

Barriers to Introduction of Autonomous Cars in US and Developing Countries

PICMET: Portland International Center for Management of Engineering and Technology - 2016

Presented By:

**APEKSHA GUPTA
RITU CHATURVEDI**



1

Devidfw

Wkh#lq#wg#x#f#w#q#t# #l#w#r#q#r# r#x#v#h#k#f#d#v#g#r#h#v#g#r#w#h#p# #r#t#e#h#l#h#t#l#w#d#q#w#e#w#u#h#
d#q#p# r#u#h#h#k#f#d#p# d#q#x#i#f#w#u#h#t#u#h#g#f#w#k#d#w#h#d#g#u#y#h#g#f#d#w#t# l#t#h#l#h#d#w#l#t#q# #q# #
w#k#h#r#d#g#v#t# #k#q#l#h#g#f#v#d#w#v#t# | #k#h#h#d#u#t#353#t# l#k#k#h#d#w#r#q#r# r#x#v#f#d#w#h#k#h#
v#w#h#v#t# #i#h#y#h#l#g#d# | #g#u#y#l#j# #f#r#x#e#g#t#h#h#g#x#f#h#g#l#q#g#k#d#w#p# #f#r#x#e#g#t#h#h#h#u#l# #h#d#
v#h#q#w#l#g#r#p# #h#e#u#g#x#f#w#y#h#t# r#u#n#l#t#l#d#e#d#g#l#q#g#t#e#h#u#d# #h#r#s#d#t#d#q#l#o#v#t#e#h#q#h#i#l#t#u#p# #
w#k#l#h#h#f#k#q#r#r#j# | #l#q#g#t#e#h#f#r#p# #h#h#d#h#d#d#q#v#w#k#h#v#h#h#t#h#e#w#l#t# #f#r#x#s#d#t# #i#h#y#h#u#d# #
v#r#f#h#d#d#p# s#d#f#w#k#l#h#h#f#k#q#r#r#j# | #d#q#t#e#u#l#j# #t# #x#u#h#v#h#t#l#t# r#u#n#l#t#l#p# #h#g#l#w# #
w#w#g# | #l#j# #k#h#t#q#d#h#g#f#h#t# #k#l#t#q#r#y#d#w#h#h#f#k#q#r#r#j# | #q#k#h#r#f#h#w# #h#v#t#e#t# k#r#d#l#

D#r#w#t# #j#p# d#u#h#w#h#v#d#u#f#k#t#d#v#d#t#r#u#k#l#h#h#f#k#q#r#r#j# | #l#t#l#y#d#l#e#d#h#t#u#p# #k#h#k#V#l#q#g# #
r#w#k#h#t#h#y#h#r#s#h#g#t#x#u#r#h#d#g#f#r#x#q#w#l#h#k#r#z# #y#h#u#h#k#h#h#t#q#d# #p# #l#h#g#t#d#v#d#l#e#d#h#t#
i#u#p# #t#h#y#h#r#s#l#j# #f#r#x#q#w#l#h#k#h#h#t#h#h#t#j#q#l#l#f#d#q#w#f#r#h#t#r#u#d#f#f#h#s#w#d#q#f#h#l#q#g# #
j#u#r#z# #k#t# #k#l#h#h#f#k#q#r#r#j# | #l#q#t#h#y#h#r#s#l#j# #f#r#x#q#w#l#h#v#t#e#h#d#h#k#h#p# #s#d#p# #h#q#w#l#w#r#q#t# #i#
d#w#r#q#r#p# r#x#v#f#d#w#h#d#v#h#d#y#l#j# #q#k#h#k#q#g#h#d#l#j# #d#f#w#t#h#h#h#q#i#u#v#w#x#f#w#h# #u#d#i#f# #
h#j#x#d#w#r#q#t#l#q#g#h#j# l#v#w#u#h#t#x#f#k#t#d#d#p# #h#w#h#t#h#y#h#r#s#l#j# #f#r#x#q#w#l#h#h#h#h#q#g#d# #
F#k#l#q#d# #e#u#d# | #l#h#t# #h#t#h#t#r#q#w#d#w#l#j#q# #t# #i#h#h#q#w#l#u#p# #k#d#w#t#h#k#h#k#V#h#k#l#t# #r#u#n#t#l#j# #
s#d#u#f#x#d#w#f#r#f#x#v#h#t#q#k#h#t#d#u#h#w#t# #p# #s#d#p# #h#q#w#l#w#r#q#t#l#q#g# #k#h#r#f#h#w#d#p# s#d#f#w#t# #i#
d#w#r#q#r#p# r#x#v#f#d#w#h#h#y#h#r#s#l#j# #f#r#x#q#w#l#h#t#

