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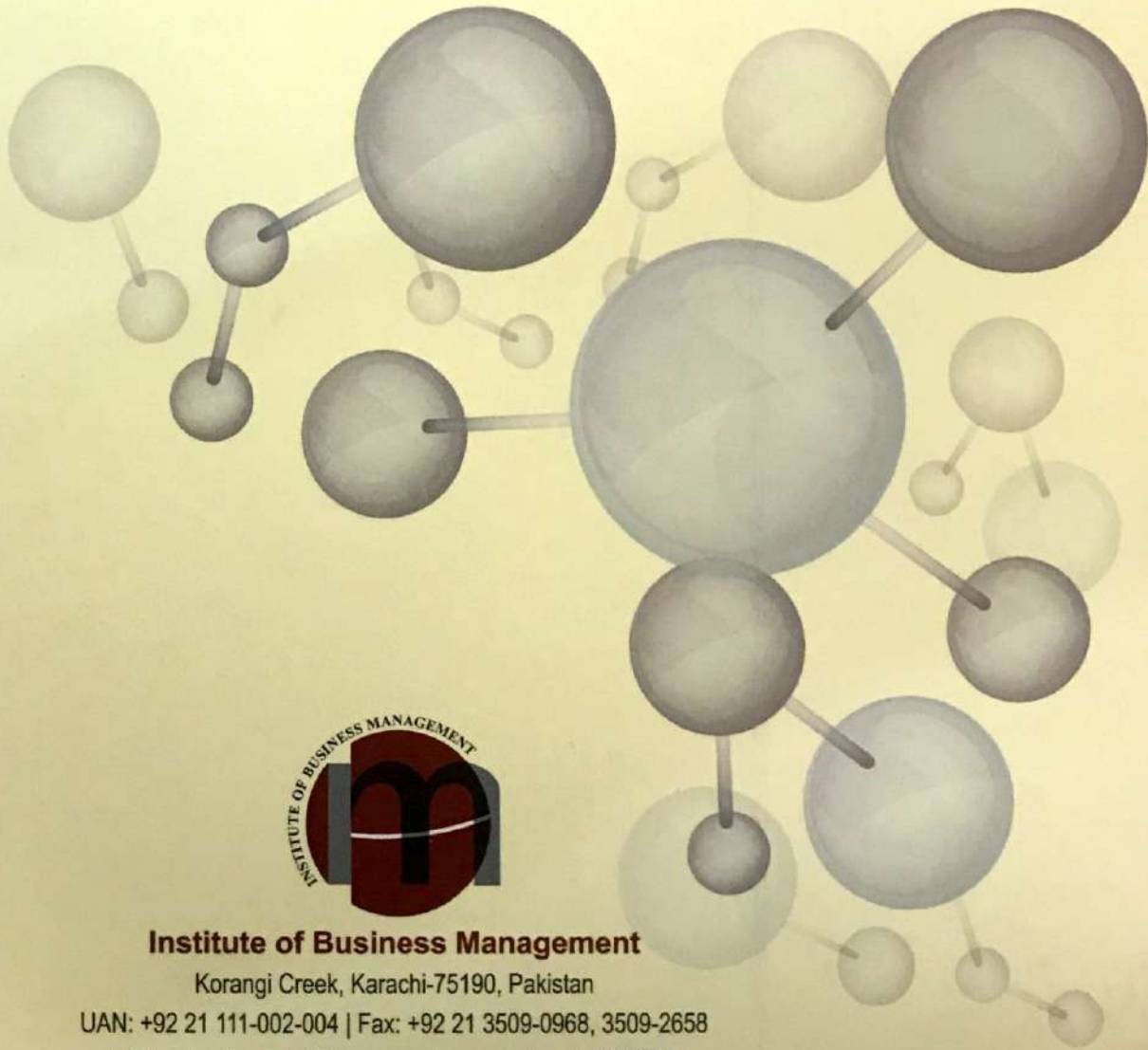

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## Editors' Note

I am very much pleased to introduce new editorial team who took the charge from Vol.9, issue No. 1, March 2021 and onwards. PJETS has changes its review process, by introducing single non-blind internal review and double-blind external reviews. This means that initially after successful internal review, papers sent for double-blind external reviews having both the reviewers and author(s) identities kept confidential. The scope of PJETS is publishing and promoting innovative ideas and original research in the field of Science, Technology, Engineering and Statistical Science since 2011, twice a year. This journal aims at publishing authentic research papers with less than 19% of plagiarism to create a culture of innovation and scientific development. The focus of the journal is limited to "Computer Science", "Engineering", relative "Emerging Technologies", along with "Mathematics" and "Statistics"

The mission of PJETS is to provide a platform to the researchers, faculty and students to spread their findings. The main goal is to link authors from different professions, for example academia and non-academia in particular and encourage them to share their research. We fortunately succeeded in developing a new editorial review board comprising of reputed scholars and researchers national and international level, from academia and non-academia.

I hope the new editorial team will be great boon to give new energy to the journal and will impart their knowledge and experience to improve the quality of publications.

Note: Dr Muhammad Tahir Qadri submitted paper for our journal, Pakistan Journal of Engineering Technology and Science (PJETS) in 2014. Due to miscommunication about the status of published article, Dr Qadri was not informed about the status.

Now, on his own request, the paper entitled "GPS Internal Missile Guidance System-PJETS" published in 2014SettingsVol. 9 issue No. 1 is withdrawn. The contribution of Dr. Qadri is appreciated

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**Dr. Zahid Ahmed**
**Editor**

# Contents

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# Change Management in a Global Distributed Environment (Process & Challenges)

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***Abstract*- Context: in a distributed environment changing requirement results in project failure, changes come from different sites by multi-site stakeholder involvement.by considering change requests from a different site and managing stakeholder issue change requests can handle efficiently. Here the objective is to find and manage the change process and suggest a solution to the stakeholder issues. Methods: we have done a literature review to find limitations in the change request process model and issue that stakeholders faced in a distributed environment. Results: We have identified activities missing in the change request process and change management process. We have also highlighted the role and responsibility for the activities to carry out a process of change management effectively. Our research also highlights stakeholder issues related to change management in a distributed environment and suggest an appropriate solution to the faced challenges. Conclusion: Our framework process not only defines a good balance change process but also identifies change activity in each process, role and responsibility to carry out the process and artifact efficiently. But there is a need to find more stakeholder issues related to managing the change request and their appropriate solution also need to find process activities in detail so that there must be no misunderstanding related to task assignment.**

**Keywords:** Requirement Change, Change Management Process, Change Process, Global Software Development (GSD), Distributed Teams, Distributed Software Development, Global Challenges, Framework for Change Management.

## I. INTRODUCTION

The process of understanding, managing, locating, controlling and authenticating the changes in the requirements are basically called as Requirement Change Management (RCM). For the success of the globally distributed projects, it is very necessary to achieve and fulfill the needs of the stakeholders, that's why making changes in the requirements is a big challenge. Global Software Development (GSD) is gaining more attraction to the software industry throughout the world. During the 1990s, the differences in development cost, the limited pool of workforce, the necessity to

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get closer to the customer and round the clock development, force the organizations to outsource their projects [1].

Change may refer to add new functionality in a system or modification of an existing system. To change the system, the system must be capable to add new functionality in the system or can accept required modification [2]. So the system must be designed in such a way that provides flexibility to the developer for change (Saleh, Mark, and Jordan; Cardinet).one term use for change is ECM (Engineering Change Management) involve a change in a component of a system or change in a whole system where change analyze, accept, change impact are identified and then it passes through to CCB(change control board) for acceptance and in last execution of change is performed [3]. It's not preferable to freeze the requirement at the start of the development phase. The changing requirements are not problematic; the real problem is how to manage these changes [4], [5].

The primary objective of this paper is to study the causes of change in a distributed environment and Input that gives rise to change request by conducting a systematic literature review. This paper also highlights challenges and their solution that stakeholders face in a distributed environment when managing the change request.

This research paper addresses the following questions:

1) The process of change request comes in a distributed environment?
2) Challenges involved for acceptance of change requests on the multi-site stakeholder?
3) A solution suggested for the discussed challenges in a distributed environment.

The rest of the paper is organized in the following section. Section 2 describes the background and motivation of Requirement Change Management. Section 3 describes the related work based on the requirement change framework. Section 4 describes the proposed framework steps for change requests and management processes. Section 5 describes the results and discussion based on our suggested work also highlight solutions to the proposed literature issues related to stakeholders in a global environment and in last conclude our work.

## II. LITERATURE REVIEW

Global software development plays an important role in increasing productivity where people of different time zone are actively involved. Some important GSD benefits are reduction in cost, skilled force, increase productivity and utilization of 24 hours working across the global environment.

Different challenges are involved in GSD due to differences in geographical, cultural, and temporal distances.

Among those communication issues are on the top of the list, these communication issues give rise to change request [6]. Change request comes due to some external and internal factors [7]. External factors involved like a bug report, changing business needs functionality and technical lacking of customer background. Internal factors involved like financial resources, equipment, copyright, and human resources. This change request arises because of geographical and socio-cultural differences in a globally distributed environment. Requirement change management (RCM) is not a simple process; it's a complex process that involves valid requested requirements, detailed planning, the reasoning behind the change, the influence of change to the existing requirement, scheduling cost estimation, propagation of change, proper decision making, approval from Change Control Board (CCB), verification and validation of the change request and change outcome [8].

The different models proposed in the literature for Requirement Change Management (RCM). According to capability maturity model change must be tracked and store in a database after that it must be analyses with the existing requirement to check the feasibility of requested change [9], [10]. Another model proposed for RCM which consist of three steps, determine the changes, approval for acceptance of that change and perform that change [11]. In order to understand the requirement need-based requirement model is proposed (NRM). This model is based on 4w (Who, what, why, where).in this model V&V method (verification and validation) used for continuously viewing of change requests in the system [12]. When multiple sites are involved change will propagate in such a way that change in design at one site may reflect the change in code at another site, this may reflect a delay in work because of cross-site communication issues [13]. One method for managing requirement changes in to establish a repository for a list of change requirements then use the Requirement Traceability Matrix (RTM) for linking it to the other requirement then communicate it to the stakeholder and in the last manage the change[14]. Table 2.1 explained below provides a brief introduction about the models that are commonly used for the required change management process. All models have some advantages as well as some drawbacks as none of them completely covered the change activity.

*Table 2. 1: Comparison of different Change Models*

| RCM Model | Objective | Input | Pros | Cons | Covered change activity | Ref. |
|---|---|---|---|---|---|---|
| Dean Leffingwell and Widrig model | Actors provided by a framework to carry out their tasks. | Customer, developer, end-user, CCB & Maintenance organization | Clearly defined entry and exit condition | No verification performed after change implementation | Overall change management | [9], [15], [1] |
| Olsen's Model | Treat all activity that is involved in a life cycle as change | Customer, developer & CCB | Life cycle independent so can be applied for maintenance | Change assignment to a resource is missing | All activity involved in the development | [1], [9], [15], [16] |
| V-like model | This model describes the technical activities for implementing a change. | Maintenance organization | Solutions are obvious and low cost. | Estimation of the cost required to implement the change is missing as well allocation of resources | Activity related to technical modification | [1][9] [15] |
| Ince's Model | The model focuses on software configuration | Customer, developer, and CCB | The same process followed for all change Request | No decision making about change input and output | Change management activity | [1][9] [15] |
| Spiral model | The process of change management is divided into cycle also solve & record Changes | No input | Easy to use | No testing and verification performed to check that the change is met or not | Same activity of V-model | [1][9] [15] |
| NRM model | Help analysts to understand accurately | Customer and developer | Efficiently manages continuous changes in the system requirement. | Decision making is missing about change whether the change should accept or reject | Verification and validation | [1], [9], [15] |
| AMES model | Help in decision making of change activity | Developers, CCB, maintenance organization | This model manages change throughout the life cycle of software | It does not cover Configuration management. | Decision making and technical modification | [1], [9], [15] |

| | | | | | | |
|---|---|---|---|---|---|---|
| S.A. Bohner Model | This model is used for Change implementation, Understanding the problems, For Solution specification And Regression testing | No actors involved for input | This model is silent about the impact analysis, that's why it finds out the scope of the change and it also helps in improved budget estimation | Provide no information about activity acceptance and rejection as well as its documentation. In short actors and key artifacts are completely missing. | Scope of change and budget estimation after the change | [1], [9], [15] |
| CHAM Model | In the CHAM model impact of the change is estimated based on cost | Customer developer and end-user | Good in estimating the impact on the resources and assess whether change detail is enough or its impact on the effort. | This model does not perform any testing activities e.g. regression testing, acceptance testing, etc. | Checks the change impacts | [1], [9], [15] |
| S.A Ajila model | This model analysis the impact of the change on the functionality | No actors involved for input | Good in checking the impact of change on functionality | Negotiation after the change is missing and does not analyze the impact on cost, effort, etc. | Checks the change impact on the functionality | [1], [9], [15] |
| Simon lock model | This model analysis the change at the initial stage and hence saves the cost of software | Customer, developer, and end-user | Save the software cost as change can be stopped at the initial stage | This model is missing the activity at the initial stage that can help in understanding the change | Saves the change cost | [1], [9], [15] |

While managing the change requests stakeholders face different problems in a distributed environment. Some of the common issues related to stakeholders are due temporal, geographical [17] and communication distances. To manage the change request effectively, we need to understand the issues in a distributed environment. Table 2.2 explained below highlights issues related to stakeholders and managing the change request in a distributed environment.

