How does Japanese "Kaizen Activities" Collaborate with "Jugaad Innovation"?

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***Abstract*--Japanese "Kaizen activities" with the power of skilled workers at actual work sites are considered to be "Japanese style grass-roots innovation (Js-GRI)". Js-GRI comes into existence from collaboration with R&D division. Moreover, "Karakuri technology" and MOT techniques (like IE,QC,VE and so on) sophisticate Js-GRI. In particular, "Karakuri technology" has been considered the backbone of Js-GRI. In the second half, bandwagon effects between Js-GRI and "Jugaad innovation" will be discussed from the aspects of Js-GRI. "Jugaad" is a colloquial Hindi word that means an innovative solution. More specifically,"Jugaad" innovation is creative solutions like the unique products rising out of the necessity of the local communities in India. Therefore,"Jugaad innovation" is the same in meaning of "Indian style grass-roots innovation". Moreover, the features regarding "Jugaad innovation" are seen not only in India but also other developing countries like China, Brazil and so on. Given this situation, the study treats "Jugaad innovation" as "Developing countries' GRI (Dc-GRI). Through the field studies and questionnaire surveys, it might be provided the fact that Js-GRI is helpful for improving Dc-GRI's value" from the results of these studies.**

Finally, further analyses of the surveys will show clearly the challenges for facilitating the collaboration between Js-GRI and Dc-GRI.

I. INTRODUCTION

One of the advantages of the Japanese manufacturing technologies ("*monozukuri gizyutsu*" in Japanese) lies in an exquisite balance between "the strength of cutting-edge technologies, or development and application capabilities of new technologies" and "that of MOT techniques, or problem-solving capabilities based on IE, QC, VE, etc." The former is directly linked with Radical innovation (Ra-I), while the latter is generally discussed in line with the Kaizen activities backed by "*Genba-ryoku*" (the capabilities of workers at actual work sites). Kaizen activities have come to be regarded as a type of "innovations with bottom-up approach" in recent years, and sometimes referred to as "Grass-roots innovation (GRI)"[5].

In this paper, therefore, the Kaizen activities are termed the Japanese-style grass-roots innovation (Js-GRI) based on the fact that they are GRI supported by the "*Genba-ryoku"* of the Japanese enterprises. In India, the unique products and services created out of the necessity of actual sites of the local communities are recognized as "Jugaad innovation" [20]. These kinds of innovations, which are, needless to say, based on a bottom-up approach, have been found in many numbers in other emerging countries as well [20]. When discussing the Jugaad innovations in emerging countries extended outside India, they are referred to as developing countries' GRI (Dc-GRI) in this paper.

Based on the above-mentioned background, the possibility of collaboration between Js-GRI and Dc-GRI emerging in the developing countries including India is discussed in this paper, by showing the results of a series of field studies conducted in manufacturing activities in India, the birthplace of Jugaad innovation.

II. TRANSITION AND CHARACTERISTICS OF JAPANESE MANUFACTURING APPROACH

The characteristic know-hows of materializing the meticulous analog mechanisms in products, which have been seen in the *karakuri* mechanical dolls since the early *Edo* period (in the 17th century), are associated with the Japanese manufacturing practices of today as the *karakuri* technology [16]. And, Japan Institute of Plant Maintenance (JIPM) has been organizing "Exhibition of *Karakuri* Contraption & Improvement" since 1993[4, 13], viewing the *karakuri* technology as a backbone underlying the present Japanese manufacturing expertise. The *karakuri* is the mechanism which is activated by springs, gears, and other analog mechanisms. Specifically, it ingeniously utilizes the law of gravity, the principles of the lever, the spring, the cam, the pulley, and so on. What lies behind are "simple," "hand-made," and "low cost." [13] These three key words are applicable in today's environmental design, and are highly relevant to "frugal innovation" [28] which has come to be seen and heard in academic conferences in the field of innovation management. Moreover, it has come to be known that they have influenced significantly to today's robotics technology, which is one of the leading cutting-edge industries of Japan [15, 25].

Since the Meiji era (around the 1870's onward) in Japan, aside from the traditional craftsmanship, the then advanced technologies have been widely introduced from the West. By mastering them, "Mitsubishi Zero Fighter Aircraft (in 1940)" and "Battleship Yamato (in 1941)" were developed. As was proven by such technical expertise (Ra-I in those days), the Japanese cutting-edge technological capabilities in heavy industries centering around the military were rapidly catching up with the level of the advanced western nations at that time [19, 26]. It is fair to say, therefore, that the Japanese-original way of manufacturing was created even before World War II to a considerable extent, by integrating the traditional (Japanese-style) technologies/skills and the then advanced technologies from the West. It is also true, however, that in some latest industrial sectors like aircraft industry, basic research and design work was highly emphasized, while much less attention was paid for production engineering and mass production engineering to deal with production in large

