle plants being ISO/TS-16949 certified and a high certification incidence among large and medium-large auto component firms. We suggest the creation of a Centre to encourage and prepare SMEs and provide financial assistance for ISO/TS-16949 certification.

Keywords: Quality Management System, QMS; ISO/TS-16949 Standard; automotive industry; international QMS Standard; India
JEL: L15; L62; F23

1. Introduction

The globalization has generally intensified the competition in international as well as domestic markets. Consumers now demand enhanced product quality and variety. In the automotive sector the global and regional outsourcing of components has risen over time (e.g. Humphrey and Memedovic 2003).[1] This has raised for auto component suppliers from emerging markets their optimal fixed outlays for quality and productivity upgradation (Sutton 2007). For them the rewards of moving up the supply chain lie in relatively more assured/ longer contracts, higher profitability and less vulnerability, as well as greater involvement in new product development by vehicle producers (Singh 2007 and 2010b). The associated challenges include, among others, crossing the quality thresholds, say by employing the world-class quality management practices.

The quality improvement is a multifaceted activity. Here we confine our analysis to the quality management system (QMS) Standards. A QMS Standard – a set of features present through documented manuals and procedures – apart from acting as a quality differentiator enhances the productivity and delivery schedule performance by reducing the wastage & errors, and improving the employees' morale and working conditions. QMS certificates issued by an accredited Certification Body are called accredits. The ISO-9000, based on process approach, is a voluntary and generic QMS Standard (a family), having 8 broad principles for quality systems; its Requirements, namely ISO-9001 can be applied to any sector. By December-end 2011 the ISO-9001certifications issued globally in 180 countries were approx. 1112 thousand[2], as compared to below 50 thousand in 1993 in 60 countries (ISO 2012); the number outside Europe and North America correspondingly jumped from approx. 6 thousand to 582 thousand. The increasing competition, insistence of multinational buyer-firms, and the government assistance have led to its extensive worldwide adoption (Franceschini et al. 2011; Oke and Owaba 2007).

However, a few industries where the quality issues are paramount have evolved their own industry-specific internationally harmonized QMS Standard. The automotive industry having the

[1] The vehicle industry has regionalized production – not as globalized as electronics and textiles; however, it is dominated by a small number of MNEs which generally produce in all major markets (Stanford 2010); apart from having significant inter-sectoral linkages, for some economies – like Japan, Germany, Canada, Korea and Spain – the automotive sector contributes much to the exports, employment and GDP directly (p. 385).

[2] Of these, China and India had 328213 and 29574 certificates, implying 29.53% and 2.66% global shares, and the 1st and 7th ranks respectively. Incidentally the number of these certificates globally fell by 0.6% in 2011 over 2010.

ISO/TS-16949 Standard (also called TS-16949), is one such case.[3] It is an 'ISO-9000 plus' Standard in terms of the QMS requirements. By end-2011 the number of ISO/TS-16949 certifications issued in 86 countries was 47.5 thousands. For the global automotive industry in the 21st century there has been heightened competition and much restructuring of production location. The geographical spread of ISO/TS-16949 certification analyzed in the present study reflects this dynamics. Like Franceschini et al. (2011), we relate at country-level the (≥4 wheeler) vehicle production and number of ISO/TS-16949 certificates. They predicted the total ISO/TS-16949 certificates to saturate around 43 thousand in 2012 (surpassed in 2010!). We expect instead a moderate to high overall growth of these certifications in near future due to: the likely increasing adoption of this certification by producers and Tier-1 suppliers of two/ three-wheeler vehicles, and by Tier-1 and Tier-2 suppliers to ≥4 wheeler manufacturers. As a special case this paper also examines separately the prevalence of ISO/TS-16949 QMS certifications among vehicle manufacturers and auto component producers operating in India – a relatively booming automotive market.

Below Section 2 discusses briefly the development of ISO/ TS-16949 Standard – its formulation and revisions. Section 3 examines the major drivers of adoption of this Standard by auto component and vehicle producers. Section 4 reports data on the global spread of this Standard, and analyzes the inter-national and inter-regional patterns of this certification, juxtaposed to the automotive production. Section 5 focuses on the rapid growth of the Indian automotive sector in recent years, and other factors propelling automotive firms in India to improve the quality parameters and management systems. Section 6 examines the Indian evidence on ISO/ TS-16949 certifications. Section 7 concludes and offers a few policy suggestions.

2. Development of Automotive Industry QMS Standard ISO/TS-16949

The product quality is a critical concern in automotive sector. Vehicle manufacturers (also called automotive Original Equipment Manufacturers, OEMs) and governments are interested in the safety and quality of vehicles sold, and therefore, also in the quality of auto components. With

[3] There are specific QMS for medical devices (ISO-13485) and petroleum, petrochemical and natural gas (ISO/TS-29001) industries too. There are special ISO-9001 guidelines for education (IWA 2) and local government (IWA.4).

platform-sharing across a number of vehicle models – a general practice followed by automobile manufacturers – the failure of a common key component poses larger risks (Bailey et al. 2010). Poor quality of vehicles can lead to excessive fuel consumption, high costs of dismantling & repairs, and accidents. In many advanced countries the vehicle sales are subjected to stringent product recall liabilities and severe penalties in accident lawsuits (Boehm and Ulmer 2008).

By the mid-1980s automotive suppliers were subjected to several nation and customer specific regulations relating to quality management. In the mid-1990s in the USA the Big Three car producers (General Motors, Ford and DaimlerChrysler) and major truck manufacturers formulated a common QMS Standard, QS-9000, based on ISO-9000:1994. Yet the multiplicity of QMS Standards prevailing in automotive sector and the lack of mutual recognition across countries/ regions acted as a kind of trade barrier (Singh 2010a).

The ISO/TS-16949 "--- standard was developed to satisfy a pressing need of the automotive suppliers, which – since the 1990s – were subject to a confusing mass of military, national and customer standards" (Franceschini et al. 2011, p. 736). "ISO/TS 16949 eliminates redundancy, cost and administrative burdens imposed by multiple standard formerly mandated in various geographic regions" (Ostadi et al. 2010, p. 496). By dispensing with the need for multiple third-party registrations for global supply of auto components, the ISO/TS-16949 certification facilitates their international trade. Having this certification lessens the second-party (customer) audits; for suppliers, each such intensive assessment involves some disruption in routine work, associated paperwork and costs.

Since 1999 the ISO/TS-16949 Standard, as a globally harmonized international QMS Standard for the automotive sector, has created a single reference point. Here 'automotive' includes cars, trucks, buses and motorcycles. The ISO/TS-16949 certification can apply to any Tier of automotive supply chain, including heat treating, welding, painting, plating or other finishing services. Apparently it is not applicable to component manufacturing sites supplying only to the aftermarket (and not parts specified by the customer).