*Table 2. 2: Stakeholder issue in GSD related to RCM*

| Problem | Description | Ref. |
|---|---|---|
| Pb1 | Misunderstandings, duplicate change requests & vague requirements. | [18] |
| Pb2 | Lack of communication medium. | [18] |
| Pb3 | Lack of changing awareness among all stakeholder | [19] |
| Pb4 | No standard format followed at different sites. | [18] |
| Pb5 | Different processes followed at different sites. | [1] |
| Pb6 | No uniform tool usage by the development team. | [1] |
| Pb7 | Lack of awareness of change needs. | [19] |
| Pb8 | No sharing of updated change documents. | [1] |
| Pb9 | Lack of understanding of change propagation | [19] |
| Pb10 | Impact of new requirements on existing ones. | [19] |
| Pb11 | Co-ordination issues due to different temporal distances. | [1] |
| Pb12 | Artifacts are produced in different formats. | [15] |
| Pb13 | Lack of decision making during traceability among artifacts. | [15] |
| Pb14 | Unassigned role and responsibility of change request activity. | [15] |
| Pb15 | Un updated and wrong selection of tool. | [1], [20] |
| Pb16 | Missing and unawareness of change validation at the end of the development phase. | [15] |
| Pb17 | Unawareness of Regression testing after change implementation. | [15] |
| Pb18 | No verification of implemented changes to check either the specifications are met or not. | [16] |
| Pb19 | Unable to perform the change configuration process by the stakeholder. | [15], [20] |
| Pb20 | Inexperience selection of cost and schedule estimation. | [21] |

## III. RELATED WORK

Different frameworks are introduced for handling the change process but the flow of work in them is not managed effectively. A global framework introduced by the author Niazi in which he improved the process of the requirement for a distributed environment [22]. Kumar & Kumar proposed the process of change according to types, relationship and interrelated activities of change. But they have not explained the communication of repository according to global context [23]. Sinha proposed EGRET (Eclipse-based requirement tool) for the understanding of the change request [21] and managing those changes in the global environment [24]. Lai proposed a repository

for change requirement but requirement change activities are missing as well process for managing change requirement is not complete.in case of rejection of requirement from the shared repository, no alternate scenario described [14]. Hussain proposed the process of a change request from initiation to a selection of change requests, analyze the change and the most important part in a change is that of the impact of change on the already existing requirement. But unable to explain the validation and verification of change after change implementation to check that the required specifications are met or not [25]. None ofthemexplained the change process fromthe verification perspective and none of them assigned the role and responsibility to the activities involved in the change process.

## IV. METHODOLOGY

As the objective of this paper is to study the change management in the distributed environment [26] and to find the processes and challenges related to it and reasons that are giving rise to change requests so for this we conducted a literature review. This paper also highlights problems that stakeholders and interacting sites faced in a distributed environment during managing the change request. This research paper addresses the following questions:

1) The process of change request comes in a distributed environment?
2) Challenges involved for acceptance of change requests on the multi-site stakeholder?
3) Did the solution suggest the discussed challenges in a distributed environment?

To address the above questions we conducted a literature review and found different models that are used to manage changes in the change request process in these models we have identified processes used to manage the change requests, activities involved in the change process and the arrival of change requests in a distributed environment. We have also searched for the main problems the stakeholders in a distributed environment and interacting sites have faced and then integrated them into a table and after proposing a framework we have provided a solution for all the mentioned problems.

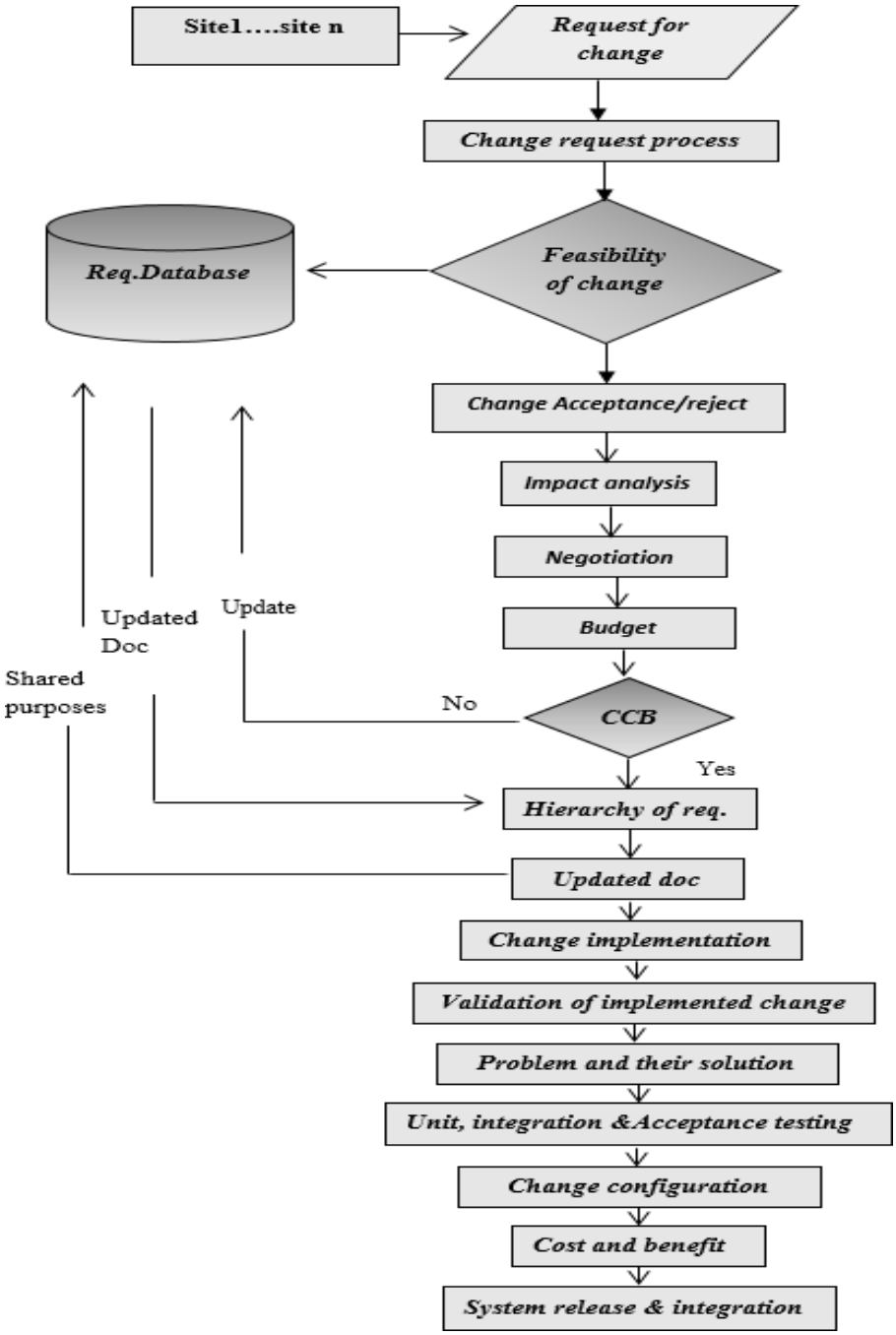


*Figure 1: Framework steps for Change Management*

## V. RESULTS AND DISCUSSIONS

The common elements in the above mention models are that none of them have explained the change configuration and change verification process after the change implementation. Models describe the process of change but provide no information about the challenges that the stakeholders faced when managing the change request. Same case with the framework proposed for requirement change management. As a framework for Requirement change management provide information about the understanding of change requests and actively involved in the change request process but they provide no information about the role and responsibility to carry out those activities and have little focus on the resulting artifact.

***Table 2.3: Change process, role & responsibility with their key artifacts***

| **Process** | **Activity** | **Description** | **Role and Responsibility** | **Artifact** |
|---|---|---|---|---|
| Change request | identify, validate, analyze control, action, and close | Title, Requested by, Reason, type of change, priority & outcome of change | Project manager | Requirement change document |
| Change Acceptance/reject | initiation, analysis, approve/reject and funding | check the impact and priority of change and also checking the funds for the change | project manager CCB | updated requirement change document |
| Impact analysis [27] | understand change, identify document & identify a task | impact on requirement functionality, impact on cost and schedule and impact on the stakeholder | CCB & developer | impact analysis report |
| Negotiation | the objective of negotiation, prepare, conduct and review negotiation | acceptable agreement between client and development team | end-user, contractor and project manager | negotiation record, change order checklist, cost estimates |

| | | | | |
|---|---|---|---|---|
| Budget allocation | create a budget, budget approval, allocate budget, utilize budget and reconcile budget | feasibility of change according to funds and resources provided | finance manager, sales manager, and marketing managers | Budget report |
| Change implementation | implement the change and monitor them | if desired output not met back out the changes | developer & testers | report on change implementation |
| Validation of implemented change | develop control &procedure, clarify and review system | check deliverable met the desired criteria or not also review system for validation accuracy | testers and developers | validation and lesson learned report |
| Unit, integration &Acceptance testing | create a test script, execute test cases and evaluate them | test cases, test criteria, test coverage, and type of testing | PM, test lead, test team, analyst and customer | test script, test log & test report |
| Change configuration | plan change configuration, deliver them, monitor configuration status and manage CR | baseline change request management according to workspaces | configuration manager, CCB & integrator | change Request, workspaces and configuration management plan |
| Cost and benefit analysis | define and identify cist elements and cost drivers, analyze risks and generate results | in this, we use different methods and technique for estimation and accuracy of the result | project manager, finance manager maintenance & engineers | cost and benefit report |
| System release planning | identify bugs, user guidance, installation manuals, and required documentation | exit criteria of a product | project manager, testers and marketing team | reports, manuals, and documentation |

Frameworks provide information about the process to carry out the task effectively but they have less focus on the challenges [28] involved by the stakeholder during managing the change request.

Here we have proposed solutions for the above-mentioned problems that are faced by stakeholders in distributed environments .mainly we have to overcome the temporal, geographical and communication distances. The table below is giving a possible solution to overcome these problems.

***Table 2. 4: Recommended Solutions for Stakeholder problems in GSD***

| Problem | Solution | Reference |
|---|---|---|
| p1 | Keep expecting and do planning for requirements that are going to change throughout the development process, prioritize requirement or reprioritize if required according to needs. | [29], [30], [8] |
| p2 | to avoid this problem we need to know our audience and need to communicate to them in ways that are easy for them to understand e.g. using diagrams, storyboards, prototypes, etc. and then get feedback from them | [29], [30], [8], [10] |
| pb3 | to solve this problem stakeholders need to be informed as soon as a change occurs in a way that, get input from them to prioritize it and identifying the reason to prioritize it | [29], [30], [8] |
| pb4 | standards should be followed throughout the interacting sites that will help to complete tasks effectively and on time | [29], [30], [8] |
| pb5 | to solve this problem inform all the interacting sites about the process to follow this is going to save time and can make the interaction better | [29], [30], [8] |
| pb6 | This is just like using the same processes among different sites so is to use the same tools among distributed interacting sites so this is also going to save time as there will then be no need to translate the information or data exchanged. | [29],[30], [8] |
| pb7 | For this, there is a need to identify all the key stakeholders including the end-user as well, and there should be a skilled facilitator as well to keep all the activities on track | [29], [8] |
| pb8 | For this, there should be one representative from each group of stakeholders how is going to keep them aware on regular basis and make it easy for all the involved stakeholders to share their feedback so that everyone gets updated. | [29], [30], [8] |
| pb9 | For this, there is a need to draw feedback from all of your stakeholder representatives and keep sharing it among the interacting sites and stakeholders | [29], [30], [8] |
| pb10 | For this, we need to test requirement changes at initial stages so that it can cost us less which is otherwise costly to tackle them in later stages | [29], [30], [8] |
| pb11 | For this, there is a need to follow standards, uniform tools, processes and to keep stakeholders informed regularly so, in this way, coordination problems should be solved to some extent. | [29], [30], [8] |

| | | |
|---|---|---|
| pb12 | For this one standard should be produced and then it should be circulated to all the distributed interacting sites and stakeholders and try to keep all related artifacts in a central repository so that it is accessible by the team. | [29], [30], [8] |
| pb13 | For this consistency should be maintained, creating manuals and then maintaining these manuals can also help to solve this problem | [8] |
| pb14 | There should be a facilitator who can keep track of every activity, representatives from each group of stakeholders so that managing change becomes easy | [8] |
| pb15 | For this try to invest in tools that efficiently gather and distribute requirements change information among different sites and stakeholders | [8] |
| pb16 | Validation should be included in the followed standards so that all sites and stakeholders are aware of this activity to minimize errors and get better results | [8] |
| pb17 | For this development team should provide advanced tool support and simulators and emulators should be provided | [8] |
| pb18 | For this verification should also be included in the followed standards so that all sites and stakeholders are aware of this activity to minimize errors and get better results | [8] |
| pb19 | Change configuration process should be followed and try to keep all stakeholders informed for this automatic notification can help to pass on this information | [8] |
| pb20 | For this, there is a need for an experienced and skilled employee in cost and schedule estimation | [8] |

## VI. CONCLUSION AND FUTURE RESEARCH DIRECTION

Different change models and frameworks proposed to manage the change process effectively and to understand the challenges involved by the stakeholder due to differences in geographical and temporal distances. Change models do not focus on verification of change requests and change configuration after implementation of a change request. The globalrequirement change framework deals with the change process effectively but unable to assign role and responsibility to the change process activities also unable to discuss challenges involved by the stakeholder due to geographical and communication distances. Our framework process not only defines a good balance change process but also identifies change activity in each process, role and responsibility to carry out the

process and artifact as well. Also, provide the solution to the challenges that are faced by the stakeholder in a distributed environment while managing the change request.