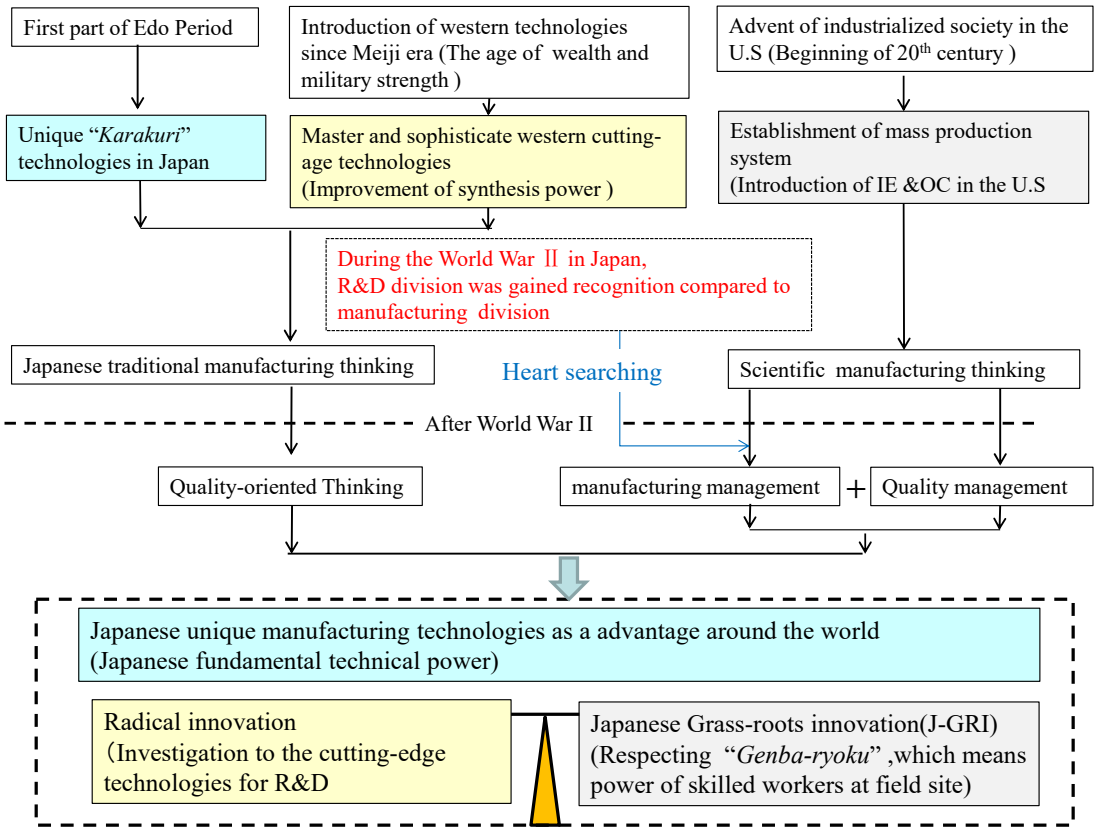

Fig. 1 Evolution process of "Japanese unique manufacturing approach"

quantities [23]. Due to the historical background, during the Second World War, the concept of quality control and production control, which stressed the necessity of controlling production processes scientifically, was not sufficiently recognized in the mass production of industrial products in Japan, excepting a few successful achievements [27, 29]. Considering the fact that this was the very time when scientific manufacturing thinking was rapidly introduced in the United States, the Japanese manufacturing, particularly in terms of approaching it from the management technology point of view, was still at the early stage of development.

After the Second World War, however, the Japanese original manufacturing approach today has been evolved by successfully unifying "the traditional Japanese way of thinking of manufacturing (the quality-oriented thinking as well as the comprehensive strength)" and "the scientific way of thinking of manufacturing (the concept of quality control)" suited to the industrialized society.

Fig. 1 illustrates the chronological summary of the process.

III. CHARACTERISTICS AND ISSUES OF DC-GRI

The symbolic example of Dc-GRI is Jugaad innovation originated in India. Jugaad is a Hindi word meaning "an innovative way of problem-solving" or "an improvised solution born from ingenuity and quick-witted cleverness" [20]. The Jugaad spirit, which can be found not only in India but also widely in other developing countries, has been seen in recent years [24]. It is a fact that, many of the commercialized cases among others received a help or cooperation of companies in the process. As was mentioned in Chapter I, however, in principle, Jugaad innovation means unique products and services created out of the necessity of actual sites of the local communities, meaning that it was mostly developed by the local people (with only low-level education generally) under the extremely restricted conditions (economically, technically, and organization-wise). There is a non-profit organization called "Honey Bee Network" (established in 1989) in India [9], its main founder and organizer is Professor Anil Gupta of Indian Institute of Management in Ahmedabad. For more than the last 25 years, this organization has been supporting the Indian Jugaad innovation, creating a network among the grass-roots innovators, and publishing newsletters periodically to disseminate their outcomes [8].

Some people say evenly locally, however, Jugaad innovation is different from Grass-roots innovation (GRI), due to the fact that so many cases of mere stopgap measures have been introduced as Jugaad innovations on the Web (particularly on YouTube) highlighting their aspects of temporary solutions (See Table1).

In order to avoid confusion of the study, this paper excludes such cases of makeshift measures and focuses only on the products and services which are basically successfully commercialized and available in the market, even only locally. Thus, Jugaad innovation can be included in Dc-GRI, as the subjects of this paper are only those which have been commercially marketed.

Based on this, the Jugaad innovation's six principles which are publicly known [20] are cited here as the typical characteristics of Jugaad innovation (and what is referred to as Dc-GRI in this paper). They are: Seek opportunity in adversity, Do more with less, Think and act flexibly, Keep it simple, Include the margin, and Follow your heart.

At the same time, as the key words to explain characteristics of "Kaizen in Kaizen activity," that is, Js-GRI, the following three are quoted from a part of definition of Kaizen prescribed by Japan H. R. Association [12]. They are: Choose/Change to better ways, Accumulate small changes, and Utilization of limited resource. These three key words, the six principles of Dc-GRI (or Jugaad innovation), and the features of *Karakuri* technology mentioned in Chapter II are illustrated below by analyzing their relationships (See Fig. 2).

From this chart, the main points to be discussed are the following three. First, "Kaizen in Kaizen activities" and *Karakuri* technology are closely associated with each other, which is easily understood from the historical background of Japanese manufacturing explained earlier. Secondly, the six principles of Dc-GRI (or Jugaad innovation) are also associated with *Karakuri* technology and "Kaizen in Kaizen activities" to a substantial extent. Particularly, "Simple" under *Karakuri* technology and "Keep it simple" mean identical, and the concept of "Do more with less" and "Seek opportunity in adversity" are very similar with "low cost," a feature of *Karakuri* technology, and "Utilization of limited resource" in Kaizen. In this way, Js-GRI and Dc-GRI are considered to be highly associated, by which a potential of their collaboration is indicated.

The third point to be noted is the difference between Js-GRI and Dc-GRI. One of the key aspects of Kaizen which is "Accumulate small changes" shows no or very little association with any of the six principles of Dc-GRI (See Fig.2). As mentioned earlier, the Jugaad approach basically provides a quick fix and has a strong impression of a one-time solution even in a commercialized case by "thinking and acting flexibly" and with little connotation of "accumulating small changes" of Kaizen. In fact, in interviews with the experts who are familiar with actual cases of GRI in India, they commented that the stable quality was hardly materialized even in successful commercialized cases of GRI as very few of them were supported by any formal sector (See Table1.). This means that, basically, the continuous Kaizen mind necessary for sustaining the stable quality is not infused in Dc-GRI.