The ISO/TS-16949 Standard has been developed by the International Automotive Task Force, IATF – an ad-hoc group of major global vehicle producers and national automotive associations – and approved by the ISO technical committee ISO/TC 176 '*Quality Management and Quality Assurance*', responsible for the ISO-9000 QMS. The IATF also manages the ISO/TS-16949 accredits through its oversight offices. As per the IATF list updated on August 14, 2013, there are 45 contracted ISO/TS-16949: 2009 Certification Bodies; among those, the Indian Register Quality Systems, IRQS, is based in India.[4]

The 1999 version of ISO/TS-16949 was aligned with the then prevalent U.S. (QS-9000), German, French and Italian QMS Standards for automotive sector – all based on ISO-9001:1994. The second edition ISO/TS-16949:2002, called TS-2, released in March 2002, incorporates the verbatim text of ISO-9001:2000. It adds certain specific requirements for the automobile industry and automotive supply chain in areas like employee competence, design and development, production and service provision, monitoring, measurement, analysis and improvement (Gryn 2003). The TS-2 allows OEMs to add their own, i.e. customer-specific requirements. Further, it would be mandatory for any ISO/TS-16949:2002 certified firm to buy its automotive intermediates only from producers having at least the ISO-9001:2000 Standard.

The third edition, ISO/TS-16949:2009 amends the ISO/TS-16949:2002 edition to ensure compatibility with ISO-9001:2008, *Quality management systems –Requirements*, and to improve consistency with the environmental management system Standard, ISO-14001:2004 (ISO 2009). There are no essential changes in the technical requirements. The IATF permitted a transition period of 120 days from the publication date – June 15, 2009 – for organizations to comply with the Standard's requirements. "The foundation of certainty that ISO/TS 16949:2009 provides in terms of improved productivity, quality, and just-in-time logistics and delivery in the supply-chain, is probably more essential than ever" (Joe Bransky, an IATF member, quoted in ISO 2009).

[4] Source: www.iatfglobaloversight.org, accessed August 30, 2013.

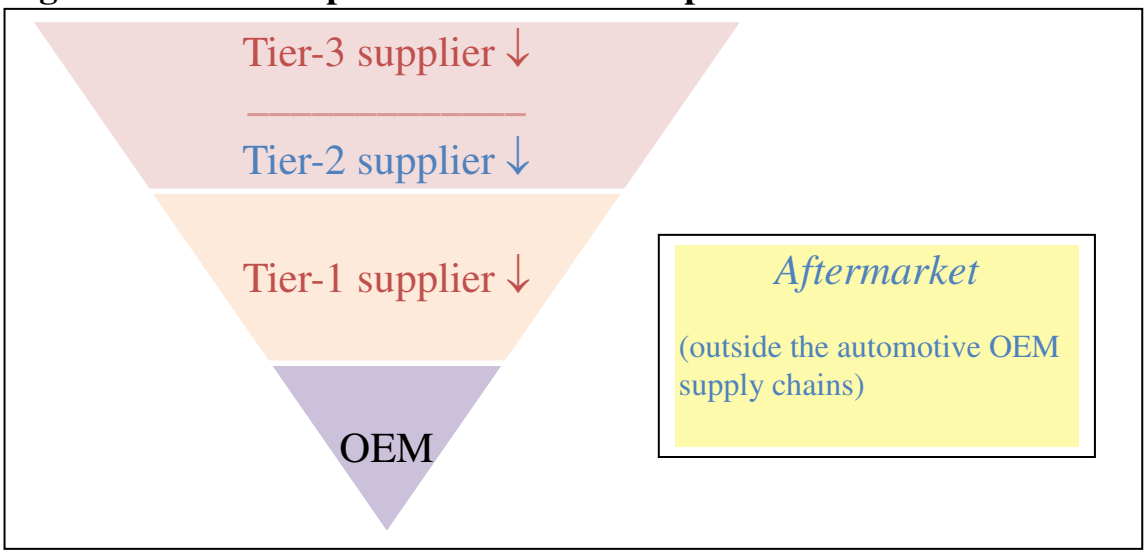
3. Drivers of Adoption of ISO/TS-16949 Standard

An auto component producer may adopt the ISO/TS-16949 Standard for the internal efficiency reason and/or as a marketing tool – to emit quality signal. As reviewed below, the existing literature indicates broadly two powerful influences of ISO/TS-16949 Standard on the certified auto component firms, more so in respect of exports than domestic sales. These effects are: quality signaling and being a facilitator in moving up the value chain; the former role itself contributes to the latter. In Section 3.1 we also examine the limited empirical micro-level evidence on the choice of this certification by auto component producers. In Section 3.2 we explain what motivates automobile manufacturers to opt for ISO/TS-16949 certification for their production sites.

3.1 Motives for Auto Component Producers

The automotive industry is tier-ized, as illustrated in Figure 1. Auto component supplies for further processing are made from lower Tiers (upstream suppliers) to higher Tiers and then from Tier-1 to the original equipment (vehicle) manufacturer, OEM. Tier-1 firms supply directly to OEMs; the firms selling assemblies/ modules to OEMs are sometimes called Tier-0.5 suppliers. A component producer may even operate at different Tiers for different items, thus playing diverse roles. The direct and indirect supplies for original equipment (vehicle manufacturing) are known as OE supplies. However, the supplies to OEMs may be partly for the aftermarket sales by OEMs, i.e. meant to be sold for vehicle-repair purpose; these supplies have to adhere to the OEM specifications. The total aftermarket/ replacement market, including also the direct supplies of components to it, is quite large in value terms (see Singh, 2010b).

Figure 1: Auto Components: OEM and Replacement Markets



Note: Adapted from Singh (2010b).

Quality Signaling Role of QMS

An important factor motivating a producer to seek QMS certification is its quality signaling role in the presence of a large number of potential suppliers of the product and their unobservable attributes (see e.g. Terlaak and King 2006). Hence customers prefer the 'third party QMS certification' assurance.[5] Without QMS certification, intensive time-consuming second-party audits of quality parameters of a prospective supplier are required – especially cumbersome for purchase contracts with foreign suppliers. However, sometimes potential overseas buyers may not be fully convinced of the integrity and capabilities of an interested supplier's ISO-9000 Certifying Body, if non-accredited. The ISO/TS-16949 certification is credible and universally recognized. Moreover, this Standard is 'ISO-9000 plus' by way of some additional QMS requirements for the automotive supply chain. Therefore, *ceteris paribus*, compared to ISO-9000, the ISO/TS-16949 certification signals a superior QMS for automotive operations. The quality signaling (differentiating) role played by ISO/TS-16949 accredit is stronger for buyer-supplier transactions across nations and those between otherwise non-linked firms.

[5] A QMS certification (registration) is usually valid for 3 years, and may be renewed. It being plant-specific, multi-plant firms may obtain multiple certifications – for identical or different QMS Standards across plants.

With the formulation of ISO/TS-16949, globally a large number of Tier-1 suppliers, especially those exporting to OEMs, have been 'pressurized'/encouraged by OEMs to adopt this Standard. Stating with a few OEMs in the early 2000s, at present many Tier-1 suppliers differentiate between their ISO/TS-16949 accredited and other suppliers. Now the vehicle manufacturers usually ask for ISO/TS-16949 certification or at least the compliance with this QMS of their direct (Tier-1) suppliers. For these transactions the general ISO-9000 Standard seems to have ceded the quality signaling/ differentiator role to the industry-specific Standard ISO/TS-16949 (Singh 2010a and 2010b). Further, for the sake of consistency major global OEMs are interested in having their entire supply chain, including their sub-contractors Tier-2 and Tier-3 suppliers, being ISO/TS-16949 certified. Even for international trade in standardized auto components the quality, delivery and logistic parameters have become more important over time. For diversified firms producing components also for related sectors like rail transport and aerospace, being ISO/TS-16949 certified may emit quality signals to those potential customers as well.