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# Improved Technique: An Alternative Method of Nodal Analysis

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***Abstract*- Electric circuits plays dynamic role in each aspects of electrical engineering. An electrical engineer talent is to study in what manner circuits are split up into simpler parts. Though, breaking up hitches into lesser stages is the core of engineering. This research offers a sample of engineering approach to problem solving in modest and effective way. In Circuit analysis, means working out voltages and currents in each component. Node Voltage method is an organized scheme in investigating a circuit. Kirchhoff's Current Law (KCL) is precondition for nodal analysis, it selects node voltage as circuit parameter that supports in minimizing the number of equations that makes the design and calculation easier. This paper reports improved method of nodal analysis that computes node voltage based on the information of Ohm's Law only. This is an easy-going technique, much simpler, carries lesser amount of time, reduces the circuit complications and keeps the calculation easier and informal as compare to formal Nodal analysis.**

**Keywords:** Extra Node, Home Node, Kirchhoff's Current Law, Modified Equivalent Circuit, Nodal Analysis.

## I. INTRODUCTION

Energy is present everywhere in nature in different forms but the most significant form of energy is electrical energy. In modern time every one is dependent on the use of electrical energy which is almost become a part of our life. An electric circuit plays a significant role in electrical engineering. It transmits power that is used for energy purposes like to run electric appliances, medical instruments etc. Several applications related to electrical circuits are observed in [1].

As the study says that mentioned in [2-8], there are numerous methods like Kirchhoff's Current Law (KCL), Kirchhoff's Voltages Law (KVL), Mesh analysis and Nodal analysis etc. to resolve electric circuit parameters (node voltage, element current or voltage).

According to the earlier researches elaborated in [9-10], Nodal analysis is a versatile procedure for examining circuits by node voltages.

In previous researches [11-12] it is discussed that; a node is an intersection point where two or more than two elements combine.

Aiming to avoid the complication in circuit analysis and to get rid from electrical rules formalities, such as KCL, we developed a new technique that will present a unique idea to get node voltages

using only the basic knowledge of mathematics. DC circuits and Ohm's Law are the prerequisite for good understanding of this method as mentioned in [13].

It can be implemented in electric network designing, voltage distribution, power management and complex network calculations such as buildings, domestic electric wiring, industry and airplane etc.

## II. GENERALIZED FORM

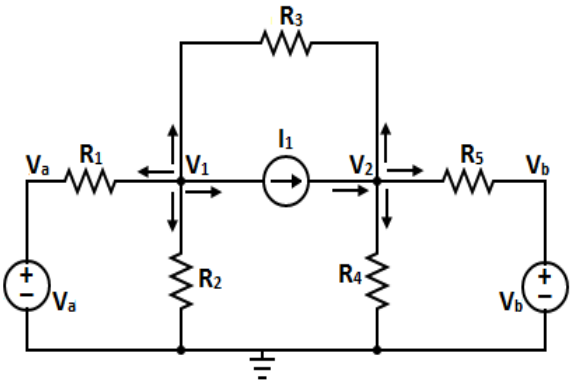


**Fig. (1).** A generalized circuit to find node voltages.

The circuit in Figure 1 consists of three elements; independent current source I, voltage source V and resistors R.

Step: 01 Firstly, find the LCM of all resistors present in the circuit. Let $R_{LCM}$ be the LCM of the all resistances.

Step: 02 Next step is to find ratio of all resistors with $R_{LCM}$ and is denoted as a, b, c, d, e and so on.

$$a = \frac{R_{LCM}}{R_1} \quad (1)$$

$$b = \frac{R_{LCM}}{R_2} \quad (2)$$

$$c = \frac{R_{LCM}}{R_3} \quad (3)$$

$$d = \frac{R_{LCM}}{R_4} \quad (4)$$

$$e = \frac{R_{LCM}}{R_5} \quad (5)$$

.
.

$$z = \frac{R_{LCM}}{R_n} \quad (6)$$

If there is any independent current ($I_1$, $I_2$, $I_3$ …) then multiply $R_{LCM}$ with it (it becomes a voltage source $IR = V$) and will be treated as independent voltage source $V_{LCM}$ but its direction remains same and voltage source remains unchanged. If there are nth current sources then voltages will be

$$V_{LCM_1} = R_{LCM} I_1 \qquad (7)$$

$$V_{LCM_2} = R_{LCM} I_2 \qquad (8)$$

$$V_{LCM_3} = R_{LCM} I_3 \qquad (9)$$

$$V_{LCM_n} = R_{LCM} I_n \qquad (10)$$

Step 03: Finally, construct the equivalent circuit to make the calculation easier and this is the main step of our new approach as shown in figure 02.

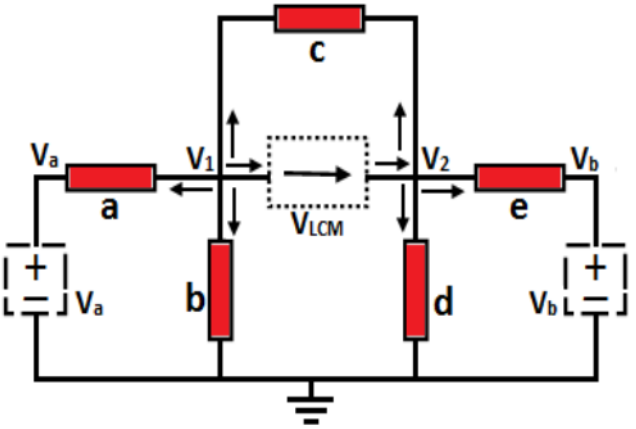


**Fig. (2).**: Equivalent circuit, the rectangular boxes show the resistance ratio a, b, c ... z and are not treated as resistor anymore.

To solve the equivalent circuit, calculate the equations for node voltage ($V_1$ & $V_2$).

*For node voltage $V_1$ (Home Node)*

Suppose $V_1$ is Home Node.

Here we are considering Home node as the node under observation and Extra node are the nodes connected to home node.

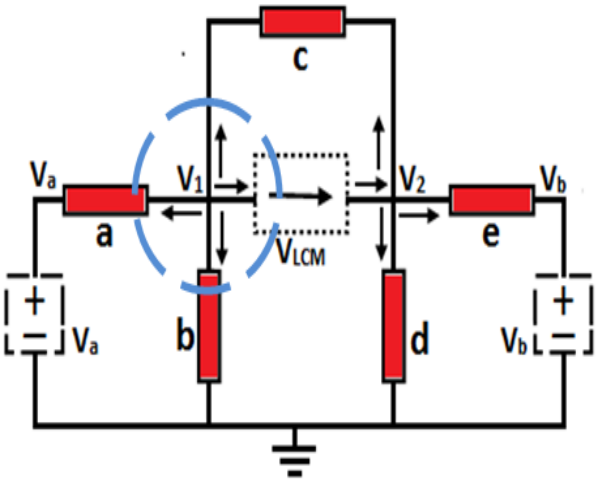


**Fig. (3).** Circuit representing resistance ratios connected to home node $V_1$.

On the left side of figure 03, take the sum of all resistor ratios connected to Home Node $V_1$ and multiply with $V_1$, similarly on right side multiply extra node (in this case $V_a$ & $V_2$) to the resistors (if any) connected to it.

Current source is converted to voltage source as discussed earlier. According to this rule, If the direction of the current source is away from the home node, write it with home node values and if towards the home node, it will be written with extra node values.

$$(a + b + c)V_1 + V_{LCM} = (a)V_a + (c)V_2 \quad (11)$$

*For node voltage $V_2$ (Home Node)*

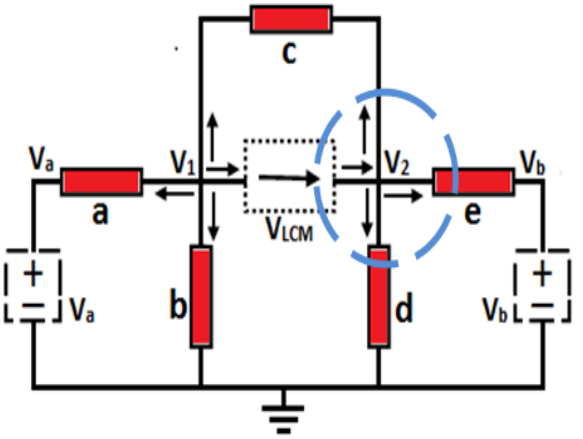


**Fig. (4).** Circuit representing resistance ratios connected to home node $V_2$.

Similarly, from figure 4, the equation for $V_2$ will be

$$(c + d + e)V_2 = (e)V_b + (c)V_1 + V_{LCM} \quad (12)$$

Now, the value of $V_1$ and $V_2$ can be find by using Inverse method, Substitution, Cramer's rule, Gauss Jordan Elimination method or by using calculator mentioned in [7-9].

## III. NUMERICAL ANALYSIS

Below few examples discussed, shows the comparison of Nodal Analysis and Modified Nodal Analysis.

***Example 01(A):*** Find the node voltages by using Nodal Analysis.

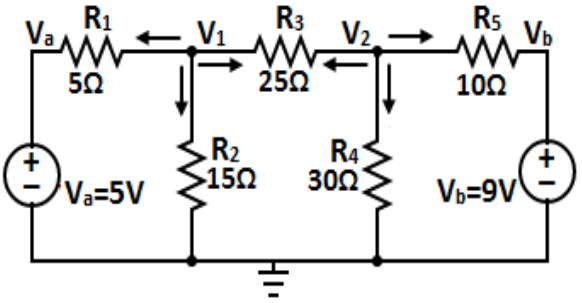


**Fig. (5).** Circuit without current source.

Solution:

At Home Node $V_1$:

According to KCL,

$$\frac{V_1 - V_a}{5} + \frac{V_1}{15} + \frac{V_1 - V_2}{25} = 0$$

$$\therefore V_a = 5V$$

$$23V_1 - 3V_2 = 75 \rightarrow (13)$$

At Home node $V_2$:

According to KCL,

$$\frac{V_2 - V_b}{10} + \frac{V_2}{30} + \frac{V_2 - V_1}{25} = 0$$

$$\therefore V_b = 9V$$

$$-6V_1 + 26V_2 = 135 \rightarrow (14)$$

Now by solving Equations (13) and (14), $V_1$ and $V_2$ can be find out as

$$V_1 = \mathbf{4.060V}\ and\ V_2 = \mathbf{6.129V}$$

***Example 01(B):*** Find the node voltages by using Modified Nodal Analysis for the same circuit as in figure 05.

Solution:

Take LCM of all Resistors:

| | |
|---|---|
| 2 | 5, 10, 15, 25, 30 |
| 3 | 5, 5, 15, 25, 15 |
| 5 | 5, 5, 5, 25, 5 |
| 5 | 1, 1, 1, 5, 1 |
| | 1, 1, 1, 1, 1 |

**Fig. (6).** LCM of all resistors used in figure 05.

$$R_{LCM} = (2)(3)(5)(5)$$

$$R_{LCM} = \mathbf{150\Omega}.$$

***Modified Equivalent Circuit:***

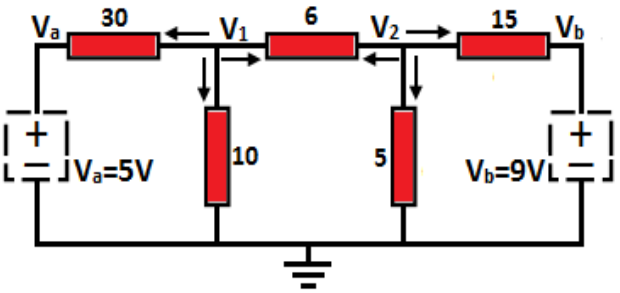


**Fig. (7).** Modified equivalent circuit of Fig (5).

At Home Node $V_1$:

$$(30 + 10 + 6)V_1 = 6V_2 + 30(V_a)$$

$$\therefore V_a = 5\text{V}$$

$$46V_1 - 6V_2 = 150 \rightarrow (15)$$

At Home Node $V_2$:

$$(6 + 5 + 15)V_2 = 6V_1 + 15V_b$$

$$\therefore V_b = 9\text{V}$$

$$-6V_1 + 26V_2 = 135 \rightarrow (16)$$

Now $V_1$ and $V_2$ can be achieved by solving Equations (15) and (16).

$$V_1 = \mathbf{4.060V} \; and \; V_2 = \mathbf{6.129V}$$

***Example 02(A):***

Find the node voltages by using Nodal Analysis.