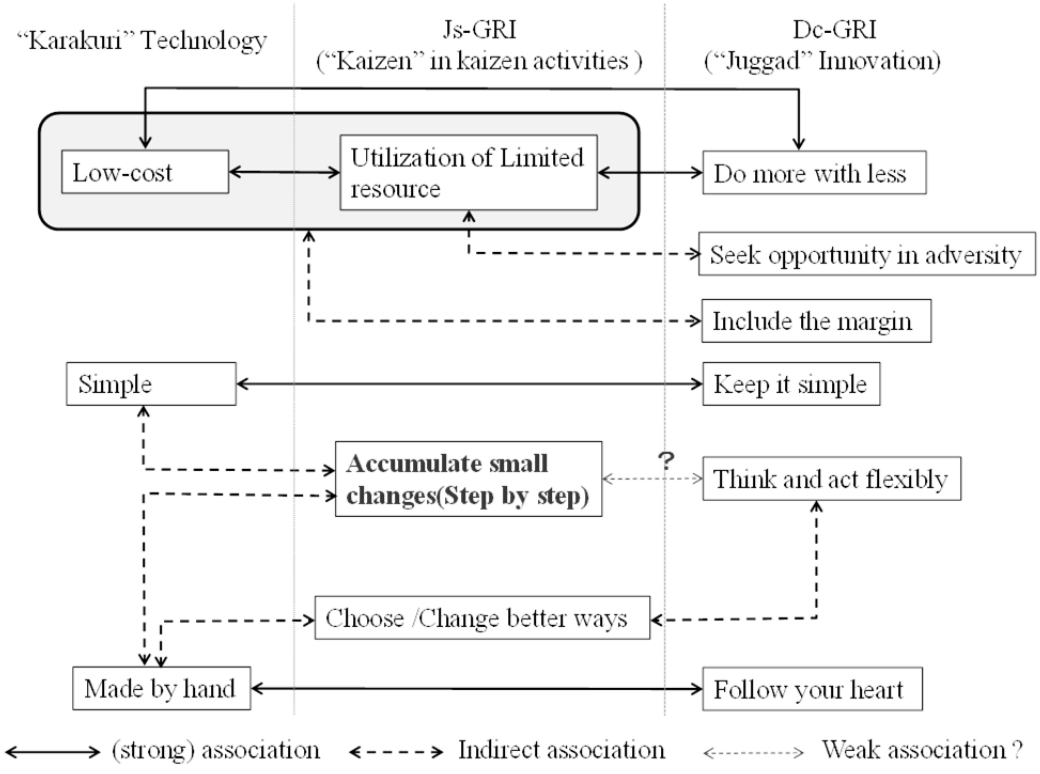

Fig. 2 Association chart showing the relationship between Js-GRI and Dc-GRI

TABLE 1. EXPERTS' VIEWS ABOUT JUGAAD AND GRASSROOTS INNOVATION

Interviewees	Organization	How about "Jugaad innovation" and "Grass-roots innovation"?
National Innovation Foundation-India (Ahmedabad) Scientist Mr. Mahesh Patel	**The National Innovation Foundation – India (NIF),** set up by the Department of Science and Technology, building upon the Honey Bee philosophy, has taken major initiatives to serve the knowledge-rich, economically poor people of the country. www.nif.org.in	Jugaad innovation basically is a alternative for temporary solutions by non-educated person and usually not supported by scientific or technical proofs. Grass-roots innovation is basically focusing on a alternative for sustainable solutions by one or a few people with reasonable educations(high-school) and supported by some knowledge based proofs. However, GRI are basically unstable quality because of unformal sectors.
National Institute of Design(NID) (Ahmedabad) Programme Officer Mr. Samir more and Director Mr. Prodyumna Vyas	NID's education is a combination of both design theory and practice, knowledge and skill. NID has Bachelor of Design and Master of Design www.nid.edu	Jugaad innovation is a kind of spark innovation and instant innovation. Therefore, although Jugaad innovation is just new ideas, sometimes might be harmful alternatives. In a single phase, after Jugaad innovation, become GRI.

On the contrary, Js-GRI (commonly referred to as Kaizen activities around the world) has been implemented as a corporate activity in principle, promoted the continuous improvement by putting into practice PDCA (Plan-Do-Check-Act) or SDCA (Standardize-Do-Check-Act), and nurtured the GR-innovators who believed in "Good processes bring good results." In other words, one of the most notable features of Kaizen is that big results come from many small changes accumulated over time [10]. Adding to that, Js-GRI is generally the activities of cross-functional teams in the organization, while Dc-GRI is basically the one conducted on individual basis in most cases. It is possible to infer, therefore, that many of Dc-GRI lack "*Genba-ryoku*," or the capabilities of skilled workers at actual work sites.

The points mentioned above suggest that, by aiming at the common goal of coming up with frugal products and services, if the organizational "*Genba-ryoku*" of Js-GRI can be transferred successfully to Dc-GRI, it is expected that the stable quality can be ensured in Dc-GRI as well. These ideas are summarized in Fig. 3.

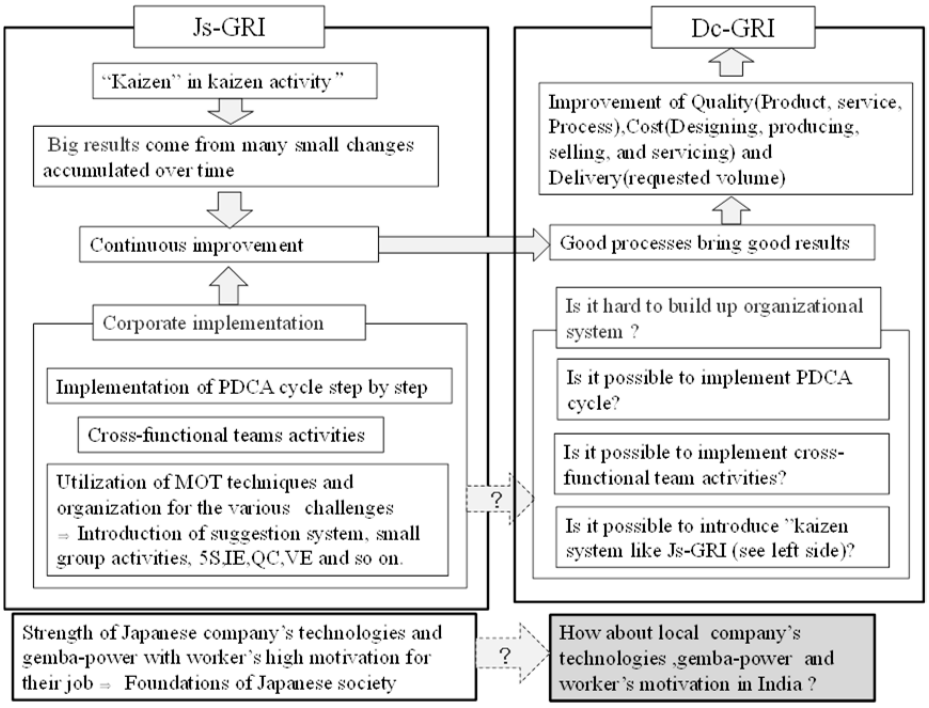

Fig.3 Conceptual diagram on the collaboration between Js-GRI and Dc-GRI in India

It must be noted here that, in Japan, in the course of implementing PDCA and SDCA steadily at workplaces, 5S activities, IE, QC, VE, and other management techniques have been introduced and put into practice, which have provided the Japanese enterprises and the society as a whole with the stable and long-term outcomes (such as high quality assurance, cost reduction and shorter lead time.) The core source of these achievements has been Kaizen activities, in other words, Js-GRI itself.