The case study evidence obtained by Sroufe and Curkovic (2008) indicates: the ISO/TS-16949 registration signals a quality image to potential customers, improves on-time delivery, reduces decline in defective parts per million and increases sales. Bevilacqua et al. (2011) find that the application of ISO/TS 16949:2009 yields high-quality products, improves the plant performance and consolidates market position of the firm. Ostadi et al. (2010) in an empirical study of a sample of thirty six ISO/TS-16949:2002 certified auto component SMEs in Iran – 4 producers having >50 to 100 employees and the others even less – examine the motives and effects of this certification as perceived by the implementing managers. The motive was 'to improve the company quality image' (78%) and 'to strengthen the quality management system' (69%). Adopting the ISO/TS-16949 Standard brought the registered Iranian plants significant gains, like enhancing the status of the organization, systematic documentation, better quality control, increased competing ability in sales, verifying the internal auditing system, etc.

Moving up the Supply Chain

The potential rewards associated with higher Tier like Tier-1 sales have been mentioned in Section 1. Globally a significant proportion of automotive Tier-suppliers seem to have progressed over time to a higher Tier of the supply chain and have changed their product profile

accordingly. Again the automotive purchases for vehicle or 'Tier-1 Level' production consist of critical/ key as well as other components. For a component producer-supplier at any given Tier-Level, increasing the relative production of critical components which have more exacting quality and delivery requirements, is an implicit progress. Holding of ISO/TS-16949 certificate – through its quality signaling role and the likely favourable influence of this QMS Standard on the productivity and delivery schedule performance, as alluded above – is expected to facilitate moving up the supply chain. For export sales, this certification may play a far greater role in these upward journeys, also because many global OEMs and even some Tier-1 auto component firms consider the ISO/TS-16949 certification of their vendors as mandatory or strongly preferred, especially for purchase of key components.

However, this expected facilitative role of ISO/TS-16949 Standard has been hardly investigated empirically. Singh (2010b) provides supporting evidence relating to exports. She examines the export behavior of auto component firms operating in India in terms of the type of QMS and other quality related factors, firm size, foreign financial and technical collaborations, isolation and cluster location variables, etc. She analyzes separately the determinants of different Levels of exports – probability of being exporter to OEMs, to OEMs and/or Tier-1 firms, or at any Level (even to the aftermarket). C*eteris paribus*, ISO/TS-16949 certified and bigger firms are found to be far more likely to be exporters to OEMs, and to be exporters to 'OEMs and/or high Tier' firms. Having a Quality-Incharge and having an internationally recognized Quality-Award increase the likelihood of being an OEM-Level exporter. Though the probability of export participation (being an exporter) is unaffected by the ISO/TS-16949 certification, among exporters the ISO/TS-16949 certified firms have a larger value of exports.

As mentioned above, the major global OEMs now want even their Tier-2 and Tier-3 suppliers to be ISO/TS-16949 certified. The OEMs are also intensifying their sales efforts in the aftermarket segment. Hence for SMEs being ISO/TS-16949 certified would enhance their exports to automotive Tier-1 and Tier-2 firms as well as for the aftermarket supply, particularly for the replacement supplies to OEMs.

Firm Characteristics and the choice of ISO/TS-16949 Standard

The decision regarding QMS certification – Yes/ No and the Type – is taken at the firm-level, weighing the various additional costs and benefits (Singh 2010a). We have not come across any econometric study explaining these choices made by vehicle firms. For auto component producers in India in 2005, Singh (2010a) investigates the factors affecting the probability of being ISO/TS-16949 certified. The logistic estimates indicate that a bigger firm-size and foreign 'pure' technical collaboration have large positive impacts on this probability. The foreign financial collaboration has a small favourable effect, only for SMEs. Gurgaon, Chennai and Bangalore (now called Bangaluru)-Hosur clusters are ahead of other locations in respect of the ISO/TS-16949 certification. The firm's age has an inverted U-shaped impact; a negative effect is implied for the pre-1980s commencement of production.

3.2 Motives for Vehicle Manufacturers

The producers of vehicles, a finished product, may adhere to the ISO/TS-16949 Standard for enhancing the productivity of their manufacturing operations. The benefits are also in terms of improving the quality consistency of their own processes and developing a common language with their vendors for an understanding of the QMS requirements. Again, for any automobile manufacturer there is a distinct possibility of vehicle recall and of accident lawsuit. Having the ISO/TS-16949 certification renders it easier to insure against/ face such eventualities. Both the product liability insurers and the courts take cognizance of the quality management system.

During the 2000s, several emerging nations, e.g. China and India, apart from having booming automotive exports, have experienced the phenomenon of rising outward FDI by their large automotive firms in the vehicle and component segments. They are even venturing into developed host nations (e.g. Pradhan and Singh 2009). Having the ISO/TS-16949 certification for their domestic automotive manufacturing sites is expected to boost the confidence of these rapidly internationalizing firms from emerging economies.

4. Global Spread of ISO/TS-16949

We analyse here the information on ISO/TS-16949 certifications, as compiled from the annual ISO Survey of Management System Standard Certifications, ISO (2012). We further relate it to the automotive production (see Tables 1-2 and Figures 2-4). A few remarks are pertinent.

First, the automotive industry has undergone much turbulence and restructuring in the 21st century. For vehicle manufacturing while there has been expansion through new plants in rapidly expanding markets of China, India and Brazil, and other low cost locations in major trading blocks, there has been a drastic downsizing in the traditional markets of the West – even some plant closures by volume producers (Bailey et al. 2010). The International Organization of Motor Vehicles Manufacturers, OICA (i.e. Organisation des Constructeurs d'Automobiles) compiles the data on production of cars and commercial vehicles (CVs) only. These data indicate an increase of 50% in global production during 1999 to 2012. Thus since the close of 20th century the global vehicle industry has grown at a modest average annual rate of around 3%, with much yearly fluctuations and an absolute fall in output in 2008 and 2009 due to the recession. The global recession hit the automobile industry badly due to the highly pro-cyclical demand for vehicles and consumer credit crunch.

In contrast to a remarkable growth of automobile industry in some emerging economies, the number of vehicles manufactured in some advanced economies, like the USA has fallen since 1999 (see Table 2 and Figure 4). The USA vehicle output decreased even before the recent global recession. The USA, Japan and Germany – the erstwhile major production centres – produced 28.6 million automobiles in 1999, accounting for about half (50.85%) of global production. Their combined output has since fallen to 25.9 million units in 2012, implying 30.81% global share. During the same period China, India and Brazil together have raised their output from 4.0 million to 26.8 million vehicles, and their global share from 7.11% to 31.80%. Their cars & CVs output growth has been based primarily on the strength of domestic demand (Stanford 2010). China's global share (rank) of output has moved up from 3.25% (9th) in 1999, to 8.12% (4th) in 2004, 22.35% (1st) in 2009 and 22.90% (1st) in 2012.