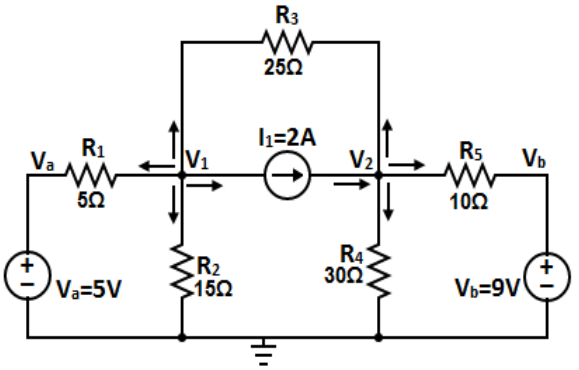


**Fig. (8).** Circuit including current source.

Solution:

At Home node $V_1$:

According to KCL:

$$\frac{V_1 - V_a}{5} + \frac{V_1}{15} + \frac{V_1 - V_2}{25} = -I_1$$

$$\therefore V_a = 5V \; \& \; I_1 = 2A$$

$$23V_1 - 3V_2 = -75 \rightarrow (17)$$

At Home node $V_2$:

As per KCL:

$$\frac{V_2 - V_b}{10} + \frac{V_2}{30} + \frac{V_2 - V_1}{25} = I_1$$

$$\therefore V_b = 9V \ \& \ I_1 = 2A$$

$$-6V_1 + 26V_2 = 435 \ \rightarrow (18)$$

Now $V_1$ and $V_2$ can be achieved by solving Equations (17) and (18).

$$V_1 = -\mathbf{1.112V} \ and \ V_2 = \mathbf{16.474V}.$$

***Example 02(B):*** Find the node voltages by using Modified Nodal Analysis for the same circuit in Figure 08.

Solution:

LCM of all Resistors:

| | | | | | |
|---|---|---|---|---|---|
| 2 | 5, | 10, | 15, | 25, | 30 |
| 3 | 5, | 5, | 15, | 25, | 15 |
| 5 | 5, | 5, | 5, | 25, | 5 |
| 5 | 1, | 1, | 1, | 5, | 1 |
| | 1, | 1, | 1, | 1, | 1 |

**Fig. (9).** LCM of resistors used in Figure 8.

$$R_{LCM} = \mathbf{150\Omega}.$$

***Modified Equivalent Circuit:***

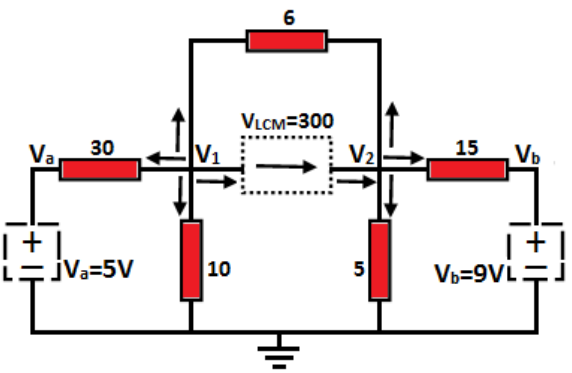


**Fig. (10).** Modified Equivalent circuit for Figure 8.

At Home node $V_1$:

$$(30 + 10 + 6)V_1 + V_{LCM} = 6V_2 + 30V_a$$
$$\therefore V_a = 5V \ \& \ V_{LCM} = 300V$$
$$46V_1 - 6V_2 = -150 \ \rightarrow (19)$$

At Home node $V_2$:

$$(6 + 5 + 15)V_2 = 6V_1 + 15V_b + V_{LCM}$$
$$\therefore V_b = 9V \ \& \ V_{LCM} = 300V$$
$$-6V_1 + 26V_2 = 435 \ \rightarrow (20)$$

Similarly, $V_1$ and $V_2$ can be achieved by solving Equations (19) and (20).

$$V_1 = -\mathbf{1.112V} \ and \ V_2 = \mathbf{16.474V}.$$

## IV. RESULT AND DISCUSSIONS

| Example No. | Nodal Analysis | Modified Method |
|---|---|---|
| **1** | $V_1 = 4.06V$ & $V_2 = 6.129V$ | $V_1 = 4.060V$ & $V_2 = 6.129V$ |
| **2** | $V_1 = -1.112V$ & $V_2 = 16.474V$ | $V_1 = -1.112V$ & $V_2 = 16.474V$ |

***Table 01:*** Comparison between Nodal Analysis and Modified method.

From the above analysis in Table 01, it can be clearly noticed that both methods providing same results and almost have same number of steps, but Modified method is easier to understand, consume less time than Nodal Analysis. This method provides direct equation without the knowing Kirchhoff's Current Law (KCL), only the knowledge of Least Common Multiple (LCM) and Ohm's Law is enough.

## V. FUTURE IMPLEMENTATIONS

Modified method can be implemented on the super nodal circuits and it may be helpful for solving the circuits with dependent voltage or current sources. It can be applied to RC, RL and RLC circuits as well.

## VI. CONCLUSION

Electric circuits play major role in our life. Many engineers, scientists have tried to make their solution easy; the efforts of Mesh and Nodal are unforgettable. But this modified analysis has presented another easy way to simplify electric circuit through LCM and Ohm's Law. So, it is finally concluded from the results that this method is more flexible and less time consuming as compare to Nodal Analysis.

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# ANALYZING THE EFFECT OF PERFORMANCE KEY ENABLERS DURING FLOW OF INFORMATION IN BETWEEN TWO UNIT IN AUTOMOBILE SECTOR OF PAKISTAN

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***Abstract*- To understand the essential need with respect to the business strategy it is necessary to assess in the domain of performance Management. In most of the pervious study researches were more focused on non-financial factors that significantly used as indictor to evaluate the productivity less focus on the transparent information sharing across the inter departmental attribute. A brief study is conduct under the frame of performance criteria to adopt and integrates with organization strategic factors.In most of organization performance measurement were critical interface to predict the pre desire set of objective in order to achievethe strategic mileage. The Aim of this study used to highlight the significant performance enablers that used to put potential influenceduring the sharing the flow of information between two different department. In case of this study more formulated focus on production and procurement were emphasis that allows investigating the relevant variables used to measure the performance.**

**Keywords:** Performance; Production; Procurement; Inventory; Rework; Loading.

## I. INTRODUCTION

The Performance measurement is necessary to evaluate the significant impact on overall strategy of organizations among public or private sector firms. Performance management assessment allow companies to rectify there shortcoming and estimate there forecast to improve the overall efficiency and effectiveness within the organization. The most challenging element for the performance assessment is to analyze overall organizational strategy align with the multiple entities of performance indicator (Glendinning, 1981; Guthrie, April 2015; Tuly, 2010) . In most case public and private sector firms used to enable performance assessment mechanism as their trademark to ensure the adequate allocation of funds to the respective needs. The culture to adopt such practices used to maintain Audit index as transparent source to measure the performance and efficiency of companies. In most cases during evaluation of performance indicator a conventional approach would be taken by most of the firm's auditor by analyzing factors from financial domains. However, in our case most of our focus on factors which commonly associate with functional communication that connects manufacturing department with others during the production process. In most of the pervious study researches were more focused on non-financial factors that significantly used as indictor to evaluate the productivity less focus on the transparent information sharing across the inter departmental attribute (Sageder & Feldbauer-Durstmüller, 2019). In Traditional way the financial attributes were taken as short term goal while as far as the non-financial attributes is used to analyze the future estimation for performance (Crabtree & Debusk, 2008; Ittner & Larcker, 1998). According to the regional and global competitiveness pressure most of the manufacturing firms used to adopt the productivity improvement techniques such as TQM, BSC, EFQM, Lean Six Sigma, and implementation of such tool had significant outcome in term of measuring the overall performance. But the problem is how much adequate such techniques

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In order to validate the effectiveness of process improvement techniques decision makers required to understand the nature of the manufacturing multiple layer information flow. That enables the significant role in between the performance evaluation process and the gathered process indicator to optimize and scale performance parameter. As the nature of manufacturing function huge resilience face by the companies due to transparent flow of information related performance such as the production variation cost or process variation cost. In contrast of transparent information sharing this research also analyze the key variables that involves in formulating the performance measurement due to information sharing between production department and procurement department

This study analyzes the variables related to transparent sharing of information during the peak manufacturing cycle in context with performance management. Multi-Regression Model was applied to frame the effect on performance management. The primary data were collected from samples of 107 production managers and around 109 iterations were collected from the procurement managers at automotive sector in Pakistan, as focus on more over the integrated information flow in between two department 115 manufacturing companies respond among 113 companies as the nature of information (PAAPAM, 2021). The major implication of the formulated information analyze in context of performance management domain and the main focus on the variable or the attributes used as the shared data among two department were further addressed.

## II. LITRATURE REVIEW

### *2.1 Performance Management in Domain of Production Unit*

Study the most recent literature regarding to the performance or attributes used to highlight performance management indicator in production before that much focus what necessary to formulate the empirical aspect of performance management with a theme more resemblance toward the business strategic plane. André A. de Waal (2000) analyze some of vital strategic aim and vision that used to enhance the effectiveness to improve performance management in production or simple in other word production performance in domain with strategic goal (André A. de Waal, 2000). As with most convention approaches the most fundamental which shed the focus on the strategic goal is SMART (Strategic Measurement and reporting technique) used to interface a transparent information flow among the other business unit (Kurien & Qureshi, 2011). Henke and Quitt (2010) brought a attention to other approach known as performance prism its advocates the ingredients used to maintain and strengths the existing measurement procedure which were adopted to improve with respect to perception of customer and shareholder Robert Kaplan and David Norton (1992), revolutionize the existing performance management indicators specifically the nature multidimensional activities in production (André A. de Waal, 2000). It used to represent the multilayer approach to control and sustain the strategic vision and reposition the organization goal through centralized decision making system. Fitzgerald in (1991) used to formulate probabilistic approach to predict the performance related result and analyze the determinates of outcomes such system known as advance performance measurement Matrix (PMM) (Lin Fitzgerald, 2003). More synchronize approach used to develop by Ghalayin (1997) used to investigate the actives among three important element such as organizational management, process improvement team, and characteristic similar to the shop floor team and try to synchronize as integrated Dynamic performance measurement (Paul Rouse, 2003). Dong et al (2010) used to investigate that significance of quality management as result they concluded the observation that EFQM excellence model is not only used to sustain quality parameter; but it can also sustain the entire aspect of performance measurement indicators that were difficult to implement (Shahryar Sorooshian, 2016). The performance management as complete system with respect to complete functions of organization and last but not least organization operating environment, Waggoner et.al (1999) used to highlight the significant force that were used to influence and unable to evolve practice of performance measurement system these four element

categories as, the first organization internal management influence, external such as customer and shareholder, individual and synchronize process related issue and last one resilience to transformation (Felix T.S. Chan, 2003). Klassen and whybark (1999) as holistic approach in most of researcher used to advocate the performance measurement can be potentially used to resolve specific organizational problem and in that regard they used to suggest the specified frame work and specified Methodologies (Klassen, 2000).

*2.2 Performance Management in Domain of Procurements Unit*

Consider previous studies on procurement function seems to be considering as critical element for both production and finance function. If analyzing the core concept of procurement, this function contain numerous practices not just make to order to the supplier but there are several activities which has direct impact overall variation on performance management indictors such process duration and quality thus influencing on performance effectiveness and overall efficiency of procurement department. Daniel Knudsen (1999) were focus more on achieving the strategic goal in domain of performance measurement decision makers use to analyze and formulate the strategies use to adopt in procurement some of performance management matrix relevant actives are strategic feedback processes , diagnostic feedback , quantitative inputs for forecasting (Cartlidge, 2007). With spam of time procurement processes and procedures changing strategies, there are many studies formulate on performance based procurement but less attention has been made more focus on side to analyze the supplier performance. Van weele (2005)examine some of the critical issue evolve during the measuring the performance in procurement because of the nature of the companies behaviors inputs and outputs relationship always under shadow Van weele identified the short term and long term KPIs that used to assess effectiveness and efficiency such as reduction of opportunity cost acceleration of flow of shard information overall market cycle (Weele, 2005). As procurement function carry strict activities of control and monitoring processes bundling of mix specific product planning in contrast of performance management and sharing of information wereused to increase the efficiency and effectiveness between production and procurement (Lotf, Mukhtar, Sahran, & Zadeh, 2013).