In particular, the Japanese-style 5S activities have served as the fundamental principles for accumulating small changes step by step. The 5-S practices specifically means First S-*seiri* (sort),Second S-*seiton*(set in place), Third S-*seiso* (shine),Fourth S-*seiketsu*(standardization) and Fifth S-*shitsuke*(sustain), and they are meant to be a self-sustaining, long-term improvement programme [21]. Moreover, through such 5S activities, based on cross-functional team, promoting the efficiency of manufacturing management, it is expected to improve companies' profit ratio and customer satisfaction [1]. Because of these factors, it is believed that one of the main challenges for the effective collaboration activities between Js-GRI (Kaizen activities) and Dc-GRI is how to introduce 5S and other skills of management in the developing countries including India and to enable development of their system to keep supplying uniform quality products.

In order to find out some clues for tackling this issue, a series of field studies were conducted in India on the cases of Js-GRI and Dc-GRI. The results of its analysis are discussed in the next chapter.

IV. QUESTIONNAIRE SURVEY ON THE CASES OF JS-GRI AND DC-GRI IN INDIA

A questionnaire survey of grass-root innovation was carried out to the participants of The 31st INVEST International Conference which was held in Bangalore on Nov. 20th, 2015. Its subject cases of Js-GRI were chosen from the typical examples of social infrastructure-related products/services, which were: "Case Example 1: Restroom in Tohoku Shinkansen (bullet train)," and "Case Example 2: Signboard of Tokaido Shinkansen (bullet train) on a platform of Shin-Yokohama Station." The reasons for focusing on these two cases are the fact that the Shinkansen is one of the most well-known social infrastructures for the foreign visitors to Japan, and that, judging from the types of the product/service, even the foreign respondents could easily understand how they are used. As for the subject cases of Dc-GRI in India, "Case Example 1: Non-electric clay refrigerator" [17] and "Case Example 2: Re-chargeable motorized tricycle" [18] were surveyed. The reason is that both of these cases have been widely introduced on the Web [2] and in some books [20, 24] as leading examples of GRI in India and relatively well-recognized by the people there.

At the time of each questionnaire survey, all the expected respondents received explanation on the "required functions" and "how to use it" of the respective case example by showing PPT slides (See Fig7, 11, 14 and 17) before the questionnaire sheet was distributed to them, although more simplified questions are shown on this paper.

1) The basic attributes of the respondents

Among the participants of the 31st INVEST International Conference, 32 persons cooperated and responded to the questionnaire. Those in their 30's to early 40's accounted for around 53% (=17/32), the largest age group, the rest of the age brackets, namely, those in their 20's, in late 40's to 50's, and 60's or older, accounted evenly for 15.6% (=5/32). This shows the respondents covered almost all the age groups in a relatively well-balanced manner. (See Fig.5)

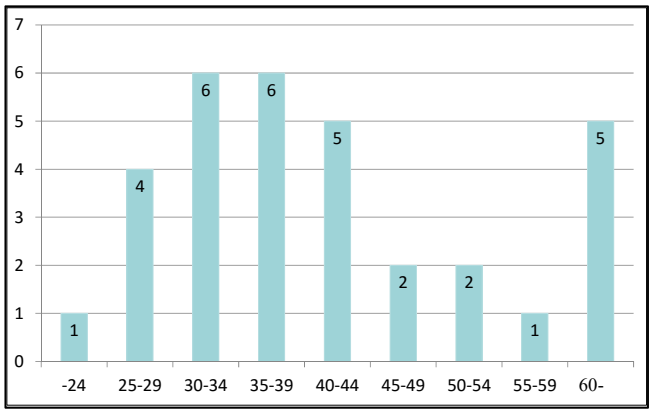

Fig.4 Age distribution about respondents at the survey

As all the respondents were the participants of the international conference, 87.5% (=28/32) of them were university graduates or with master degrees. With an additional Ph.D. holder, as high as nearly 90.6% (29/32) of the respondents had university or even higher educational background. In other words, this survey eventually focused mostly on the highly educated respondents.

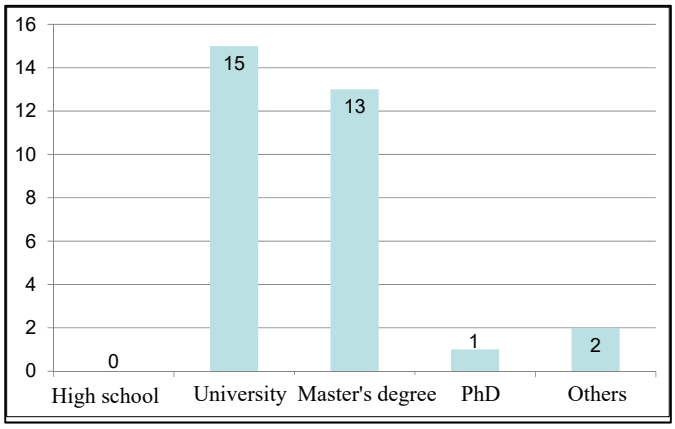

Fig.5 Academic background about respondents

With regard to their areas of expertise, 37.5% (15/40) of them belonged to the upstream R&D or development design.

With the additional 32.5% (=13/40) of those who were from production-related departments (specifically production engineering, production, production control, quality control), the total percentage reached 70%. That shows the majority of respondents of this survey represented the technical personnel of organizations. There were nine respondents who were not included in this category. It was highly likely that at least some of them were specialized in cost management and well versed in VE.

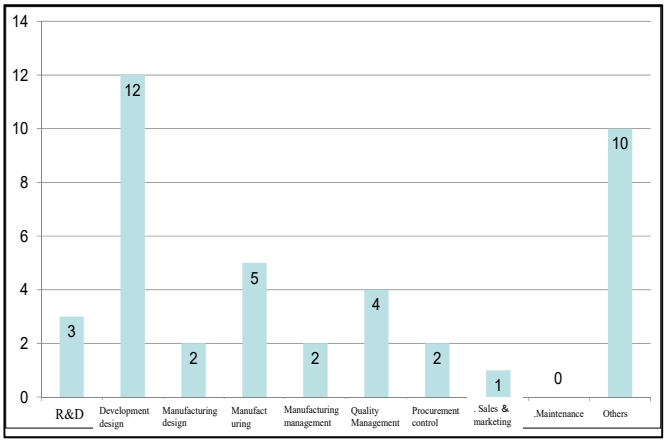

Fig.6 Area of expertise for respondents (Multiple answers allowed)

2) Two case examples of Js-GRI

[Case Example 1: Restroom in Tohoku Shinkansen (bullet train)]

The subject restroom (See Fig.7) is available in the E5 series of Tohoku Shinkansen called "Hayabusa" operated by East Japan Railway Company, commonly called "JR East," (its operation started on March 5th, 2011.) The toilet seat in it has shower function, which is getting common in urban restaurants in Japan. Such a facility has become available even in a closed space like Shinkansen thanks to the technological advancement which enabled shower water saving and presumably with the operator's willingness to ensure further customer satisfaction.