Second, the ISO/TS-16949 certification can be applied to automotive manufacturing and certain automotive-related services production sites (plants). Among all such automotive sites globally, the vehicle manufacturing sites are a small minority. Vehicle assembly requires numerous components and many related services. The producers linked to automotive value chains generally supply (directly or indirectly) to multiple OEMs. Overall, for the application of ISO/TS-16949 certification the upstream supply base for vehicle production is heavy, i.e. in terms of the number of auto component/ sub-assemblies/ assemblies and related services producing plants (sites) as compared to the number of vehicle manufacturing plants. The impressionistic evidence indicates that in the automotive supply chains currently the adoption of ISO/TS-16949 Standard certification is mainly found among suppliers to cars and commercial vehicle manufacturers, especially among their Tier-1 suppliers, and among suppliers to Tier-1 firms having international operations. Thus at present the ISO/TS-16949 QMS certifications No. is expected to be high in countries where the 4-wheeler vehicle production is concentrated and/ or which are major supply centres to global OEMs and Tier-1 firms.

Operationally the ISO/TS-16949 Standard certification commenced in 2000. By end-2004, just a few years since its launch, 10 thousand certificates had been issued globally (Table 1, Part A).[6] During 2004 to 2007 there was a steep increase of 2.5 times in these certificates, followed by a relatively modest growth subsequently.

4.1 Inter-National and Inter-Regional Diffusion

The disaggregate figures on ISO/TS-16949 certifications reflect certain interesting geographic and dynamic patterns (Table 1, Parts B and C, and Figures 2 and 3).

ISO/TS-16949 Inter-National Diffusion: China, S. Korea, India, Brazil, Thailand and Mexico – also significant producers of auto components – appear in the list of the top 10 countries in terms of the number of ISO/TS-16949 certificates as on December-end 2011 (Table 1, Part B, and Figure 2). The global share of the top 5 ISO/TS-16949 certification nations – China, S. Korea, USA, India and Germany, having a total of 30936 certificates in December-end 2011 – is about 65.11%. During 2004 to 2011 China's rank improved from the 5th to 1st (since 2006); S. Korea

[6] The data reported in Table 1 are for the number of sites covered by single/ multiple-site ISO/TS-16949 certificates.

Table 1: Global Spread of ISO/TS-16949 Quality Management System Certification

A. Worldwide Total Certificates (Year-end figures)

	Year	2004	2007	2008	2009	2010	2011
→	**Total Certificates No.**	10019	35198	39320	41240	43946	47512
→	**No. of Countries**	62	81	81	83	84	86

B. Top 10 Countries: Year 2011

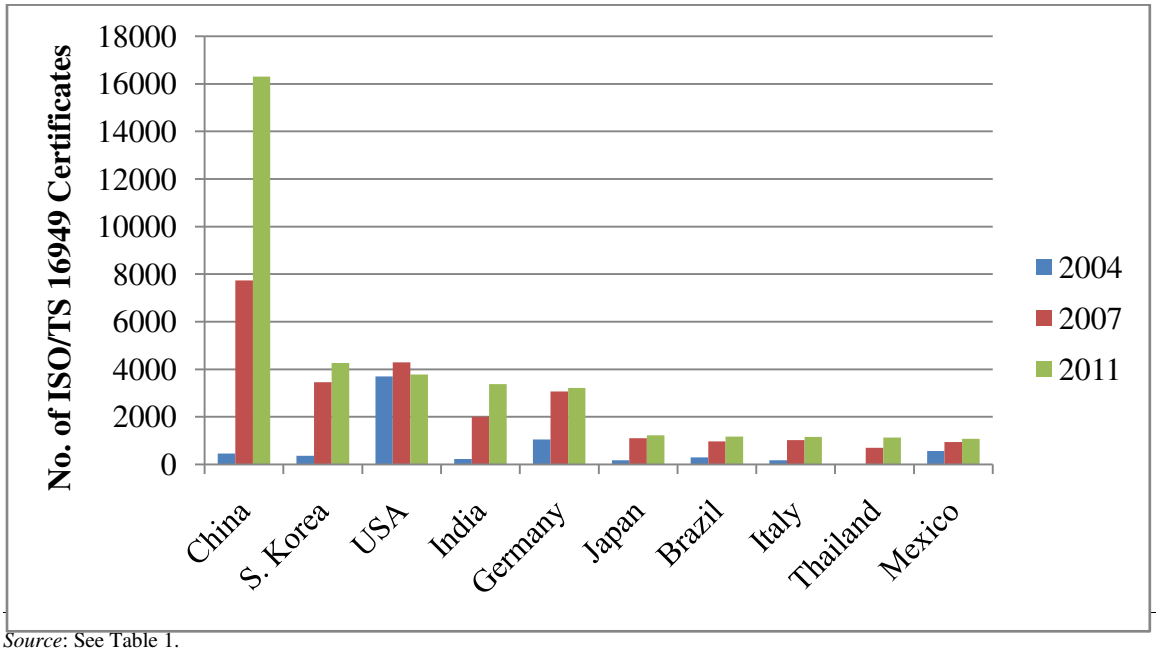
Rank in 2011 & Country	**Total No. of Certificates 2004**	**2007**	**2011**	**2012: Cars & CVs Produced (thousands)**	**2011: Increase in Certificates Rank & Country**	**No.**
1. China	459	7732	16310	19272	1. China	2110
2. S. Korea	366	3453	4262	4558	2. India	397
3. USA	3693	4288	3778	10329	3. S. Korea	248
4. India	225	2008	3376	4145	4. Iran	125
5. Germany	1043	3068	3210	5649	5. Taipei, Ch.	95
6. Japan	169	1106	1223	9943	6. Thailand	79
7. Brazil	299	972	1172	3343	7. Mexico	64
8. Italy	173	1024	1155	672	8. USA	51
9. Thailand	18	694	1125	2483	9. Turkey	48
10. Mexico	566	947	1073	3002	10. Italy	37
'Top 10' Total			**36684**	**63395**	**Sub-Total (1-10)**	**3254**
World Total			**47512**	**84141**	**World Total**	**3566**

C. Region-wise Certificates

Region	**2004 No.**	**2007 No.**	**2011 No.**	**2011 Global Share (%)**	**2011 Increase in No.**
Africa	144	415	472	1.0	25
Central / S. America	394	1383	1575	3.3	44
North America	4517	5929	5334	11.2	117
Europe	3212	10159	10891	22.9	267
East Asia and Pacific	1479	14569	24968	52.6	2590
Central and S. Asia	226	2016	3388	7.1	397
Middle East	47	727	884	1.9	126
Total	**10019**	**35198**	**47512**	**100.0**	**3566**