*2.3 Shared information influence on both department*

Most of the organization un-cascaded there transparent data sharing to other functions which cause severe consequences. It is necessary to match certain information in order to float the smooth decision making (Heisig, 2012). To create the detail map of production and procurement schedule some of transparent indicator used to exchange the valid information such flow contains number of useful information (Karel van Donselaar, 1997). The first one, the complete Bill of material which provides the complete set of information explains inventory status with respect to that how production can pull their demand to meet, second on time delivery depends upon the number of factors stored inventory, rework, value of productivity, order delay, and loading time and most important is lot size (Münch, 2015). Van weele and Knudsen (2003) suggested some generic information used among all manufacturing and procurement departments that includes: inventory, cost per order, effectiveness of delivery, supplier evaluation, solving error rate, supply chain cost effective processing time inventory, rework, value of productivity, order delay, and loading time by exchanging and relating such information flow between procurement and production units of organization helps to formulate the generic prospect of finding the most influential factors in order to optimize performance outcome which impact on overall performance measurement in order to achieve the strategic business goal (Głodziński, 2019). These studies granted a Model on the bases of elements used to coordinates among production and procurement and help to drive and map the effectiveness and efficiency for performance measurement Online survey and interview design and circulates among Manufacturing companies which used to facilitate for data collection.

## III. MATHEMATICAL MODELLING

The research tool sends to 38 automotive registered companies in Pakistan. The primary data were collected from samples of 38 production and procurement managers and around 27 iterations were collected from the procurement managers at automotive sector in Pakistan, as focus on more over the integrated information flow in between two department (PAAPAM, 2021). A total of 34 companies responded out of 38 through email, some companies due to the nature of information they keep their confidential parameter and reply the reason not to respond to the information overall response rate is 24.14% this response consider the much moderate as compare to other study which is reported to similar in literature (Kumar, Ozdamar, & Ng, 2005; Lisboa, 2007). Considering the fact that it is really difficult to receive the complete response most of the companies unable to provide the transparent data even most of the companies were out of the shape that due to nature of the economy. It is really complex to analyze the preciseness of the iteration therefore the most of the people from academies and researchers led to believe that the complete outcome in response is enough to analyze on the desire model. There is no change on the characteristic on the significant nature of responded sample and non-responded sample therefore no significant change in terms nature of receive samples $\alpha$=0.05. This use to illustrate that chance of finding the ripple effect with respect to the data sample does not really exit is only 5%. In other this probability error is acceptable. A Sample of research questionnaire contain the useful data attributes which will soon use to formulate on the design model distribution of questionnaire responded by Managers of each departments some of the companies outsource their procurement function most of the Managers promoted from downstream most common error need to analyze as the perception of understanding the performance management under the domain of human resource and try to counter their argument according to it most focus were made a transparent information share which generally include eight attributes commonly use among production and procurement unit.

The adoption of research tool was drive from the empirical investigation of yeap chin chong related work on Malaysian local industry which use to analyze the remuneration based performance system, this research study used to highlight the generic prospect thus some of the ambiguities which was inconsistent nature of information regarding that some literature is added, In second layer this research based questionnaire to float among some of the people of academicians and professional consultant in order to oversee the leftover iterations. The final version of the tool is send to the 38 manufacturing companies to get the respond relevant to the attributes used to share among production and procurement has impact on performance Management. The questionnaire is designed on simple likert-type scale consist of five option

### *3.1 Mathematical Modeling*

In order to predict the significant variable that is used to illustrated the influential probabilistic estimation regarding the critical information common in between the Production and procurement department for that purpose multiple regression analysis used to investigate the depended variable which are continuous in nature. Most of the researcher used to investigate the multi regression analysis to predict the comprehensive estimation. Cohen, Cohen, West, and Aiken (2013) Formulate the break through by analyzing stress experience by an individual person and with respect to the amount of illness suffer due to that stress. Powell (1999) used to estimate the probabilistic nature of the number of job experience in contrast to employee pay which is essentially depend up the number of female employee in the workplace in order to increase their pay rise. Ghosh (2014) Use multi regression model in order to analyze the food consumption of the different type fish spices. Coleman, Hoffer, Kilgore, Center, and Statistics (1981) Investigate the educational policy adopted in private and public school with respect to the student achievements. Weiner, Freedheim, Schinka, and Velicer (2003) Formulate chance of breast cancer patient for recommendation of mammography etc. In spite numerous application multi regressions. Required certain parameter to adjust

before applying regression analysis it is important that predicted model may affect due to the multi variable correction its mean the characteristic of certain variable has some similarity (Ghosh, 2014).

Multi-collinearity among the in-depended variable cause dramatic effects to identify which variable is the most important contributor in the physical process. Neeleman (2012) stated that if the absence of the Multi-collinearity and non-singularity among the covariance it is difficult to calculate the unbiased estimator of the coefficient of the equation. There certain important method available as to reduce the Multicollinearity and redundant in-depended variable by Map there values data through principle component Analysis (PCA). From various studies it is observe multi regression based on (PCA) used for reduce the interrelationship among in depended variable during forecasting the stock index (Montgomery, Peck, & Vining, 2015; Nop Sopipan 2012 )

*The basic Multi regression form*

$$P = Q0 + Q1x1 + Q2x2 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots Qnxn \quad \text{Equation 1}$$

*While in General form sample regression model written in term of $n^{th}$ iteration pair data ($P_i$, $x_i$) (i=1, 2, 3, 4 n) thus, the least square criterion is*

$$S(Q_0, Q_1) = \sum_{i=1}^{n} (Pi - Q0 - QiXi)^2 \quad \text{Equation 2}$$

*Least square estimation of $Q_0$, $Q_1$ says $\hat{H}_0 \hat{H}_1$ must be satisfy*

$$\frac{\partial s}{\partial x}\Big|_{\hat{H}_0 \hat{H}_1} = -2\sum_{i=1}^{n} (P_i - \hat{H}_0 - \hat{H}_i x_i) = 0 \quad \text{Equation 3}$$

$$\frac{\partial s}{\partial x}\Big|_{\hat{H}_0 \hat{H}_1} = -2\sum_{i=1}^{n} ((P_i - \hat{H}_0 - \hat{H}_i x_i)_{xi}) = 0 \quad \text{Equation 4}$$

*By simplifying these two equation yields*

$$\eta\hat{H}_0 + \hat{H}_1 \sum_{i=1}^{n} xi = \sum_{i=1}^{n} Pi \quad \text{Equation 5}$$

$$\hat{H}_0 \sum_{i=1}^{n} xi + + \hat{H}_1 \sum_{i=1}^{n} (x_i) \sum_{i=1}^{n} Pi\, xi$$

*The least square normal equation*

$$\hat{H}_0 = \bar{P} \hat{H}_1 \bar{x} \quad \text{Equation 6}$$

$$\hat{H} = \sum_{i=1}^{n} P \quad xi \; (\sum_{i=1}^{n} Pi)(\sum_{i=1}^{n} xi)/n \;/\; (\sum_{i=1}^{n} (xi^2)) \quad \sum_{i=1}^{n} (xi)^2/n \quad \text{Equation 7}$$

*There for the $\hat{H}_0$ and $\hat{H}$ become the LSE to intercept and slope respectively*

$$\hat{p} = \hat{H}_0 + \hat{H}_i x_i \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{till nth value}$$

*Nomenclature with respect to our requirement*

$$OTD = \beta 0 + \beta_1 (INV) + \beta_2 (REW) + \beta_3 (PROD) + \beta_4 (ORDD) + \beta_5 (LOD)$$

*INV= Inventory, REW= rework, PROD=productivity, ORDD= order delay, LOD =Loading*

## IV. RESULTS AND DISCUSSION

The most interesting fact that observed from the information that used to influence the performance of both departments used to extract from different tools most common used in balance sore card method to scale the attributes regarding through iterations were formulated in case of this research the information that is accumulates from these tool were used for both pre and post analysis in order to find the fitness of goodness. Most of the observed iteration map using companies' internal audits accordingto the

criteria set in this research is to formulate the gather information according to the scale of used in questionnaire and observed 5 independed variable that is directly made influence one depended variable in our case on time delivery is consider as depended variable, while the independed variable are Inventory, loading, order delay, productivity and rework, to analyze the impact over (OTD) on time delivery for that purpose 27 sample were collect of each independed variables IBM SPSS 22, Minitab 17 and Microsoft excel tool were used to valid the accuracy of iterations.

One step necessary to measure before formulated and analyze the complete observation it necessary to validates some critical test which used to align the information more towards the probabilistic estimation, there are two ways to conduct such evaluation; The first one correlation among independed value the observation because it effects the statistical analysis. The most important aspect if there is Multicollinearity among independed variable cause large *R* square in multi regression analysis none of the individual beta weight are statistically significant. As result bizarre beta weight estimates one thing is critical removing and addiction of one or more predictor variable result in enormous change to the model

**Coefficient Correlations**

| Model | | | order delay | rework | Inventory | Productivity | loading |
|---|---|---|---|---|---|---|---|
| 1 | Correlations | order delay | 1.000 | -.084 | -.065 | -.188 | -.216 |
| | | rework | -.084 | 1.000 | .362 | .212 | .194 |
| | | Inventory | -.065 | .362 | 1.000 | .032 | -.151 |
| | | Productivity | -.188 | .212 | .032 | 1.000 | -.463 |
| | | loading | -.216 | .194 | -.151 | -.463 | 1.000 |
| | Covariance | order delay | .000 | .000 | .000 | .000 | .000 |
| | | rework | .000 | .000 | .000 | .000 | .000 |
| | | Inventory | .000 | .000 | .000 | .000 | .000 |
| | | Productivity | .000 | .000 | .000 | .000 | .000 |
| | | loading | .000 | .000 | .000 | .000 | .000 |

a. Dependent Variable: on time delivery

***Table 1 : Coefficients Correlation***

The worthiness of Multi collinearity test illustrate the adverse effect on Multi regression analysis as there are strong correction among the independed variable for that purpose correlation coefficient scale the value in between +1 and -1 this approximation defines the Pearson or monotonic relationship (Gravetter & Wallnau, 2007) in above case no independed variable having a strong resemblance among each other and according to the approximation its illustrate that independed variable with more absolute value drive strong relation between variable. If it is equal to zero it illustrate absence of relation and in Multicollinearity if the values of independed variables more or absolute toward a -1 that mean variable A has high value associated with the variable B lower value

ANOVA

| | Df | SS | MS | F | Significance F |
|---|---|---|---|---|---|
| Regression | 5 | 0.015084993 | 0.003016999 | 812.5782119 | 2.78698E-23 |
| Residual | 21 | 7.79703E-05 | 3.71287E-06 | | |
| Total | 26 | 0.015162963 | | | |

***Table 2: ANOVA***

Analysis of Variance use to highlight the number of distinct values that independed variable can take one as result in different mean values of the independed variable in above case the ANOVA test used to express values against the critical approximation made by most of the researcher suggested on various cases the most critical is cronbach alpha (α) values in generally if the probabilistic estimation or the p- value associated with each independed variable is more less than suggested value which is α = 0.05 then the chosen level of significance. This indicates independed variables close to that value or less that value has strongly contributor for significantly to measure variability in outcomes or on depended variable. As follow this approximation the according to data sample collected from the questionnaire the value of significance is much less than α = 0.05 in above case significance F = $2.7\times 10^{-23}$shows probabilistic estimation must be measure because the independed variables (INV, REW, PROD, ORDD, LOD) has significant variability in outcomes while keep in mind the sum of the square which used to calculate the total variability on overall mean value of data which is around 00.015084993 while the nature of availability of independed variable for purpose to calculate sum of square (DF= 5)

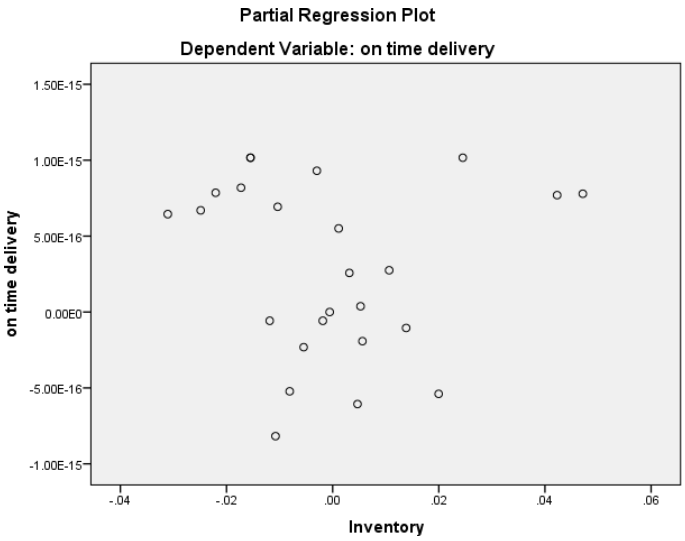
| SUMMARY OUTPUT | |
|---|---|
| *Regression Statistics* | |
| Multiple R | 0.997425609 |
| R Square | 0.994857845 |
| Adjusted R Square | 0.993633523 |
| Standard Error | 0.001926881 |
| Observations | 27 |