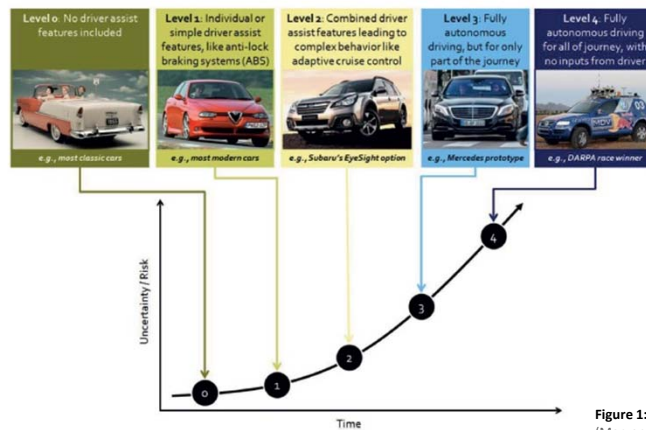
SHVWHH#l#q#g#d#v#l#t#u#p# #z# #r#u#n#l#t#l#v#h#g#t#h#k#l#t# #r#u#n#t#l#q#d#d# | #h#k#h#t#d#u#h#w#t# #
l#u#r#g#x#f#w#r#q#t# #i#d#w#r#q#r#p# r#x#v#f#d#w#t# #x#u#y#h# | #l#t#f#r#g#g#x#f#w#h#g#t# #k#g#g#h#w#d#g#g#k#h# #
z# #l#t#j#q#h#w#t#r#t#f#h#s#w#d#w#r#q#r#p# r#x#v#f#d#w#l#q#g#t#w#t#p# s#d#f#w#t#h#y#h#r#s#l#j# #f#r#x#q#w#l#h#v#t#
l#g#v#h#z# #t# #l#q#g#x#w#d# | #t#u#r#h#v#t#k#q#d#o#t#e# l#t#l#o#v#t#e#h#f#r#g#g#x#f#w#h#g#t# #k#g#g#h#w#d#g#g#k#h# #
f#k#d#d#q#j#h#v#d#f#h#g#t# | #t#h#k#f#d#t#p# d#q#x#i#f#w#u#h#w#t#e#u#l#j# #k#l#t#h#v#l#r#q#t# #h#d#d#l#

Agenda

- Overview
- Research Methodology
- Literature Review
- Analysis & Recommendations
- Conclusion
- Q&A

Evolution of Cars

Autonomous Vehicles Are Actually Part of a Continuous Evolution of Driver-Assist Features



Why Autonomous Cars?

- Reduce number of accidents
- Elimination of human error
- Productive use of travel time
- Environmental benefits
- Increased road capacity
- Efficient use of parking space
- Independence to elderly



Figure 3. Geneva Motor Show (BBC 2014)

Objective

- This Research Project aims to identify what are the BARRIERS to the successful introduction of AV's into the US and other developing countries
- Analyze these barriers from multiple perspectives to understand what actions technology managers and policymakers should take

Introduction

- The introduction of autonomous vehicles does not seem to be a distant future anymore in the US.
- Vehicle manufacturers predict that we will be able to see self driven cars on the roads of United States by the year 2020
- However, the future of this technological innovation is not very clear in developing countries.

Companies involved in AVs



Figure 2. 25 Corporations Not Named (CB 2015)

Methodology

9

STEEP

- Social
- Technological
- Economic
- Environmental
- Political

Reference [1] [2]

Social Barriers- US

10

- Psychological
 - Resistance to change
 - Trust
 - Risk
- Data Security and Privacy
 - Not comfortable with tracking of personal data.
 - Survey conducted by Seapine Software company, where 2,039 U.S. adults were sampled:
 - ✓ 37% stated that data privacy was one of the reasons of being reluctant to driverless cars
 - ✓ 52% adults, fear that a hacker could take control of their car

Reference [3]