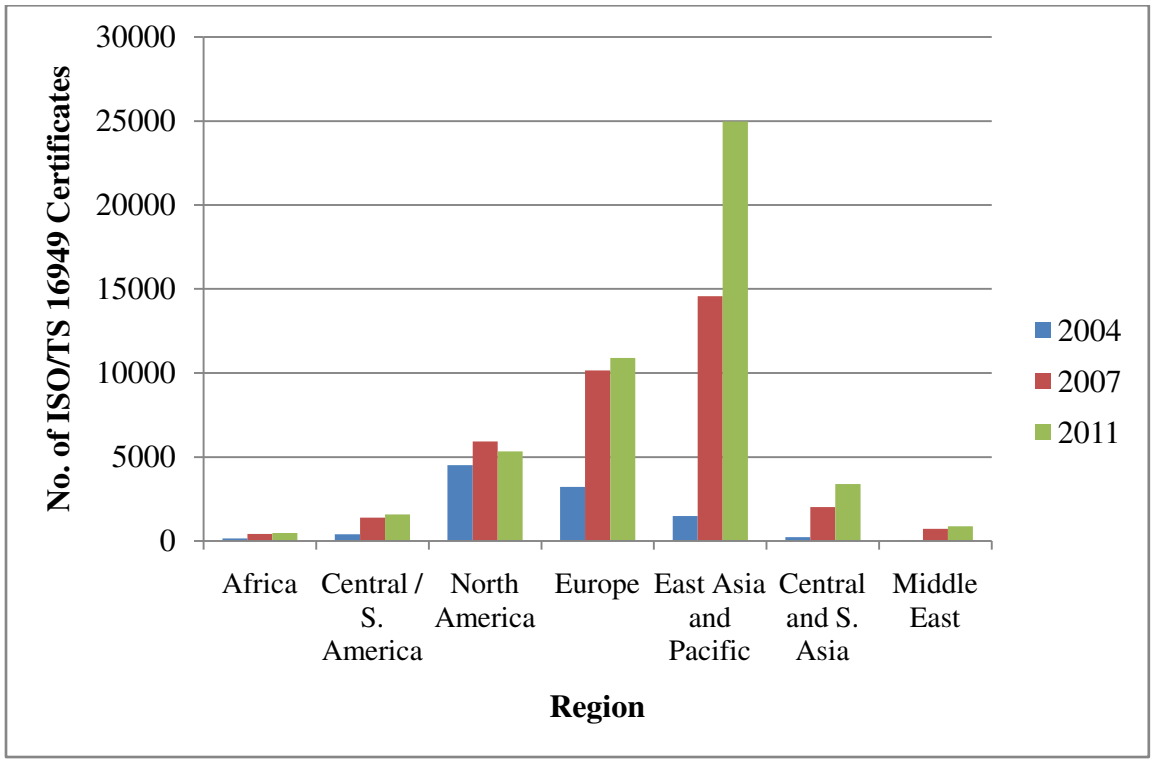
Sources: The data on certificates are from ISO (2012); these data have been provided to the ISO by the International Automotive Task Force. The data on cars and commercial vehicles (CVs) production units are from the OICA website (www.oica.net, accessed September 1, 2013).

Figure 2: Top 10 Nations in terms of No. of ISO/TS-16949 Certificates (Year 2011)



Source: See Table 1.

Figure 3: Region-wise Spread of ISO/TS-16949 Certificates



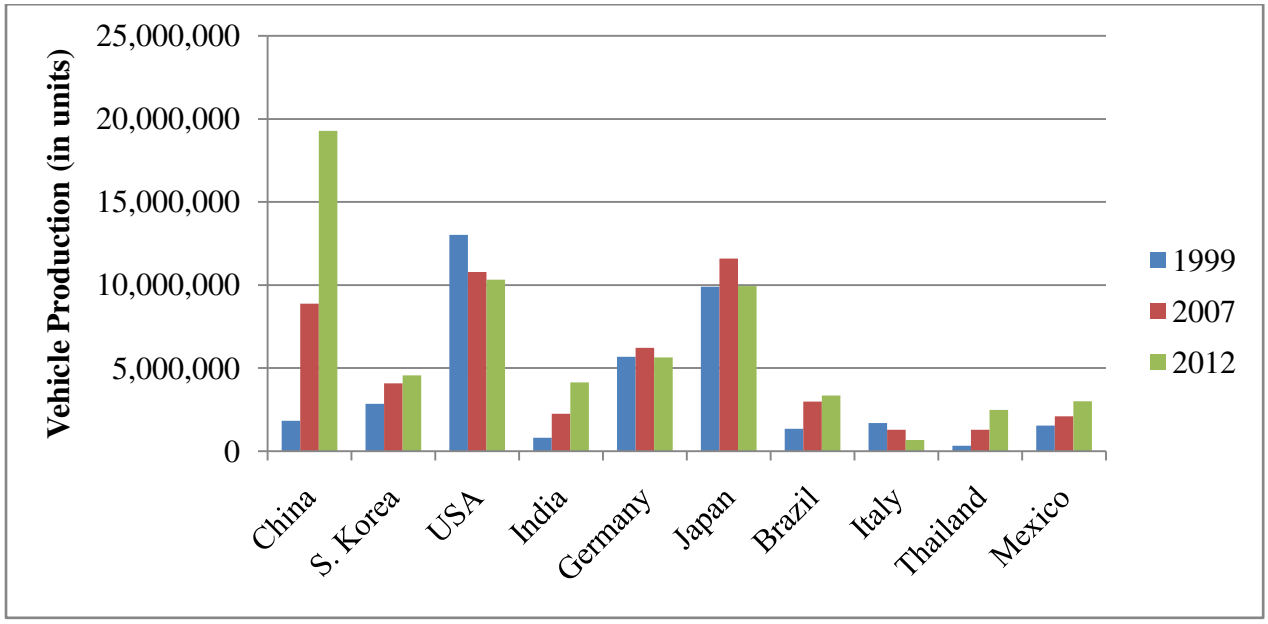
Source: See Table 1.

Table 2: Vehicle Production in Top 10 ISO/TS-16949 Certificate Nations (Year 2011)

Country	ISO/TS-16949 Certificates: 2011 Global Share (%)	Cars & Commercial Vehicles Production					
		No. (thousands)					2012 Global Share(%)
		1999	2004	2007	2011	2012	
China	34.33	1830	5234	8882	18419	19272	22.90
S. Korea	8.97	2843	3469	4086	4657	4558	5.42
USA	7.95	13025	11989	10781	8662	10329	12.28
India	7.11	818	1511	2254	3927	4145	4.93
Germany	6.76	5688	5570	6213	6147	5649	6.71
Japan	2.57	9895	10512	11596	8399	9943	11.82
Brazil	2.47	1351	2317	2977	3408	3343	3.97
Italy	2.43	1701	1142	1284	790	672	0.80
Thailand	2.37	323	928	1287	1458	2483	2.95
Mexico	2.26	1550	1577	2095	2681	3002	3.57
Total 10 Nations	77.21	39024	44250	51457	58548	63395	75.34
Total World	100.00	56259	64496	73266	79880	84141	100.00

Sources: Complied from ISO (2012) and www.oica.net, accessed September 1, 2013.

Figure 4: Cars & CVs Production in Top 10 ISO/TS-16949 Certificate Nations (Year 2011)



Source: See Table 2.

moved from the 6th to 2nd position and India from the 11th to 4th rank. The number of ISO/TS-16949 certificates in India reached 15-times over this period, while in China even higher, being 35 times. In the USA during 2007 to 2011 the number of certificates declined absolutely by 12%.

ISO/TS-16949 Inter-Regional Diffusion: In terms of the region-wise data North America and Europe together accounted for slightly over 3/4th of the ISO/TS-16949 certifications worldwide at the end of 2004 (Table 1, Part C, and Figure 3). During 2004 to 2011 the global share of certificates has fallen for Europe. For North America, the decline is steeper; the number of certificates in 2011 is lower by 10% than in 2007.

During 2004 to 2007 while the number of certificates increased even in North America (also in the USA), the other regions witnessed a noteworthy proportional increase. Even during 2007 to 2011 there is a sizeable growth in the number of certificates in the East Asia & Pacific and Central & South Asian regions, mainly due to the expansion in China and India respectively. This is understandable as India and several countries in the East Asia & Pacific, including China, have gained as low cost suppliers for auto components, apart from having a relatively buoyant domestic automobile industry. Over half of the ISO/TS-16949 certificates in 2011 in Africa, Central/ South America and Middle East have been issued only in one country each, namely South Africa (272 of 472), Brazil (1172 of 1575) and Iran (849 of 884).