Furthermore, from the viewpoint of human-centered design, due consideration is given in this barrier-free restroom for the convenience of elderly, handicapped, and female users, ensuring the hygienic and comfortable environment all the time. In fact, the author of this paper was a member of the prototype-making project of this restroom, and the outcome was publicly announced in 2004[11]. Even after that, this product has undergone further improvement. There must have been the continuous improvement activity behind that, for sure.

The results of this survey on its service quality are shown below.

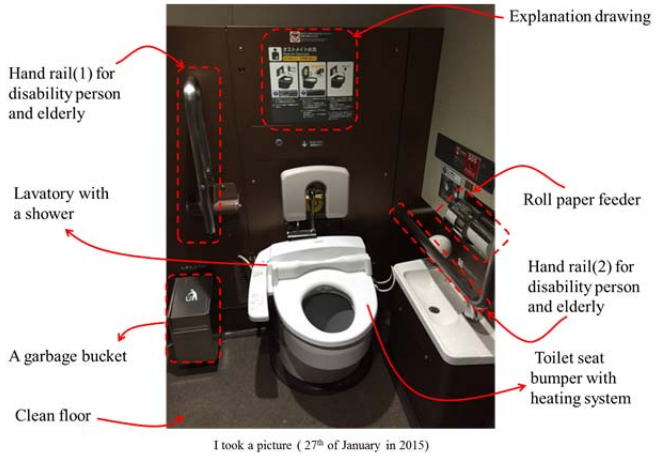

Fig.7 Case example1 : "A restroom in Tohoku Shinkansen (bullet train)"in Japan

Q1: What do you think of the case example 1 in Japan? "A restroom in Tohoku Shinkansen (bullet train)"

Fig.8 Evaluation about case example1 in Japan

This subject product was highly evaluated by 87.5% (=28/32), while it was judged as "excessive" by 3.1% (=1/32).

Among the six evaluation categories shown above, "Excellence" to "Usual" were grouped as positive evaluation and the others ("Not so good ","Bad" and "Excessive") as negative one. The former's ratio was tested by 1% level of significance with one-tail test, coming near standard normal distribution.

Judging from the number of sample "n" as small cross-section statistically, even where the ratio of positive evaluation is tested by binomial probability distribution (n=32, P=1/2), null hypothesis H_0 is obviously rejected by 1% level of significance with one-tail test. It is because the result of Q1 indicates the number of the positive evaluation as "31", which means cumulative probability is "1".

TABLE2. STATISTICAL RATIO TESTED BASED ON STANDARD NORMAL DISTRIBUTION

Q1	Frequency	Ratio(%)	Z_0	Z0<Z(0.01)=2.33	1% level of significance
Positive evaluation (including usual)	31	0.969	5.303	H1	High Occupancy
Negative evaluation (including excessive)	1	0.031	-5.303	Ho	
	32	1			

That is to say, what the result makes clear statistically is that the ratio of positive evaluation is absolutely, significantly higher. The fact, however, that one respondent judged it as "excessive" should be noted. The reason behind is not known well, but at the time of a similar survey conducted in Shanghai in China, not a few of the respondents also commented this product was "excessive [22]".That indicates, if the toilet functions are not well understood by the users, their excessive service may have a risk of causing serious trouble. In fact, there are some reported cases of actual troubles caused in toilets with shower function involving foreign visitors [3]. Based on that, even though only one respondent commented this was an "excessive" service, this should be noted.

Q2: What do you think of the installation of same restroom system in the express train in India?

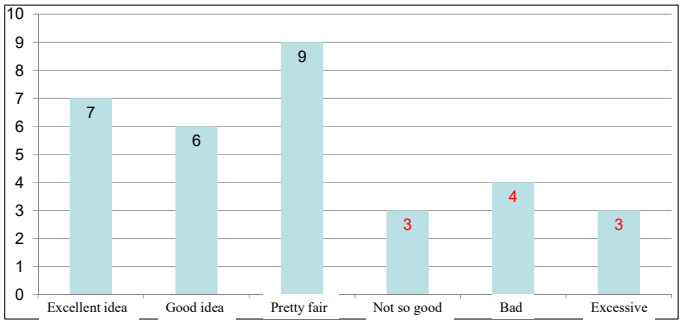

Fig.9 Evaluation of an idea about installation of same restroom in the express train in India Japan

The idea was positively accepted by 68.8% (=22/32) of the respondents, while 31.3% (=10/32) of those were against it. By the same token about Q1, based on binomial probability distribution (n=32, P=1/2), the result of ratio test of Q2 indicates, null hypothesis H_0 is not yet by 1% level of significance with one-tail test, rejected by 5% of that. It is because the number as "22" in positive evaluation means cumulative probability is "0.989". Therefore, statistically, it is indicated the ratio of positive evaluation is significantly higher. However, based on ratio difference test by 1% level of significance, it was found negative evaluations' in Q2 is higher than in Q1.

They (who responded "Not so good," "Bad," or "Excessive") were asked to explain the reasons, which are summarized below.

[Main reasons of the negative comments]

a) We cannot afford to install multi-functional restrooms like this one in the trains in the current India.

b) This toilet is too complicated to be used by the Indian public, as our awareness towards hygiene of public toilets is low.

c) I don't think the passengers are interested in high-cost products like this.

d) This much of facility is not necessary because even a simple design toilet can satisfy the basic needs of functions.

e) Quality assurance is important, but this much of precision shower is not required in a toilet.

These negative comments seem to reflect the respondents' thinking that, in the present Indian society, people generally prioritize the lower cost rather than the higher quality and more multi-functional service, and the mindset of keeping public toilets neat and clean is not yet taken root among the local common people. This would suggest that not a few of the quality services which are considered as the standard level in Japan could be regarded as excessive quality in India.