Technological Barriers-US

11

- Development of Digital Infrastructure
- V2V (Vehicle to Vehicle) communication between two vehicles
- V2I (Vehicle to Infrastructure) communication between vehicle and infrastructure

- Decision making to the level of holistic human cognition
- Detection and recognition of objects on the road

- Planning routes

Economic Barriers -US

12

- High Cost -2016 average new car price: \$33,560
- Estimated current cost of AV: \$100,000
- J.D. Powers and Associates survey indicated that if the AV prices come close to the conventional vehicle prices, there is a ready and willing market for AVs. 37% of people will probably or definitely buy AVs.
- Economic Disruption due to chances of Job Losses
 - AVs will affect professional driver jobs
 - According to Unites States Department of Labor, there were around 1,701,500 truck driver jobs, 6,54,300 bus driver jobs in United States in 2012

Reference [3]

Environmental- US

13

- Based on our research, there are no considerable environmental barriers to the adoption of AVs. Instead, it poses some benefits:
- Reduce Fuel Usage and Emissions
- Reduce Traffic Congestion
- Increased Ridesharing
- Changing Ownership Model

Political Barriers -US

14

- Liability
- Standardization of laws
- Different States have different laws and regulations Legislation
- Creating new set of laws regulating the actions of AVs, owners and drivers
- Concerns around safety

How is it different in Developing countries - Case of India ?

15

- In India, underlying factors like infrastructure, traffic regulations, legislature, technology innovation parameters are contrastingly different from US; which has been the basis of studies leading to this technological innovation.
- India needs a different approach to bring Autonomous cars successfully, taking into consideration the current society and the developing stage of these important parameters.

U h j x o l u # w d i i f # / f h q d u r # q #
I q g b

16

<https://www.youtube.com/watch?v=KnPiP9PkLAs>

17

Eduhw#ru#hyharsbj#rxqwhv

18

Vrflde#duhw0lgb

- Increased risk of security and Privacy of personal information
- Resistance to change and risk of depending completely on a machine

Challenges of AV in India

- Very slow internet (data exchange) coverage is a biggest challenge for Vehicle to Vehicle communication
- India also needs a different type of vehicle infrastructure outside the car to overcome the following challenges on road:
 - Avoiding numerous potholes on road
 - Animals are sharing the roads with pedestrians and vehicles
 - Cars and other vehicles do not obey the traffic rules
 - Huge amount of traffic