In the 2000s the global restructuring of location of automobile production and that of foreign outsourcing of auto components seem to have been accompanied by corresponding changes in the inter-national and inter-regional spread of ISO/TS-16949 certification, as seen here. The number of certificates for a region or an economy can fall due to non-renewal of some existing certificates, when due. The observed decrease in the ISO/TS-16049 certificates for North America (USA) in 2008, 2009 and 2010 and little variations for Europe may be partly due to the global recession. More important, the relatively increasing competitiveness of automotive producers from some other regions appears to be the main causal factor.[7]

[7] According to Stanford (2010), during 2004 to 2009 in the US the vehicle sales fell dramatically while the ratio of net imports to domestic sales increased to above one-third; North American vehicle producers' share of total vehicle sales in North America dropped from 55% to 43%. Their losing regional and global competitiveness is primarily due

4.2 Relationship with Automotive Production: A Closer Look

We relate the number of ISO/TS-16949 certificates in a country and the number of vehicles (cars and CVs) manufactured (OICA data), *a la* Franceschini et al. (2011). They depict graphically the relationship between these certificates and vehicles produced for 39 countries in 2008. We consider the end-2011 (i.e. 2012-beginning) certificates data for the top 10 certificate No. countries only. For these nations, the simple correlation, r, with vehicles manufactured domestically in 2012 is +0.8542 (+0.8916 for 2011 vehicles data) and highly significant. These 10 countries – including 9 of the top 10 vehicle producers in 2012, excluding the 10th rank, Canada – account for 77.21% world share of ISO/TS-16949 certificates in 2011 and for 75.34% vehicles production in 2012 (73.29% in 2011). Thus at present the number of ISO/TS-16949 certifications in a country appears to be quite closely associated with the quantity of ≥4-wheeler CVs and cars manufactured there.

Other Factors: Though we do not have the requisite comparable data across countries, we mention a few additional variables pertinent to these certifications in a nation:

- *Production of two/three-wheelers and their components*: The OICA data exclude the vehicle segments two-wheelers and three-wheelers – extensively used modes of personal and commercial transport in developing/ emerging economies and predominantly produced there. Barring high-end motorcycles, these are highly price competitive segments. As of now, the concern for quality is relatively high in the ≥4-wheeler segments. However, the producers and buyers of two/ three-wheelers are becoming increasingly quality conscious.
- *Extent of OEM/ Tier-1Level trade in auto* components: Foreign outsourcing of direct OEM/ Tier-1 Level supplies used in domestic production and the auto component exports to OEMs/ Tier-1 firms may have potentially negative and positive partial influences on ISO/TS-16949 certifications in the country. Foreign investors may continue to source critical components from their own home countries/ erstwhile preferred third-country suppliers.

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to the perception of their less innovativeness and appeal in technical and design features, further reinforced by the impact of consequent declining profitability on research and innovation.

- *Nationality-associated patterns*: For example, comparatively speaking, Japanese automotive majors are known to rely far more on an intensive second-party (customer) assessment of quality management system of the potential suppliers; German firms are generally more stringent about the formal technical specifications.
- *Recent growth of automotive production and exports*: This is due to this certification acting as a quality signal and increasing the operational efficiency. Again, these low/ negative growth rates may be followed by non-renewal of some existing certificates.

Likely Future Trends: Fitting a logistic growth curve to the 2002–2008 data on the number of ISO/TS-16949 certifications worldwide - like modeling the future diffusion of new technology based on the past trend - Franceschini et al. (2011) predicted that the total number of these certificates would reach saturation soon, settling at about 43 thousand in 2012. However, as argued below, we do not expect any tapering off in near future.

Impressionistic evidence indicates the existence of a large number of direct and indirect suppliers exclusively for two/ three-wheeler vehicles production and repair. Considering only the ≥4-wheeler vehicle segments, Franceschini et al. (2011) estimate the number of direct and indirect automotive supplier '*firms*' globally to be about 250 thousand. Currently (Dec.-end 2011) the ISO/TS-16949 certified total '*plants*' are less than $1/5^{th}$ this number. We believe that henceforth there would be more extensive ISO/TS-16949 certification, especially by Tier-2 component producer-suppliers to car and CV manufacturers, and by two/ three-wheeler vehicle firms and their Tier-1 component producer-suppliers than at present.

Again, the global restructuring of automotive production can affect the average size of automotive plants. The QMS certification is plant-specific. For auto components the low cost supplier countries, like India, having expertise at low levels of automation, may have relatively small capacity plants. Besides, there may be major technological changes and their wide dissemination globally – e.g. the shift to alternative fuels. Also there is a likelihood of more extensive worldwide participation in the 1958 and 1998 Agreements dealing with the adoption and development of harmonized Global Technical Regulations, GTRs for vehicles & components, bearing on the vehicle safety, fuel efficiency and emissions (see Singh 2010b).

These factors and the government support to ISO/TS-16949 certification can accelerate the overall growth of this certification in future and affect its inter-national spread.[8]

5. Indian Automotive Industry Growth in Recent Years

Here we present important facets of development of the Indian automotive industry having a bearing on the ISO/TS-16949 certification in India. Since 2001 this industry has undergone much dynamism – reflected in an 'explosion' in variety of vehicle models and features, and a rise in the degree of internationalization as trade in goods and technology, and equity flows.[9] This industry enjoys 100% FDI being permitted on an automatic basis. New auto clusters have emerged, e.g. at Sanand (Gujarat), having OEMs and their major auto component producer-suppliers plants in close proximity.

The Indian automotive industry has grown quite fast during the recent past, as is evident from Tables 3-4 complied from the industry associations Automotive Component Manufacturers Association of India, ACMA and Society of Indian Automobile Manufacturers, SIAM websites. During April-March 2007-08 to 2012-13, the annual average growth rate of auto component industry turnover was 7.86% in dollar terms and 14.61% in rupee terms. The exports grew by an average 16.60% per annum. The import intensity has been quite high. The growth prospects for total turnover and exports seem optimistic, as seen from the 2020-21 estimates (Table 3). Further in recent years some Indian auto component firms have initiated or intensified diversification in auto-adjacent sectors like aerospace, railways, construction equipment, etc.

About 3/5th of India's auto component exports in 2012 had Europe and North America destinations – 36% plus 24% (ACMA 2013a, p. 81). The ratio of OEM and Tier-1 Level of exports to total exports of auto components from India[10] seems to be rising. Many foreign

[8] The 'public vs. private transport' policies would influence indirectly via the growth and pattern of road transport, as any discouragement to private transport may adversely affect the demand for automobiles.
[9] See e.g. Pradhan and Singh (2009).
[10] The ACMA guesstimate for its member-firms is 80% (ACMA, 2013b, p. 12). For the entire industry including small firms, the ratio is likely to be lower (Singh 2010b).