[Case Example 2: Signboard of Tokaido Shinkansen (bullet train) on a platform of Shin-Yokohama Station]

The signboard as shown in Fig.10 is put up on safety fence doors of Shinkansen platforms at Shin-Yokohama Station. The passengers, including business people who often travel by Shinkansen, often wonder which side of its boarding door, on the right or left, is closer to get to their seats. There must be many tourists (including foreigners) who fell difficulty finding their seats after boarding from the wrong side of the door. This signboard, therefore, is designed to help them find the nearer side of the boarding door to their seats easily. It is a simple idea of Kaizen, but can be seen as a typical Japanese way of well-considerate service. The following shows how the Indian respondents evaluated this signboard.

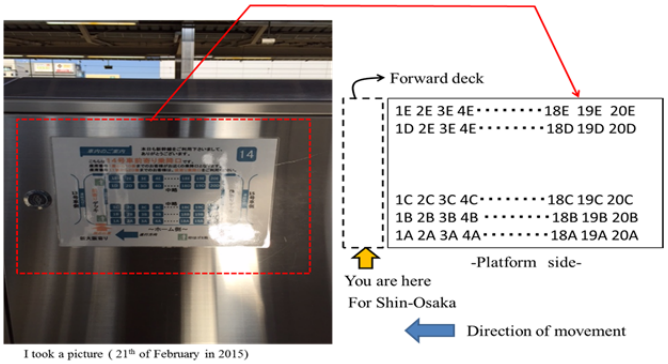

Fig.10 Case example2: The signboard of Tokaido Shinkansen (bullet train) on a platform" in Japan

Q1: What do you think of the case example 2 in Japan? "The signboard of Tokaido Shinkansen(bullet train) on a platform"

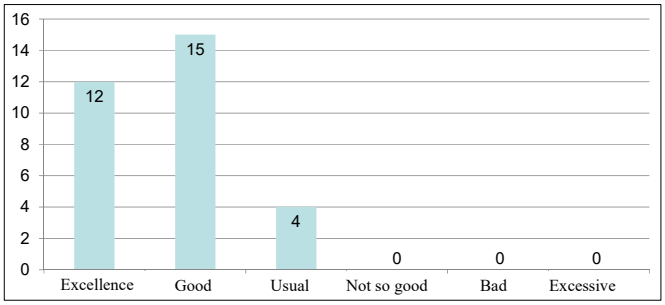

Fig.11 Evaluation about case example 2 in Japan

It was highly evaluated by 87.1% (=27/31) of them, by adding 12.9% (=4/31) who rated as "Usual," the total covers 100%, meaning none of them evaluated it negatively. The result implies that this kind of simple solutions without involving any investment would be highly evaluated also in India, although the number of samples of this survey is too small to conclude this is always the case.

Ratio test based on binomial probability distribution (n=31, P=1/2) is not implemented because of all respondents in positive evaluation.

Q2: What do you think of the introduction of same signboard on the express train's platform in India?

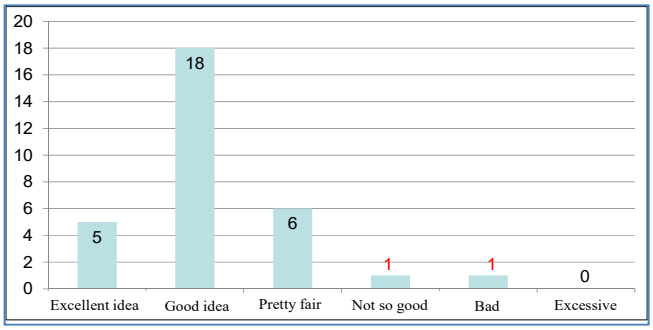

Fig.12 Evaluation of an idea about installation of same signboard in the express train in India

The proposal of introducing this guiding signboard for passengers in India was positively accepted by the vast majority of 93.5% (=29/31), which was more or less consistent responses to Q1.

Based on binomial probability distribution (n=31, P=1/2), the result of ratio test of Q1 indicates , null hypothesis H_0 is absolutely rejected by 1% level of significance with one-tail test. It is because the number of the positive evaluation as "29" implies cumulative probability is "0.9999‥". It means, statistically, the ratio of positive evaluation is significantly higher.

The negative reaction was also found from 6.5% (=2/31), a minority though, at the same time. Their reasons were not known as they were not described in the survey. There was, however, another survey (carried out on Nov. 16th to 18th, 2015) on various Js-GRI cases (12 cases in total) by interviewing three business persons in the small and medium service sector and four experts of GRI in New Delhi, Ahmedabad and Mumbai. Five out of seven commented that this signboard case would not be well-suited in India. According to their opinions, very few Indian passengers would try to find a signboard like this for their reference before boarding a train as such services like this signboard are very limited in the Indian public sector. What these comments and the field study results suggest is that it is extremely important to understand the actual situation of infrastructure in India and how the services are being recognized by the common people in the society.

3) Two case examples of Dc-GRI in India

[Case Example 1: Non-electric clay refrigerator in India]

In India, electric power supply is not very stable. In fact, when the author of this paper was in New Delhi in November last year, he encountered a nearly one-hour power failure during his company visit. Using an electric refrigerator, therefore, has a risk of spoiling the food kept there in the event of power outage. Moreover, refrigerators are beyond the reach of the poor there. That is why Mr. Prajapati, a GR innovator, devised a non-electric refrigerator made of clay. (See Fig.13) The water charged from the top gets absorbed into the clay walls on the sides, and the evaporation heat generated in the process can keep the food inside cool. It needs no electric power, can be 100% degraded in the nature, and generates no waste at all. This is an example of frugal innovation and a realization of eco-design. Its inventor, Mr. Prajapati, was a high-school dropout, but successfully developed it out of his skills and experience as a craftsman. This is a typical example of Dc-GRI. The following shows how it was evaluated by the Indian respondents.

Reference cited: Design For Freedom http://d4f.asia/#wrapper (with permission)

Fig.13 Case example1:"Non-electric clay refrigerator" in India

Q1: What do you think of the case example 1 in India? "Non-electric clay refrigerator"

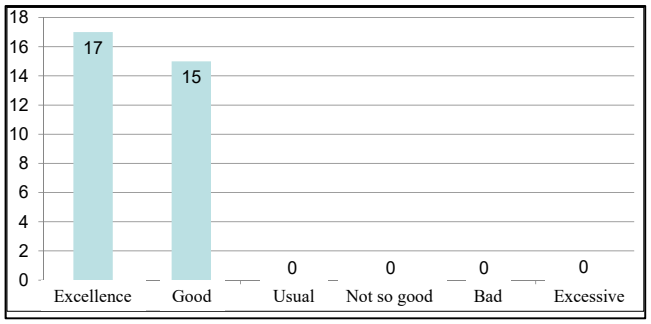

Fig.14 Evaluation about case example 1 in India

All the respondents, 100% of them (=32/32), highly evaluated the product, thinking that, by considering the local electric power situation, this locally developed non-electric clay refrigerator is to be extremely highly valued. This, therefore, is surely one of the successful cases of Dc-GRI.