Challenges of AV in India

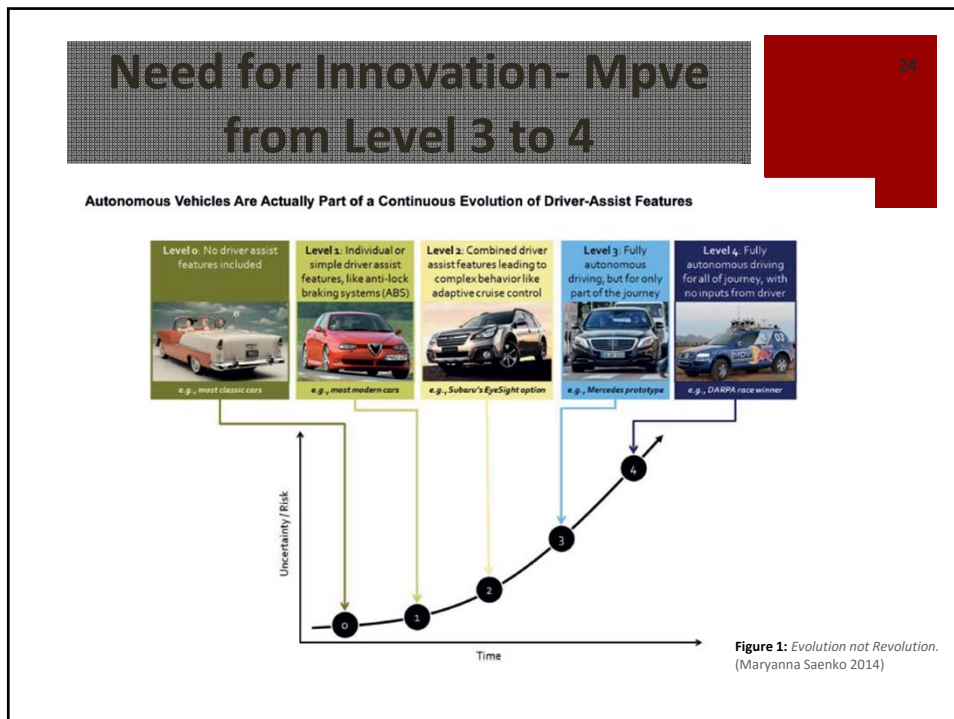
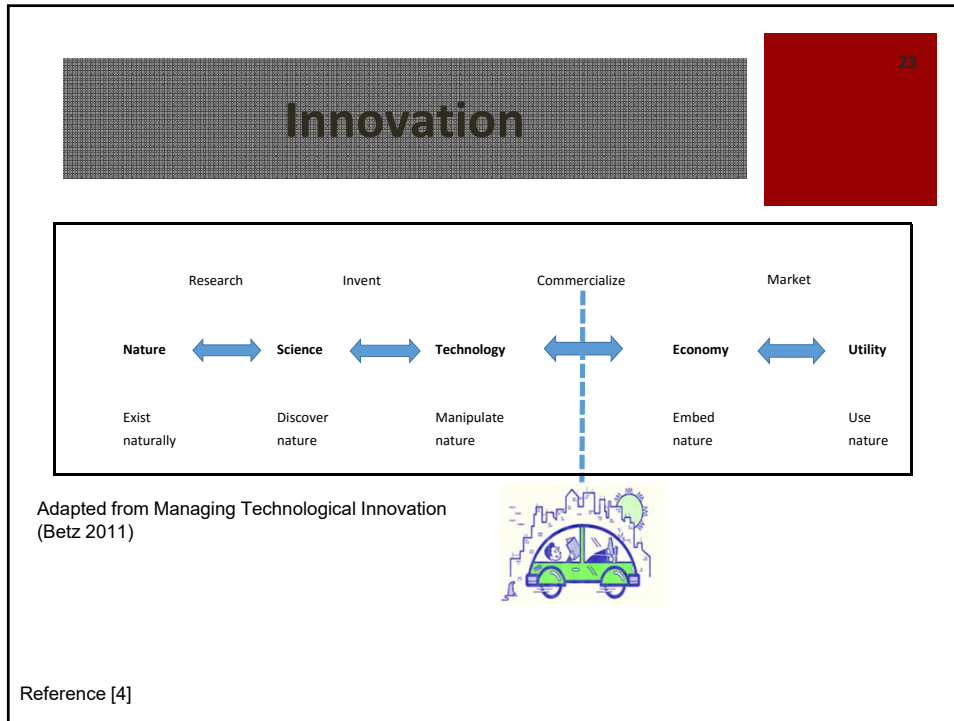
- Huge workforce in India make their living from driving people's personal cars as Chauffeurs. There are also a lot of local cab companies which employ huge number of drivers. AV's might result in unemployment and thus affecting economy of India
- Increased cost of buying as compared to general cars will result in a limited adoption of AVs

Slow development

- AV will need special regulations and permissions that would be common across the country.
- Loose Traffic regulations have to be improved to a stricter adherence
- Legislation has been slow moving to cope with the development as the infrastructure is very unfriendly for AVs

Analysis

- Challenges are technological and social in nature
 - Urgency for technical innovation
 - Development of laws and policies
- Technology Development -- Political Framework
- Technology managers and policymakers work together and not step on each others toes



Technical

25

Recommendations

- Self drive mode so that driver can take control incase of emergency or malfunction
- Alert the driver of a malfunction
- Ability to report any malfunctions to determine root cause
- Localization and infrastructure
- Object recognition
- Companies that develop these technologies

Technology Leaders

- Help drive policies
- Strong market opportunity

The followers

- Imitators
- Reactive to the rapidly changing technology landscape

Political

26

- No industry standards around testing and usage
- Undefined liability and varying degrees of human control

Recommendations

- For US- use California's existing policies and guidelines to create standardized legislation between states while a new set of rules are required for developing countries
- Use existing legal groundwork used in the aircraft and robotics industries for AVs.
- Establish a separate national vehicle innovation team to lead the discussions in law, insurance, and ethics.