Table 3: Indian Auto Component Industry – Growth in Recent Years

	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	*2020-21 Estimate*	Growth Rate p.a. 2007-08 to 2012-13 (%)
Turnover (Rs. bn)	1093	1106	1386	1883	2047	2161		*14.61*
Turnover ($ bn)	27.2	24.1	30.8	41.3	42.2	39.7	*115.0*	*7.86*
Exports ($ bn)	4.5	5.1	4.2	6.6	8.8	9.7	*30.0*	*16.60*
As % of Turnover	16.54	21.16	13.64	15.98	20.85	24.43	*26.09*	
Imports ($ bn)	7.1	8.2	8.0	10.9	13.8	13.7	*35.0*	*14.05*
As % of Turnover	26.10	34.02	25.97	26.39	32.70	34.51	*30.43*	

Source: Compiled from ACMA (2013a, p. 81; 2013b, pp. 11-12, 14-15). The 2020-21 estimates, quoted in ACMA (2013b), are as per 'The Vision 2020 Document', prepared by ACMA and Ernst & Young, August 2010.

Table 4: Indian Automobile Industry: Production and Export Trends

Segment	No. of Vehicles (thousands)								Growth Rate (%) (2004-05 to 2011-12)
	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	
Automobile Production									
Passenger Vehicles	1210	1309	1545	1778	1839	2357	2983	3124	14.51
Commercial Vehicles	354	391	520	549	417	568	761	912	14.48
Three Wheelers	374	434	556	501	497	619	800	878	12.94
Two Wheelers	6530	7609	8467	8027	8420	10513	13349	15454	13.10
Grand Total	**8468**	**9744**	**11088**	**10854**	**11172**	**14057**	**17892**	**20366**	**13.36**
Automobile Exports									
Passenger Vehicles	166	176	198	218	336	446	444	507	17.26
Commercial Vehicles	30	41	50	59	43	45	74	93	17.52
Three Wheelers	67	77	144	141	148	173	270	363	27.35
Two Wheelers	366	513	620	820	1,004	1,140	1532	1947	26.95
Grand Total	**630**	**806**	**1012**	**1238**	**1531**	**1804**	**2320**	**2910**	**24.45**

Source: Compiled from the industry association Society of Indian Automobile Manufacturers, SIAM website www.siamindia.com, accessed on April 12, 2011 and September 8, 2013.

automotive OEMs and Tier-1 firms have established international purchasing offices in India for their regional/ global procurement of components[11] – over 30 IPO offices (ACMA 2013b, p. 13).

In India the two/ three-wheeler vehicle segments are quite big (see Table 4) – in 2010-11 accounting for about 22% of gross turnover of vehicles, excluding engines (SIAM 2012). During 2004-05 to 2011-12 the average annual rate of growth of domestic production in each vehicle segment has been high, while the respective exports growth rate has been even higher (Table 4). These growth rates for passenger cars and commercial vehicles together are 14.50% and 17.30%, while 13.09% and 27.01% for two/ three-wheelers segments overall.[12] During this period the overall vehicle export intensity (ratio to production volume) has gone up from 7.43% to 14.29% - for 4-wheelers from 12.56% to 14.87%, and for 2/3-wheelers notably from 6.27% to 14.15%. At present, vehicle exports from India are mainly to developing/ emerging nations.[13]

In recent years India's rapid average growth rate of cars and commercial vehicles production, though not as spectacular as China's, has considerably improved its global share of output of these vehicles: from 1.45% in 1999 to 4.93% in 2012, moving up from 15th to 6th world rank (OICA data; see Table 2). There is a faster trajectory for cars production alone, by advancing from 1.34% to 5.21% global share, and from 16th to 6th rank over the same period.

Till the recent past globally the motorcycles sub-segment and ≥4-wheeler vehicle segments have been marked by the dominance of Western MNEs. Remarkably during 2011-12 India exported 0.60 million (≥4-wheeler) passenger and commercial vehicles (Table 4) – including automobiles produced by India-based vehicle MNEs like Tata Motors and Mahindra & Mahindra. The fact that a majority of large and medium-large Indian auto component producers are ISO/TS-16949 certified (Section 6), influences the 'quality image' of vehicles manufactured in India, particularly for export sales.

[11] IBEF (2010) estimates about $20-25 billion auto component production outsourcing to India by 2015; also India's share in global auto components market is expected to rise from 0.9% in 2008-09 to 2.5% in 2015.
[12] However, the financial year 2012-13 has been marked by overall near-stagnancy, with production growth of 1.20% for all vehicles and the exports having negative growth (-1.34%). Source: News>View>Auto Industry End the Year Almost Stagnating, dated April 10, 2013 (www.siamindia.com).
[13] Source: Ministry of Commerce Imports and Exports Database, Government of India.

6. Quality Management Standards in the Indian Automotive Sector

In India subsequent to the 1991 liberalization, auto component producers have increasingly realized the importance of quality (Balakrishnan et al. 2007), probably keeping it the foremost in the priority list (Singh 2007). The major factors motivating them to lay emphasis on quality improvement – also through an advanced QMS Standard certification – include:

- high growth rates of the automotive sector (both vehicle and component segments) domestic sales and exports, along with the optimistic forecasts;
- increasing quality-consciousness among the domestic vehicle buyers;
- a majority of auto component exports from India having developed country destinations;
- a high ratio of Indian auto component exports being sold to OEMs or Tier-1 firms.

The data presented earlier in Table 1 indicate a fairly extensive adoption of ISO/TS-16949 Standard in the Indian automotive sector, having 3376 certificates in December-end 2011, implying 7.11% of global share. These data are sourced by ISO from the International Automotive Task Force which compiles the information from the contracted ISO/TS-16949 Certifying Bodies; the ISO reports the country-wise total number only. These comprehensive data cover vehicle plants, and also plants producing auto components or certain auto-related services, whether as primary or non-primary activity of the firm. Multi automotive plant firms may acquire as many ISO/TS-16949 certifications as their automotive manufacturing sites. We examine next the QMS certification data collected by auto component and automobile industry associations in India, namely ACMA and SIAM, for their respective members.[14] These data provide additional insights.

Auto Component Firms: ACMA collects the data on QMS and other Standards by asking which accredits the Member firm (i.e. any of its plants) has. The ACMA membership is voluntary, involving an annual payment. It excludes the unorganized sector (<10 employees) units and primarily non-automotive producers. Among primarily auto component manufacturers in India, the ACMA member-firms include a large proportion of big producers as well as many SMEs, though under-representing the industry SMEs, specially the small firms.[15]

[14] We may mention that in India the National Accreditation Board for Certification Bodies (NABCB) is a member of Quality Management System Multi-Lateral Arrangement of Pacific Asia Cooperation (PAC) and International Accreditation Forum (IAF); thus the QMS certificates issued by the NABCB accredited bodies are recognized globally among the member countries of PAC and IAF.

[15] According to IBEF (2010) there are about 6,400 total auto component producers in India (p. 5).

Table 5: Indian Auto Component Producers and Quality Standards

ACMA Members (No. of Firms = 691)	
	No. of Firms[a] having
QMS Standards:	
ISO/TS 16949	467
ISO 9001	576
Other Standards:	
ISO 14001	208
OHSAS 18001	105
Quality/ Productivity International Awards:	
JIPM	3
Deming Award	12
TPM Award	15
Japan Quality Medal	2
Shingo Silver Medallion	1

Source: ACMA (2013a, p. 83; 2013b, p. 20).
Note: [a] The information here is limited to the industry association ACMA members.