Ratio test based on binomial probability distribution (n=32, P=1/2) is not implemented because of all respondents in positive evaluation.

Q2: What do you think of the introduction of Non-electric refrigerator in Japan?

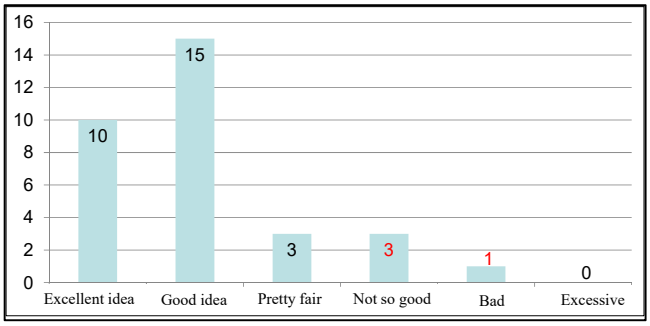

Fig.15 Evaluation of an idea about the introduction of non-electric refrigerator in Japan

The majority of the respondents, 87.5% (=28/32), positively supported this idea, while 12.5% (=4/32) of them were against it. This result signifies not a few people don't agree to this idea, probably they think highly acclaiming this product for use in India is one thing, but introducing it into Japan is another.

By the way, based on binomial probability distribution (n=32, P=1/2), null hypothesis H_0 is rejected by 1% level of significance with one-tail test. It is because the number of "28" in positive evaluation indicates cumulative probability is "1". It is clear the ratio of positive evaluation is significance statistically. Those who were against the idea were a minority, but their opinions should be noted. Their main reasons, therefore, are as described below.

[Main reasons of the negative comments]
a) I'm afraid this product concept may not be accepted in Japan practically.
b) The climate and the social infrastructure situation in Japan are different from those in India.

These comments can be interpreted as the views including such a product as non-electric clay refrigerator probably is not needed in a country like Japan where the social infrastructure is well developed and the stable electric power supply is secured, and it is doubtful whether such a natural cooling apparatus utilizing the evaporation heat can work effectively in air-conditioned rooms in Japan in hot and humid summer. On the other hand, there was a positive opinion, too, saying that "this product could be space- and cost-saving as houses are small in Japan." It is true that an eco-design product like this can match the environment-oriented society like the current Japan. Rather than using it inside the house, its outdoor use may have more business potential, which may turn out to be a new pattern of reverse innovation [7] if that is materialized.

[Case Example2: Re-chargeable motorized tricycle in India]

Mr. Dhukka, a GR innovator and the inventor of this product, is a Muslim living in Gujarat. His father suffered from paralysis from his waist down due to illness. Mr. Dhukka's willingness to help his father going outside was the motive of his development. Basically, the battery and the motor installed underneath the driver's seat move the chain which rotates the wheels. The mechanism of this rechargeable battery-operated tricycle is very simple. In details, however, it was meticulously designed and made into a kind of high spec model, somewhat comparable with the Japanese cars. The thick tires originally designed for mopeds are used to enable driving in any harsh conditions including on bumpy roads and sand beaches. The wheel locking system works in case the vehicle starts sliding down the slope accidentally. The position of its driver's seat is adjustable so as to ensure comfortable driving for those of different body sizes and

driving postures. The arm rest can be raised not to disturb the driver when getting in and out of it. This tricycle can drive for eight hours after a full charging of three to four hours. This is another typical example of Dc-GRI developed under restricted conditions by an individual who had a strong will.

Reference cited: Design For Freedom http://d4f.asia/#wrapper (7th /June /2015)

Fig.16 Case example2:"Re-chargeable motorized tricycle" in India

Q1: What do you think of the case example2 in India? "Re-chargeable motorized tricycle"

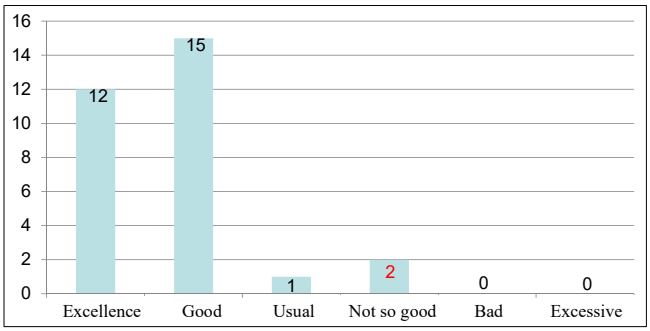

Fig.17 Evaluation about case example 2 in India

As much as 93.3% of the respondents (=28/30), including the one who chose "Usual," positively evaluated this product, meaning that it was highly rated as a whole. At the same time, however, it was negatively rated by 6.7% (=2/30). The binomial probability distribution (n=30,P=1/2) indicates cumulative probability is "1" because of "28" respondents in positive evaluation. That is why null hypothesis H_0 is rejected by 1% level of significance with one-tail test. It makes clear the ratio of positive evaluation is significantly higher. Although only a few respondents rated it negatively, their comments should be noted, including the one below.

[Main reasons of the negative comments]
a) Through RE/VA (Reverse Engineering/ Value Analysis) activities in Mahindra, for example, products like this one can be made at a low price.

The comment mentioned above is appealing that there are large enterprises in India which are capable of commercializing low-cost models of even higher quality motor tricycles. It is assumed that such an opinion was raised as the survey was conducted at the time of the conference participated by many business people representing leading large corporations in India (including TATA Group, Mahindra Group and Maruti/Suzuki). Although the middle-class population in this country is increasing thanks to the rapid economic growth, it is a fact that the majority of the people are still poor or in BOP (Base of the Pyramid). In such markets including India, Dc-GRI like this case is still believed to be an effective solution.

Q2: What do you think of the introduction of re-chargeable motorized tricycle in Japan?