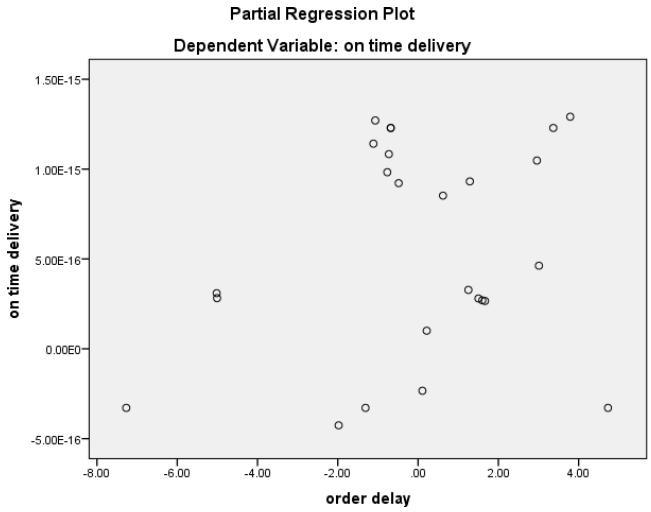
***Table 3: Output Summary***

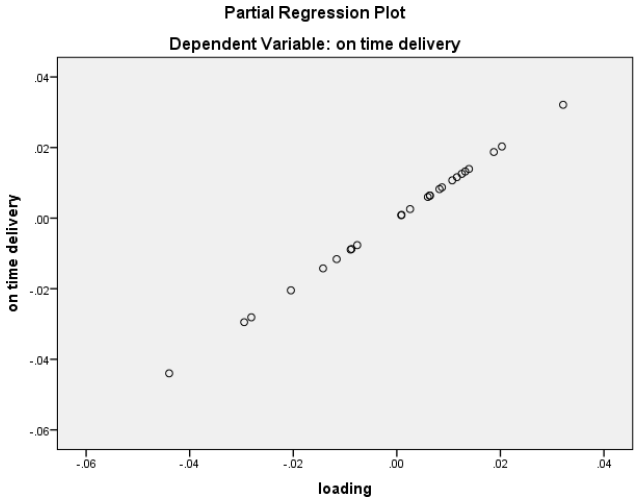
For regression analysis illustrate that $R^2$ = 99.48% illustrate that independed variables (INV, REW, PROD, ORDD, and LOD) account 99.4r % of the variance on depended variable OTD (on time delivery) similar in case of Adjusted $R^2$ = 99.36% represent the total variability on OTD (on time delivery) is explain by (INV, REW, PROD, ORDD, and LOD)

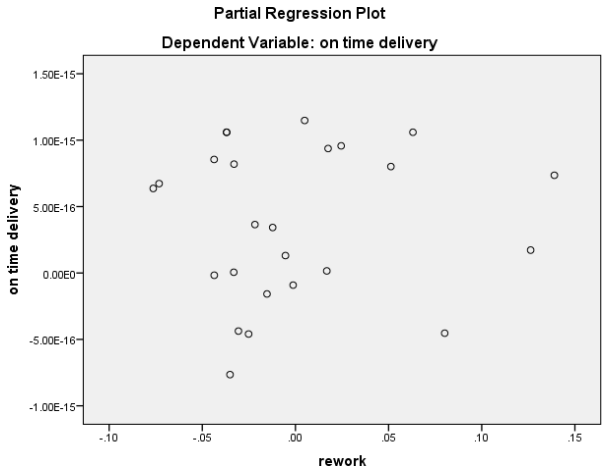
| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | -7.883773538 | 0.180426011 | -43.69532703 | 4.18905E-22 | -8.258989966 | -7.50855711 | -8.25899 | -7.50855711 |
| INV | 0.002391073 | 0.020298434 | 0.117795936 | 0.907348773 | 0.039821831 | 0.044603978 | -0.0398218 | 0.044603978 |
| REW | -0.001227905 | 0.007091555 | -0.173150334 | 0.864191342 | -0.0159756 | 0.01351979 | -0.0159756 | 0.01351979 |
| PROD | -0.000160479 | 0.015592753 | -0.010291898 | 0.991885547 | 0.032587383 | 0.032266425 | -0.0325874 | 0.032266425 |
| ORDD | -0.000205008 | 0.000132212 | -1.550604095 | 0.135937089 | 0.000479957 | 6.99413E-05 | -0.00048 | 6.99413E-05 |
| LOD | 0.986968796 | 0.02112189 | 46.72729538 | 1.03808E-22 | 0.943043421 | 1.030894171 | 0.94304342 | 1.030894171 |

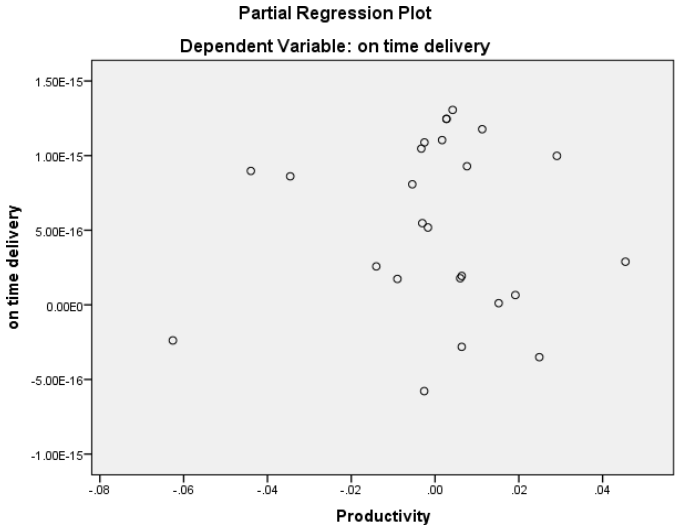
Table 4 : Complete Model Summary


Partial Regression Plot
Dependent Variable: on time delivery
on time delivery
Inventory


Partial Regression Plot
Dependent Variable: on time delivery
on time delivery
order delay


Partial Regression Plot
Dependent Variable: on time delivery
on time delivery
loading


Partial Regression Plot
Dependent Variable: on time delivery
on time delivery
rework


Partial Regression Plot
Dependent Variable: on time delivery
on time delivery
Productivity

Inserting the coefficients in the Multi regression equation, the final equation can be express as

$OTD = \beta 0 + \beta_1 (INV) + \beta_2 (REW) + \beta_3 (PROD) + \beta_4 (ORDD) + \beta_5 (LOD)$ [*EQ1*]

OTD = -7.88377+ 0.002391 (INV) -0.00123 (REW) -0.00016 (PROD) -0.00021 (ORDD) + 0.986969 (LOD)

Overall summary even including scatter plot illustrate (LOD) loading time become one of the significant contributors among the in-depended variable that illustrate the straight line in scatter plot that's influence of LOD would case variation as probabilistic estimation while insignificant in depended variable has no impact on regression process. Similar studies also conducted by Janak Singh (1996) Analyses the activities within the supply chain and illustrates the importance of the relationship between goods movement and the exchange of information.

## V. CONCLUSION

The transparent information shared among both departments depends on numbers of variable but for the purpose of adequate strategic goal and keep the effectiveness and efficient process flow six variable most common to anticipate between exchanging the protocol between both functional units most important process OTD (on time delivery) does get influence by number of factors with respect to the coherence and fit to goodness test five responded use estimates as potential contributors on the outcome Thus important components in performance management during the share information is concerned among both function of organization, on time delivery (OTD) get statically variant by Loading time(LOD) because it is only independed variable that significance or p value less than cronbach alpha ($\alpha$)

The main goal that need to implement for both functional units regarding the pre amative approach is concerned to sustain the progress to achieve the strategic goal valuable effort required to improve the logistical procedure not only that frame work implemented only by the procurement unit but also overall lead time also matter that inputs depends on production unit. This study allows future researchers to get the maximum customer satisfaction, In loop process feedback mechanism need to deployed in both the department in order to sustain their performance mechanism to sustain the, Procurements need to map the flow not only for the customer On time delivery but also receive on time delivery required a supplier development process used to active dramatic change on performance balance card.

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# NON-LINEAR DYNAMIC RELATIONSHIP BETWEEN EXCHANGE RATE AND STOCK PRICE OF PAKISTAN FROM 1965 TO 2015

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***Abstract*- This study aims to determine the dynamic association between stock prices and exchange rates of Pakistani currency (PKR) from 1965 to 2015, including the war era. Long and short-run associations are explored between these variables. Vector Autoregressive Model has been used to examine the association between the stock prices and exchange rate of PKR. Daily time series data of Pakistan from 1 Jan 1965 to 31 May 2015, from Thomson Reuter's software, is used. The Johansson co-integration approach reveals that two co-integration factors are existing between the two series, which shows that these two-time series have long-run movement. Nevertheless, the Granger causality test reveals that bi-direction causality exists among the variables. While the Vector Error Correction Model reveals that there is a short-run association among the series.**

**Keywords:** Exchange rate, Stock price, Co-Integration Vector Auto Regressive and Vector Error Correction Model.

## I. INTRODUCTION

Movements of exchange rates and the stock market are a hot topic for economists. Both factors have a significant influence on any country's development. The movement of the exchange rate affects a company's financial aspects such as profit, company's assets, liabilities, and cash flows. It is not easy for companies to estimate exchange rate movements and thus they suffer this downside risk. This risk affects a company's value and stock prices, and hence the stock prices of the companies changes[1]. Two diverse theories are commonly used to regulate the association of exchange rate and stock prices, both theories provide conflicting results. The first theory is "Flow-Oriented" which states that any change in exchange rate directly affects a company's revenue and also has an impact on a company's stock price[2]. The second theory is "Stock-Oriented". This theory states that capital market activity affects stock market return, that is increase in capital flow increases the domestic demand of domestic currency and thus affects the exchange rate[3].

Many empirical kinds of research have been carried out to regulate the long-period pattern and causality of the stock prices and exchange rate. However, all previous results are clashing with each other. Numerous analysts have experimentally examined the trade rate and stocks return relationship and have established a long-run association between them[4][5][6]. However, other researchers have found conflicting results concerning the long-period association of the two[7][8]. Similarly, conflicting results exist regarding the causality test. Many researchers have found that there is a cause and effect connection among the exchange rate and stock return[6][4][8]. On the other hand, numerous researchers have shown contradictory consequences in the causality test, that is say, there is no causal link among the exchange rate and the equity yield[7][9].

Asian markets constitute a big portion of the world economic market. Numerous foreign investors invest in these markets through foreign direct investment and use the US dollar as currency.

In this research, we try to answer two questions, is there any long-run or short-run association between the exchange rate and stock prices, including the war era?. Does any causality of exchange rate and stock prices exist in Pakistan?

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## II. LITRATURE REVIEW

### *2.2. Theoretical Framework*

Numerous theories practice to the stock costs and exchange rate link, as an example, some of the theories are Efficient Capital Market, Capital Assets Pricing Model, Arbitrage Pricing Theory (APT), Purchasing Power parity, Flow-Oriented Model, Stock-Oriented and Monetary theory. All above theories are used in investigation, though, in this work, only two theories such as the flow-oriented model and the stock-oriented will be deliberated. This is because these two theories are related to our problem and determine the directions and relationships among the variables and also determine the impact of one variable on other variables.

#### 2.2.1. Flow-Oriented Theory

With the help of flow-oriented theory, an association amid stock prices and the exchange rate will be determined. This theory proposes that the amendment in the exchange rate will automatically change stock prices[10]. This theory assumes that competition among the companies also affect the exchange rate, fluctuates a company's earnings, value, and stock prices. This theory also assumes that exchange rate fluctuation can be determined by the existing account of the state and the trade performance of the country. But stock prices frequently define the current situation of the company and also define the future cash flow of the company[11]. Exchange rate movement also affects future company's receivable. When local currency value increases, profit also increases, and when local currency value decreases, the profits of every firm also decrease. The conclusion of this is that stock price effect exchange rate movement[12]. Hekman used the foreign exchange market model and concluded that the exchange rate affects stock prices[11]. Sercu and Vanhulle also determined that when the increased exchange rate has a positive effect, exporting firms stabilizes, volume and exchange rate[13]. Another author investigated the connotation amid exchange rate and stock costs with the help of econometric approach like unit root test, co-integration method, Granger causality approach, and impulse response function. He determined that exchange rate leads to stock costs and stock price leads to exchanging rate with undesirable correlation[14]. Adler and Dumas conducted research and concluded the result that local companies depend on international business, and the exchange rate is a risk factor for local companies, if there is any adjustment in the exchange costs it will disturb the local company's efficiency, price, and demand. International business influences exchange rate movements and stock price[15].

To sum up, when the exchange rate changes, it automatically changes the stock prices. The influence of the stock costs calculation is difficult and the correlation sign amid stock costs and the exchange rate is not easy to discovery. As per the flow-oriented theory, there may be optimistic connection amid stock costs and exchange rate, and when the exchange rate rises it rises in stock price[16]. In causal conditions there may be a optimistic association amid the variable mean, causal condition can also be applied to the case of exchange rate and stock price[17].

#### 2.2.2 Stock-Oriented or Portfolio Balance Theory

The stock-oriented theory is also known as portfolio theory[18][19][20]. This theory was developed by three authors namely Branson, Halttunen, and Masson[21]. This theory defines the movement of the exchange rate and how it affects movements of stock price.

As per the flow-oriented theory, exchange rate movement's leads to the stock costs activities, although the stock-oriented theory proposes, when fluctuation occurs in stock prices, it affects the exchange rate movement with a negative correlation. The stock-oriented theory claim is that the stock costs has an adverse association with the exchange rate, when the stock price declines, domestic wealth also deteriorates.