Table 5 indicates the current status of QMS certifications among the ACMA members. Along with the ISO/TS-16949 QMS, the ISO-9000 Standard is quite prevalent. A multi-plant firm may not have the same QMS Standard for all its plants. At present 68% of (467 of 691) ACMA members have the ISO/TS-16949 certification.[16] This is indeed remarkable. Yet there is scope for further diffusion of this Standard. At the same time since the smaller firms in the Indian auto component industry lag behind in terms of the adoption of this international quality management system Standard (Singh 2010a), both the government and the industry association ACMA need to focus on increasing its spread among SMEs.

The Indian automotive industry has the largest number of Deming Prize Award winning companies outside Japan. Approximately 30% and 15% ACMA members-firms are certified respectively for environmental management Standard ISO-14001 and 'Occupational Health and Safety Assessment Series' management system OHSAS-18001 (Table 5).

[16] As per ACMA's 2006 publication '*Buyer's Guide*', in 2005 about half of ACMA-members then had this certification.

Automobile Firms: SIAM (2012) provides company and plant-wise information on the status of management Standards adopted by SIAM members. It indicates a significant proportion of car and commercial vehicle plants in operation in India being ISO/TS-16949 certified. In the 4-wheeler segments this certification propensity, on the whole, seems greater among the Indian-owned firms vs. wholly foreign-owned units. The producers of only two/three-wheelers are generally managing with the ISO-9000 QMS Standard only. A major exception is TVS Motor Company Ltd – part of a large automotive Group in India, TVS Group – producing two-wheelers and three-wheelers, having ISO/TS-16949 certification for all three manufacturing plants in India; it has also a plant in Karawang, Indonesia.

As for the India-based vehicle MNEs producing cars, trucks and buses, there is a high incidence of ISO/TS-16949 QMS among them (SIAM 2012; company websites and other internet sources). According to Tata Motors (2010), as on 30th September 2010, of its five principal automotive manufacturing facilities in India, the Jamshedpur, Pune and Lucknow manufacturing facilities are ISO/TS-16949 accredited; the Pantnagar (Uttarakhand) and Sanand, Ahmedabad (Gujarat) plants are relatively new, having commenced operations in Fiscal 2008 and June 2010 only (p. 36). As per SIAM (2012), the Ahmedabad plant received ISO/TS-16949:2009 certification in 2011. Tata Motors consistently gives preference to ISO/TS-16949 certified auto component vendors. For its Jaguar Land Rover, U.K. manufacturing operations the vendors must be ISO/TS-16949 and ISO-14001 certified (Tata Motors 2010, p. 17). Tata Motors' vehicle subsidiary Tata Daewoo, South Korea obtained ISO/TS-16949 certification in 2007. Tata Motors is a major company of the Tata Group. Mahindra & Mahindra - part of the Mahindra Group - has 6 manufacturing plants in India and all the plants are certified for ISO/TS-16949 and ISO-14001 Standards[17]; the Nasik (Maharashtra) vehicle plant got this certification initially in 2003.

Another major producer of CVs in India, namely Ashok Leyland – the flagship company of Hinduja Group, a UK-based and India-originated transnational conglomerate - became the first Indian auto company in 2006 to receive the ISO/TS-16949 corporate certification – for all its six

[17] PRNewswire-USNewswire, 'Mahindra Joins International Automotive Trade Association', Feb. 3, 2013.

manufacturing units across the country.[18] Many Indian auto component and related products units of these Business Groups are ISO/TS-16949 accredited.

In passing a few remarks are in order. In the automotive sector the environmental/ emission and safety regulations have become quite rigorous, and so in turn the quality parameters in vehicle manufacturing and automotive supply chain. The environmental regulations in India are based on existing international regulations like WP.29, *albeit* less stringent[19], and are catching up fast. From Euro I emission norms introduced in 2000 India has now advanced to Euro IV and Bharat Stage IV norms in 2010. The Ministry of Shipping, Road Transport & Highways has been widening the list of critical automotive components requiring the 'conformity of production' certification from a specified agency, namely ARAI, Pune or iCAT, Manesar. India is planning to introduce law for vehicle recall in case of a major technical/ manufacturing defect.[20] In February 2011 ACMA along with Ernst & Young brought out a White Paper on 'Legislative Improvements to Combat Counterfeit Auto Components' in India. It highlights the extent and consequences of counterfeiting in the automotive components aftermarket and makes concrete suggestions for urgent government intervention. All these policy initiatives are likely to influence the quality management practices and (formal) systems adopted by producers.

7. Conclusions and Policy Suggestions

The above analysis points to a rapid worldwide spread of the ISO/TS-16949 quality management system (QMS) Standard in the 2000s. It is an 'ISO-9000 plus' QMS Standard developed specifically for the automotive industry by the International Automotive Task Force. As a quality signal/ differentiator, in the automotive sector the ISO/TS-16949 Standard is considered far superior to simple ISO-9000. Being ISO/TS-16949 certified facilitates moving up the supply chain.

[18] According to internet sources, under corporate site certification, each site receives a separate certificate, with a common Certification Body certificate number plus letter suffix e.g. 115A, 115B, 115C, etc.; if a single corporate site loses its certificate based upon the performance issues, then all the related corporate sites also lose their certification.
[19] ACMA (2010), '*ACT now*', August, p. 6, Automotive Component Manufacturers Association of India, Delhi.
[20] *Hindustan Times*, September 22, 2011, p. 19.

The patterns of regional and national concentration of ISO/TS-16949 certificates seem to be closely related to the world-wide location of automotive production and its dynamics in this century. There has been a major global restructuring of the geography of automotive production since the close of the 20th century. At present (December-end 2011) the 'top ten ISO/TS-16949 certificate No.' nations hold 3/4th of these certificates worldwide, and have a similar global share of cars & commercial vehicles produced. These country-level data indicate currently a high correlation between the ISO/TS-16949 certificates and ≥4-wheeler vehicle production volume. In near future the ISO/TS-16949 QMS is likely to spread more extensively (than at present) among Tier-2 auto component suppliers for cars & commercial vehicles, especially among participants in global OEMs' supply chains. Emerging automotive markets are also likely to undergo an increased diffusion of this Standard in the two/three-wheeler vehicle segments and their components manufacturing. We suggest a number of factors potentially relevant to any study modeling the inter-national diffusion of ISO/TS-16949 QMS in future (Section 4.2).

In India many large and medium-sized auto component producers, as well as car & commercial vehicle manufacturers have adopted the ISO/TS-16949 Standard which, we believe, has contributed to their global competitiveness. However, if we look at the entire automotive sector in India, there is much scope for further spread of the ISO/TS-16949 certification. A significant proportion of auto component SMEs in India are still without any QMS certification, like even the basic generic Standard ISO-9000. China is far ahead of India in adopting the ISO/TS-16949 Standard (also ISO-9000), and, of course, in terms of total automotive production as well.

There are all-industry government schemes in India to promote ISO-9001 and ISO-14001 under which the QMS Standard certification expenses are reimbursed up to a specified small limit. An enhanced QMS-reimbursement amount for the ISO/TS-16949 certification (as compared to ISO-9001 or ISO-14001) shall be desirable. Given the importance of the automotive sector in India and its strong growth potential, we suggest that the government should set up a separate Centre or Fund to encourage the adoption of the ISO/TS-16949 Standard. This Centre/ Fund should motivate the non-certified auto component SMEs to acquire the ISO/TS-16949 certification, and provide the preparatory guidance and financial assistance for the same. To start with, the focus can be on Tier-2 producers, especially exporters.

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