Analysis - Social

27

- Od fnr i #shwrqdc #xvw #lqg #lffhsdqfh #lurxqg # |ehu #hfxul | #lqg #
gdwl #surwhfwrq
 - X qdiirug de d #r #kh #hghud #exedf
- Uhfrrp p hggdwrrqv*
- P dnh # |ehu #hfxul | #lqgxvu | #wdqgdug #r #lqg #lffhsdqfh #lurxqg #
 - Ghyh #s #lqg #gdwrrqdd)h #lqwh #lqg #hghud #exedf #kdulj #lqg #lqdcv #lqg #hghud #
 - R yhfrrp h #ljk #lqgw | #rvw # |
- Fkdqjh #z qhwk #p rgh #
 - Xvh #xh #dyljv #lqg #hghud #lqg #hghud #
 - Uhgxfhg # dlwhqdqfh #rww

Other Recommendations

28

- Organizational and Personal factors will drive technology innovation because it creates a vacuum or void that the then technological innovation can fill
- Standardize safety features and make them a requirement

Conclusion

29

- Radical innovation has happened- AV's can travel from A to B
- Customers demands are creating a void for technology to fill
- Car manufacturers are pushing to innovate and need to continue to standardize
- Legislation not to stifle the technological innovation
- Opportunity to be technology leader and drive regulations
- Vast majority waiting for technology maturity stage

Wkdqnrx\$

30



References

1. [Ijzab P du|dggd Vdhqnr1Hyxawqg#ru#hyxawqg#kws-zz-z-z-ixw-rw-yhz-rug-erp-2p-hj-dwhqgrv0du#chw2hyxawqg0-hyxawqg0wcz-0whdg|0dgydqfhd0xwqrp-rxv0fdu](#)

2. [Ijzab 8#rusrudwqrv0rw0dp hg#E#B348#rxufh#kwsv-zz-z-z-ife-irvijkwifrp-2e-aj-2ixwqrp-rxv0ruyhuhv0zhkif0v0-frusrudwqrv0w](#)

3. [Ijzab 1Krwqg#Jhghyd#rww#krz-#6dvthqjhu#z#-dy-lyhuhv#fdu#EF#ghz-v#3471-kws-zz-z-z-ef-erp-2ghz-v2xvvhvv0597667<6](#)

Y Ijhr #qfthgledh#ggldq#uuiif #rxweh#kwsv-zz-z-z-1|rxwehifrp-2z-dwfkBy@NqS E<SnODv

4. [4#Mkqvrq#hu|#Ekr0v#hyiq#Ekdug#kldqjwq#\(sarubj#rusrudw#wudv#|#kdw#kh#HVWHO#uip-hz-rub#-shqwh#kda-6339#](#)

5. [5#0Iqwrq#kduq#1Ghfzq#dnlj#ru#hfkqraj|#\(hExwzhv#Kvlyj#xas0h#hwshfwzhv#suryhg#huirp-dqf#-Erwrq#Dwhfk-Krxvh#<<#Bulq#Dwhfk-Krxvh#hfkqraj|#dqdjhp-hqwhqg#ur-hvvrqda#hyharp-hqwh#eud|1](#)

6. [6#dunrrw#duk#Bzrhqwh#rdgea#rv#ru#xwqrp-rxv#dun#hdsIqhVr#e-dh#7#dq#347#he1](#)

7. [7#dhyh#xwqrp-rxv#lylj#Q#KWVD#348#dggwq#vdp-hv#1#lyk#dad#aduq#G#vdaq#|#dxc#ruhqvq#-Frqvdqwh#dp-duiv#agg#ocz-dwe#D#R#ocz-dwe#D#xwqrp-rxv#h#k#hfkqraj|##xgh#ru#rd#|p-dnhu#B#DQG#-Frusrudwqg#h#1Subw](#)

8. [8#hw#huhghu#n#dqdjIj#hfkqraj#Idagqryd#wq#rp-shwzh#gydqvdjh#erp#kdqjh#K#ernhq#M#h|#344#Bulq](#)

9. [9#rdjh|#dfkha#xwqrp-rxv#dun#gg#d#h#hyharsIj#kdcqjh#D#wep-rwzh-Z-rug#B#348#du#347#he#9#su#-5349#kws-zz-z-z-ixw-rw-yhz-rug-erp-2dqdv#2ixwqrp-rxv0d#w0lq0lq0d0dgyhyharsIj#0kdcqjh2A](#)