Given indication regarding stock prices, stock costs performance has a significant influence on the exchange rate, domestic investor, wealth, and influence of money, Gavin investigated the research and concluded that the effect on the equity market has a important consequence on investor's wealth and money demand[22]. Tabak investigated the dynamic association among stock costs and exchange rate, for this purpose he nominated the Brazilian economy and he used unit root test co-integration approach and Granger causality approach. He determined that there is no long-period link among the variable then he found a linear relationship using the Granger causality test between stock costs and exchange rate. Both the stock costs and exchange rate had aadverse correlation. Additionally, he also found a nonlinear relationship using the Granger causality approach amid exchange rate and stock costs[23]. Qiao indicated that capital outflows have a important consequence on the exchange rate, meanwhile, stock prices are stable[24]. According to the stock-oriented theory, Granger asserts, because there is a link amid stock costs and exchange rate, when stock price increase, the value of domestic currency also increases. Similarly, when a decrease in stock price occurs, a decrease also occurs in the exchange rate[25]. According to economic analysis, the value of a company is associated with exchange range movement. This statement is confirmed by Shapiro and concluded that when a decrease in a domestic company's value occurs, there is a decrease in domestic currency[26]. This experimental analysis shows that there is a link amid stock costs and exchange rates. There are numerous sorts of investigation to estimate the link amid the exchange rate and stock costs. But these two theories, stock-oriented and flow-oriented suggest that there exists a link and evidence from the literature review suggests, this problem has a mixed conclusion[27].

Numerous researches have been lead to determine the association amid stock costs and exchange rate. When we take into consideration developing and developed countries we get conflict results. Frank and Young investigated the association amid the stock costs and exchange rate and it was concluded that there is no link among these variable[28][29][30][31][32].Phylaktis and Ravazzolo investigated the long and short-period association amid stock costs and exchange rate with the help of co-integration and multivariate Granger causality approach. For this purpose, he selected the period from 1980 to 1998. He found some evidence and concluded that stock costs and foreign exchange rate have a positive link and he also found out that economic crunch had a limited effect on long-period fluctuation[33].

Diamandis and Drakos investigated the long and short-period assertion among stock costs and exchange rate, for this cause he decided data from January 1980 to February 2009. They used the data of four countries in Latin America, Argentina, Brazil, Chile, and Mexico. They used co-integration test and multivariate Granger causality approach. They concluded that stock costs and exchange rate are conclusively correlated, but this is correlation is independent of exchange rate restriction[34].

Nieh and Lee investigated long and short-period associations among stock costs and exchange rate. They discovered two major results from this investigation. The first result that they found is that there is no long-period association amid stock costs and exchange rate in G-7 states. And the second result that they found during this investigation is that there is a short-period link between stock costs and exchange rate in G-7 states[1].

Murinde and Sunil investigated the relationship amid exchange rate and stock costs in emerging markets of India, Pakistan, Korea, and the Philippines. He used a bivariate vector autoregressive approach for this purpose and he selected the era from the period of 1985 to 1994 of these countries. He concluded that unidirectional causality exists among the exchange rate and stock costs of all the emerging markets[35].

Pan et al. studied the dynamic association amid the exchange rate and stock costs of seven countries in Asia such as Hong Kong, Japan, Korea, Malaysia, Singapore, Taiwan, and Thailand. For this purpose, he selected era from January 1988 to October 1988 and he used econometric techniques such as Granger causality approach, variance decomposition test, and

impulse response function. It was concluded that there is causal link between exchange rate and stock costs in Hong Kong, Japan, Malaysia, and Thailand before the 1997 economic disaster. He also found out that no country showed any causality amid stock costs and exchange rate throughout the Asian financial crisis, no causal relation existing between exchange rate and stock costs except Malaysia[36].

Inci and Lee investigated the association amid stock return and exchange rate in five European states (France, Germany, Italy, Switzerland, and UK). He concluded that the exchange rate had a major influence on stock return and also found that Granger causality approach, results in a link that is in a reverse direction[37].

## III. RESEARCH PROBLEM

Determination of dynamic association amid stock costs and exchange rates in the short and long-period is a progressively significant study issue. In Pakistan, the stock market, as well as stock prices, are highly volatile. The main reason for this volatility is exchange rates. The exchange rate not only affect the stock costs, according to the portfolio approach, automatically increases investment in the domestic and international market by the local and foreign investor and also increase the money supply. The problem of this research is to determine the dynamic association amid stock costs and exchange rate in the long and short-period including the war period in Pakistan. In the earlier research, the different period was used, regarding stock costs and exchange rate.

## IV. METHODOLOGY

### *4.1 Data and Data Source*

Secondary data for two variables namely exchange rate and stock price are used in this research paper. The data has been extracted from Thomson Reuters Software by the website (https://www.psx.com.pk/). The exchange rate is taken against the US dollar and stock price and daily closing prices are considered.

Research hypothesis:

a) Is there any long and short-run association amid exchange rate and stock price?
b) Is there any causal association amid exchange rate and stock price?

During the empirical analysis, many steps are performed; these steps are performed in econometric software E-views 7. The steps are given below:

### *4.2 The Model*

In time-series data, mean and variance are not constant all the time. Time series data have non-stationary patterns and the results may be surprising. The vector error correction technique is a classical model to determine the long-run and short-run associationamong the variables. Time series data may lose useful information when taken the difference of the variable. When we take the difference of time series variable the order of integration of the variable is larger than zero, this situation can be solved by a simple time series model but the VECM model can deal with this situation without risking surprising results. This model usesthe time series variable at the level of first difference and the same order of integration.

### *4.3 Methodology*

The methodology consists of the following steps:

Step 1 Stationary test: to examine that the time series are stationary.

Step 2 Determination of optimal lag selection for the model (AIC, SC, HQIC, etc.)

Step 3 Perform Johansen co-integration with lags.

Step 4 On the basis of step3, if the co-integration Vector Auto-Regressive (VAR) model is not effective; Vector Error Correction Model (VECM) is used.

Step 5. Diagnostic test of residuals (normality, serial correlation, heteroscedasticity, etc.)

**Step 1 Stationary test**

Step one in our evaluation is to assess whether or not the series is stationary or not. We use the unit root test to test the stationarity of the two series. It is notable that majority economic and financial time series are non-stationary at level[38][27][28], however, they attain stationarity after the first difference. There are two our selected variables, exchange rate, and stock prices. The Augmented Dickey-Fuller test and Philips-Perron (pp) approach are employed forth unit root test. Unit root approach can be used with the assistance of the direction of integration of the series. Order of integration as denoted as I (d). The mathematical form of the Augmented Ducky-Fuller (ADF) test is

given below:

$$\Delta y_t = \beta_0 + \beta_1 trend + \gamma_1 y_{t-1} + \beta_i \sum_{i=1}^{n} \Delta y_{t-1} + \epsilon_t$$

Where $\Delta y_t$denote the first difference of the variable and n denotes the number of lags, $\epsilon_t$ is the error term.

We test the following hypothesis:

$H_0$: series has a unit root (it's mean series is non − stationary).

$H_1$: series has no unit root (it's mean series is stationary).

Another unit root test is the Phillip-Perron test. This is a parametric test. This test aims to check the accuracy of the Augmented Ducky-Fuller test, correct serial correlation, and heteroscedasticity in the series. It is the updated version of ADF.

$$\Delta y_{t-1} = \gamma_0 + \alpha y_{t-1} + e_t$$

Where $\alpha$ is the coefficient of AR (1) regression equation which explains any serial correlation in residual.

**Step 2 Determine the optimal lag selection for the model**

The next step in this research is to regulate the optimal lag measurement for the model because empirical analysis needs standard error terms in the model. The standard error is affected by any type of autocorrelation. For this case, the analysis used is Vector Auto Regression (VAR) approach, by using EViews software. This model is based on five dissimilar conditions which are extensively used in literature to determine optimal lag measurement, namely the sequential modified ratio (LR) test statistics, the final prediction error criteria (FPE), the Akaike information criteria (AIC), the Schwarz information criteria (SIC), the Hannan-Quinn information criteria (HQ)[39][40][41].

**Step 3 Co-integration test**

Co-integration approach is the status where two or more different series are related to each other with respect to time. Both series move together and have the same difference. The co-integration test aims to regulate, whether the order of co-integration among the sequence is the same or not. If there is any association among the sequence it means that there is a long-run association among the series. This problem is highlighted by Granger[42], but in the Granger test, there are some drawbacks. Johansen (1988) and Johansen and Juselius (1990) introduced different approaches and overcame the deficiency in Granger's test. With the help of these two tests, we can easily regulate the number of co-integration trajectories. The names of these two approaches are the Trace and Maximal Eigen value tests.

$$J_{trace\ statistics}(r) = -n \sum_{i=r+1}^{k} \ln(1-\lambda_i)$$

$$J_{Maximal\ Eigenvalue\ statistics}(r, r+1) = -nln(1-\lambda_{r+1})$$

As per the above equation, 'n' denotes the number of observations, 'r' denotes the number of co-integration and '$\lambda$' denotes the eigenvalue. In some of the cases, there is a conflict in the result between trace statistics and maximum eigenvalue. In this type of situation, Alexander recommends using trace statistics[43].

**Step 4 Vector error correction model determine optimal lag selection for the model**

Engle and Granger, stated that when two different series are co-integrated it means that there is an error correction in the series[42]. This model is called the Vector error correction approach. This is a very famous approach in econometrics. The purpose of this model is to capture any dynamic association among the variable with the first difference. The standard mathematical form of VECM is given below:

$$\Delta y_t = c + \phi_1 \Delta y_{t-1} + \phi_2 \Delta y_{t-2} + \cdots \phi_p \Delta y_{t-p} + ECT_t + \varepsilon_t$$

In the above equation, ECT is denoted error correction term in the equation; this is the product of two-factor $\alpha$ which denotes the adjustment factor and the co-integration vector $\beta$. Co-integration factor denotes the long term association among the variable, on the other hand, adjustment factor show speed of adjustment, to reach equilibrium.

*4.4 Granger Causality*

Casual association between the two different series can be determined by the Granger Causality test[44]. This approach is established on the VAR model. Granger test also can predict one variable based on another variable [45].

$H_0$: No Granger causal relationship exists among the variables.

$H_1$: Granger causal relationship exists among variables.

**Step 5 Diagnostic tests of residuals (normality, serial correlation, heteroscedasticity, etc.)**

**Histogram-Normality (Jarque-Berra)**

$H_o$= residuals do not follow a normal distribution

$H_a$= residuals follow a normal distribution

Result of Jarque-Berra test

| | STOCK_PRICE | EXCHANGE_RATE |
|---|---|---|
| Jarque-Bera | 2.70E+10 | 8.78E+09 |
| Probability | 0.000000 | 0.000000 |
| Sum | 42064.46 | 104.2903 |
| Sum Sq. Dev. | 1.06E+09 | 9886.670 |
| Observations | 18442 | 18442 |

According to the above table, the Jarque-Bera probability value is fewer than our significance level. As per the lower probability we reject the null hypothesis. Consequently, it is enough indication to infer that the regression residual is normal.

**The Breusch-Godfrey Serial Correlation LM test**

Result of Breusch-Godfrey test

| Breusch-Godfrey Serial Correlation LM Test: | | | |
|---|---|---|---|
| F-statistic | 328.3192 | Prob. F(4,18413) | 0.0000 |
| Obs*R-squared | 1226.777 | Prob. Chi-Square(4) | 0.0000 |

$H_o$=There is a serial correlation among the residuals.

$H_a$=There is no serial correlation among the residuals.

As per the above table, the probability of the Chi-square value is lower than our significance level; the Breusch-Godfrey LM test rejects the null hypothesis.

**The Breusch-Pagan LM test (Heteroscedasticity)**

$H_o$= The variance of the residual is not constant.

$H_a$= The variance of the residual is constant.

Result of Breusch-PaganGodfrey test

| Heteroscedasticity Test: Breusch-Pagan-Godfrey | | | |
|---|---|---|---|
| F-statistic | 10.08590 | Prob. F(10,18416) | 0.0000 |
| Obs*R-squared | 100.3695 | Prob. Chi-Square(10) | 0.0000 |
| Scaled explained SS | 209821.9 | Prob. Chi-Square(10) | 0.0000 |

According to the above table, the chi-square probability value is fewer than our significance level. Therefore, there is enough evidence to reject the null hypothesis and infer that there is no evidence related to heteroscedasticity regarding the variance.

**Autocorrelation (Durbin-Watson test)**

$H_o$= There is no autocorrelation among the residuals.

$H_a$= There is autocorrelation are among the residuals.

Result of Durbin-Watson test

| R-squared | 0.492006 | Mean dependent var | 0.000000 |
|---|---|---|---|
| Adjusted R-squared | 0.491868 | S.D. dependent var | 1.032051 |
| S.E. of regression | 0.735681 | Akaike info criterion | 2.224286 |
| Sum of squared residuals. | 9974.271 | Schwarz criterion | 2.226832 |
| Log-likelihood | -20496.35 | Hannan-Quinn criterion. | 2.225122 |
| F-statistic | 3569.793 | Durbin-Watson stat | 2.006517 |
| Prob(F-statistic) | 0.000000 | | |

According to the above table, there is enough indication to infer that there is no autocorrelation amongst the residuals.