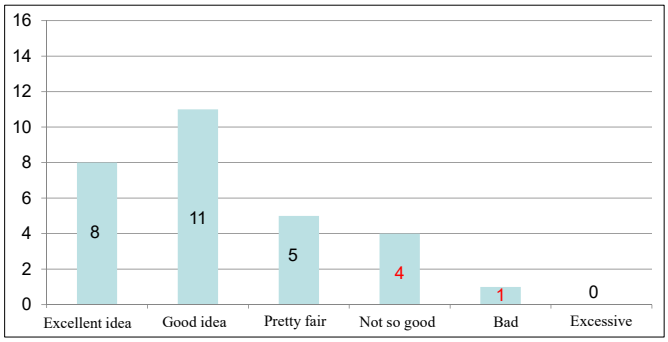

Fig.18 Evaluation about case example 2 in India

It was positively rated by 82.8% of the respondents (=24/29), including those who rated it as "Pretty fair," which indicated that they thought a product like this could be accepted in Japan, too. At the same time, however, five respondents, or 17.2% (=5/29) were against the idea. The binomial probability distribution (n=29,P=1/2) implies cumulative probability is "1" and null hypothesis H_0 is rejected by 1% level of significance with one-tail test. Moreover, based on the ratio difference test, it was indicated that the ratio of negative evaluation in Q2 was not bigger compared to it in Q1. the Negative comments, however, are described below to be kept it in mind.

[Main reasons of the negative comments]
a) The rechargeable cars are already available in Japan. I'm afraid more numbers of vehicles of this kind may cause more congestion on roads and sidewalks and even traffic accidents.
b) Through RE/VA (Reverse Engineering /Value Analysis) activities in Mahindra, for example, products like this one can be made at a low price.

What they meant presumably include that there was very few chance of entering the Japanese market with this kind of product as it already had the similar vehicles there, and that

exporting the product like this to Japan was difficult due to the road conditions in Japan. It is true to say that the Indian large manufacturers should have marketed the product like this much earlier if exporting that were feasible. It may be unrealistic, therefore, to try to reversely introduce this case of Dc-GRI into Japan without further modification.

V. CONCLUSION

Based on the results of the field surveys on GRI in India, the potential of collaborations between Js-GRI and Dc-GRI in India has been explored to some extent in this paper. What was discussed so far can be summarized as follows. In principle, Js-GRI consists of two types: Type 1 is, as represented by the case of "A restroom in Tohoku Shinkansen," the combination between the technological advancement which achieved water saving to materialize the shower function to its toilet and the continuous improvement for the purpose of enhancing customer satisfaction. Type 2 is the ideas for improvement proposed in the course of daily continuous improvement activities at the actual workplaces, as shown in Case 2: "Signboard on a Shinkansen platform." Both types of Js-GRI are characterized by the fact that they are primarily practiced as an activity in the formal sectors, backed by *Genba-ryoku*, the power of skilled workforce on actual work sites. Js-GRI, therefore, is achieved a result of continuous improvement activity based on the common practice of PDCA and SDCA in the company organization. Taking an example of JR East, this activity is called "My Project" and promoted with the aim of strengthening its *Genba-ryoku* based on the employees' self-initiatives [14].

On the other hand, both cases of Dc-GRI in India in this paper, namely, Case 1: "Non-electric clay refrigerator" and Case 2: "Rechargeable motorized tricycle," are not supported by any formal sector such as large corporations even in their commercialization process, as they are the problem-solving examples done by the individuals who tried to tackle their own issues within the local communities.

Based on these points mentioned so far, the hint for collaborations between these two types of GRI seems to lie in the difference between them. In Js-GRI, highly stable quality is achieved as a result of proposed improvement ideas, which was explained earlier as their characteristics. On the contrary, Dc-GRI, in spite of its superb idea, mostly gives an impression of a one-time solution without any scope of ensuring the stable quality in a continuous manner. Complementing this difference must be the important key point. Specifically, what is essential is, with due consideration given to the social environment in India, to establish a system which allows proposing improvement ideas step-by-step in such a way of being naturally accepted by the public there. In other words, it is extremely important to thoroughly disseminate the concept of "Big results come from many small changes accumulated over time" among GR innovators in the developing countries including India. At the same time, employee education emphasizing the importance of the process of work must be enforced by not only the Japanese companies there but also the local small- and medium-sized firms. To do so, first and foremost, it is necessary to introduce and spread the practice of 5S, and promote continuous improvement activities by keeping PDCA and SDCA always in mind and considering the local social environment (See Fig.19). This is what the author of this paper felt with confidence through the field studies in India. Actually, the Kaizen activities, the backbone of Js-GRI, have been in practice on conditions of having the best process and skillful workers at work sites, and have been aiming at further enhancement of customer satisfaction [6]. In the course of achieving the goal, implementation of PDCA and SDCA and promotion of 5S primarily are believed to be prerequisite for Js-GRI. As the practice of 5S takes root in the organization, what should be done as the important next stage is to introduce and make the best use of IE, QC, VE, and other management techniques, depending on the features of upcoming various problems. The point here is, "haste makes waste." It is primarily important to understand all these points when initiating collaborations with Js-GRI in India or in other developing nations such as China. How to overcome the above-mentioned hurdles by creating the feasible system would become one of the main issues for the organizations seeking such collaborations aside from the already well-established large Japanese enterprises. .

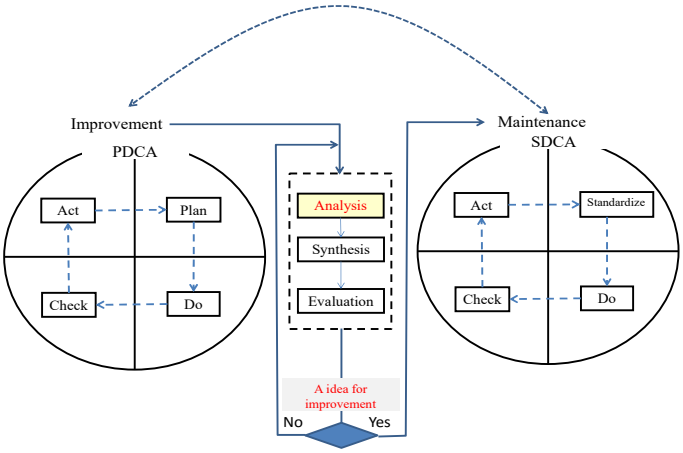

Fig.19 Continuous improvement activities based on PDCA and SDCA

It is to be noted that, although the respondents of the surveys conducted in India for this paper were limited to highly educated persons, their responses were sufficiently reliable as they were the upper-middle class citizens who were believed to have an objective understanding of the social infrastructure and the ordinary people's lives in India. To tell the truth, however, most of them belonged to the local large-scale enterprises or higher educational institutions including universities there. In order to study further for establishing more effective business models of collaboration between Js-GRI and Dc-GRI, additional field studies will be necessary by targeting at the local top management of small-

and medium-sized enterprises as they are the ones who often have direct interaction with the local ordinary people.

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