**Stability diagnostic test (Quandt-Andrews Break Point test)**

According to the following figure, we can conclude that there is no structural break in the selected sample. The test reveals that the parameters are stable since the blue line is lies within the red lien.

This blue line within two red lines. It can be concluded that the model is constant, in other words, our dependent variable stock price has stability.

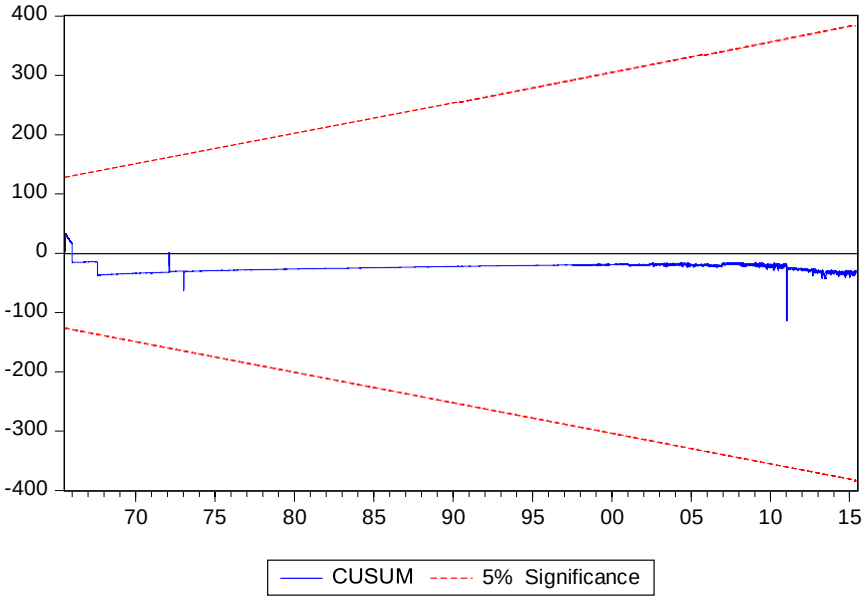


Figure of Stability diagnostic test

## V. ANALYSIS

The summary of the data is presented in Table 01

Table: 01 Descriptive Statistics

| | DSTOCK_PRICE | DEXCHANGE_RATE |
|---|---|---|
| Mean | 2.280906 | 0.005655 |
| Median | 12.00100 | 100.4500 |
| Maximum | 8945.000 | 52.50029 |
| Minimum | 24175.54 | 47.30000 |
| Std. Dev. | 240.3114 | 0.732205 |
| Skewness | -55.15923 | -12.88979 |
| Kurtosis | 5925.626 | 3382.296 |
| Jarque-Bera | 2.70E+10 | 8.78E+09 |
| Probability | 0.000000 | 0.000000 |
| Sum | 42064.46 | 104.2903 |
| Sum Sq. Dev. | 1.06E+09 | 9886.670 |
| Observations | 18442 | 18442 |

Table 01 shows the descriptive statistics of the study. Three are two variables namely stock price and exchange rate, USD/PKR. Three are eighteen thousand four hundred and forty-four observations which are covered from the period of 1965 to 2015. In the above table mean value of the stock price is 2.2809 and the exchange rate is 0.0056. Variation is very high in the stock price as compared to the exchange rate. The USD/PKR mean is 0.0056, the maximum value is 100.45 and the lowest value is 47.3 and the variation is very small throughout the sample. But on the other hand, the stock price means the value is 2.25, the maximum value is 8945 and the lowest value is 24175.5, variation is very high for this variable.

*5.2 Unit Root Test Result*

Stationary properties are very important in time series. There are numerous approaches available to check the stationary behavior of data by graph and econometrics test. There are many methods in econometrics to check stationarity, but in this research two methods are used namely the augmented Dickey-Fuller test and Phillips- Perron test.

To determine the stationarity of the selected variable, time-series observations are plotted individually without taking the first difference.

*5.3 Graphical Analysis*

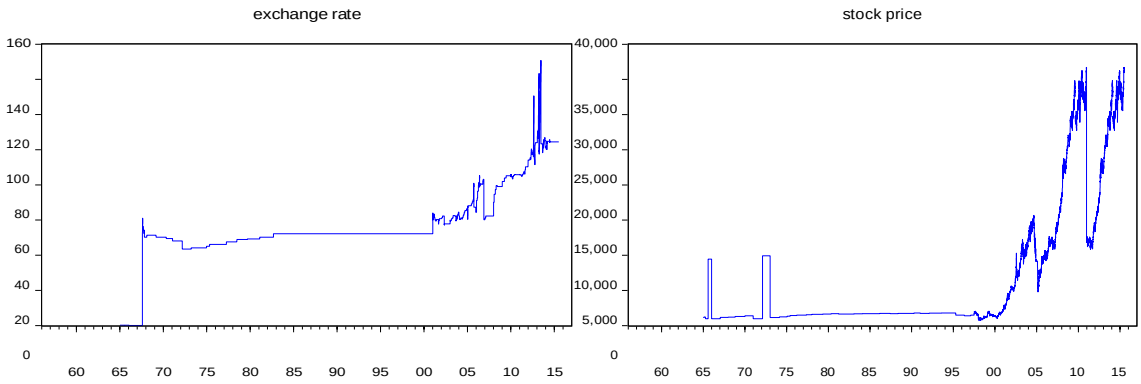


Figure 01: Time series graphs of stock price and exchange rate without the first difference.

According to the above graph, the exchange rate and stock costs have some trend in the series; it means that the data is not stationary. However, non-stationary data in a time series is a problem, for this problem the first difference and econometric test are used in this study.

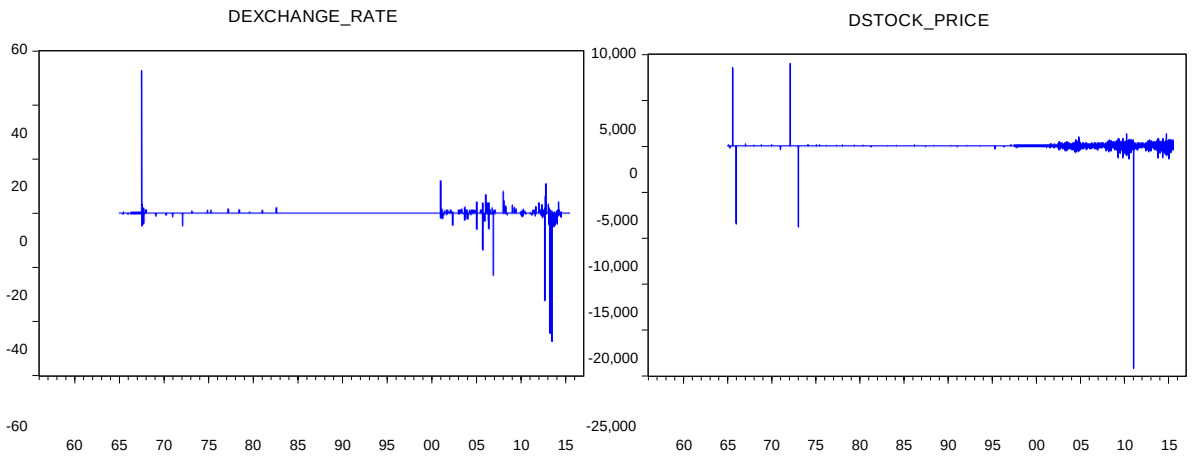

Figure 02: Time series graphs of the stock price and exchange rate with the first difference.

According to the above graph, after taking the first difference of the exchange rate and the stock price, both time series are stationary at the first difference. There is no trend in the series.

*5.4 Augmented Dickey-Fuller (ADF) and Phillips-Perron(pp) test Result*

It is essential to determine the stationarity of the variable using a co-integration test and establish a long-period association amid the variables. For this purpose, there are two tests are used in this research. This test reveals that all variables are non-stationary at level, but after taking the first alteration all variables are stationary. The outcome of these two tests are shown in Table 01

Table 02: Augmented Dickey-Fuller (ADF) and Phillips-Perron (pp) Result

| | ADF | | | | PP | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Variable at level | | First difference | | Variable at level | | First difference | | |
| | Test statistics | P-value | Test statistics | P-value | Test statistics | P-value | Test statistics | P-value | |
| exchange | -2.5820 | 0.0967 | -134.8555 | 0.0001 | -2.4158 | 0.1373 | -135.45 | 0.0001 | |
| stock | 0.0318 | 0.9603 | -132.362 | 0.0001 | 0.0795 | 0.9642 | -132.41 | 0.0001 | |

*5.5 Lag length Criteria by using Vector Autoregressive*

Lag length criteria are based on Akaike information criteria and Final Prediction error criteria, because AIC showing the smallest lags length which is two for the selected variable.

Table03: VAR lag order selection criteria

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -147592.8 | NA | 30978.49 | 16.01680 | 16.01765* | 16.01708* |
| 1 | -147586.4 | 12.93269* | 30970.19 | 16.01653 | 16.01908 | 16.01737 |
| 2 | -147582.1 | 8.541001 | 30969.28* | 16.01651* | 16.02075 | 16.01790 |
| 3 | -147581.7 | 0.823700 | 30981.34 | 16.01689 | 16.02284 | 16.01885 |
| 4 | -147580.8 | 1.856198 | 30991.67 | 16.01723 | 16.02487 | 16.01974 |

*5.6 Johansen Co-integration test result*

All variables are stationary at first alteration; therefore, the Johansen co-integration approach was used to determine any long-period link amongst the designated variables. Johansen tests are based on dual statistics, namely, trace statistics and maximum eigenvalue test. The outcomes of the Johansen technique are presented in table 3.

$H_o$= There is no co-integration amongst the variables at a significant level.

$H_1$= There is co-integration amongst the variables at a significant level.

The outcomes for together trace statistic and maximal eigenvalue statistic are stated in Table 4 and Table 5 separately. Together tests revealed that there are two co-integration amid the variables.

Table4: Unrestricted Johansen Co-integration Rank Test (Trace Statistics)

| Unrestricted Cointegration Rank Test (Trace) | | | | |
|---|---|---|---|---|
| Hypothesized | | Trace | 0.05 | |
| No. of CE(s) | Eigenvalue | Statistic | Critical Value | Prob.** |
| None * | 0.162925 | 6522.704 | 15.49471 | 0.0000 |
| At most 1 * | 0.161494 | 3245.608 | 3.841466 | 0.0000 |
| Trace test indicates 2 cointegrating eqn(s) at the 0.05 level | | | | |
| * denotes rejection of the hypothesis at the 0.05 level | | | | |
| **MacKinnon-Haug-Michelis (1999) p-values | | | | |

Table5: Unrestricted Johansen Co-integration Rank Test (Maximum Eigenvalue)

| Unrestricted Cointegration Rank Test (Maximum Eigenvalue) | | | | |
|---|---|---|---|---|
| Hypothesized | | Max-Eigen | 0.05 | |
| No. of CE(s) | Eigenvalue | Statistic | Critical Value | Prob.** |
| None * | 0.162925 | 3277.096 | 14.26460 | 0.0000 |
| At most 1 * | 0.161494 | 3245.608 | 3.841466 | 0.0000 |
| Max-eigenvalue test indicates 2 co-integrating eqn(s) at the 0.05 level | | | | |
| * denotes rejection of the hypothesis at the 0.05 level | | | | |
| **MacKinnon-Haug-Michelis (1999) p-values | | | | |

*5.7 Short-run Causality association in VECM*

To determine the short-run dynamic association among the variable, a vector error correction approach was employed. The result of the Vector error correction approach is shown in table 6. In this model, D (stock price) is applied as a dependent variable, and the exchange rate is applied as an independent variable. Wald test is also used to determine short association direction among the variable.

The long-run causality association amongst the variable is determined by C (1). When C (1) is negate, it means that there is a long-run connotation among the variables, significance also determines by probability value, when a probability is less than the significance level, it means that it is important. C (1) exhibits the speed of adjustment from disequilibrium in the model, in this research. C (1) is -0.9641and the probability value is less than our significance value. The speed of adjustment here is 96.41%. Nearly one year is required to achieve equilibrium in the long-run.

The majority of the probability values are less than our significance level and the F-statistic value is 3569.79 which are very high and significant.

The R-square value in this model is 0.492006. It means 49 % can be explained in stock price by exchange rate. There 51 % variation is unexplained. Unexplained variation belongs to some other variables which are not included in this research.

Table 6: Result of Vector Error Correction Model

| | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C(1) | -0.964122 | 0.012555 | -76.79433 | 0.0000 |
| C(2) | -0.020249 | 0.010339 | -1.958502 | 0.0502 |
| C(3) | -0.002030 | 0.007370 | -0.275496 | 0.7829 |
| C(4) | 0.000334 | 1.91E-05 | 17.49194 | 0.0000 |
| C(5) | 0.000158 | 1.87E-05 | 8.418438 | 0.0000 |
| C(6) | 2.46E-05 | 0.005418 | 0.004533 | 0.9964 |
| R-squared | 0.492006 | Mean dependent var | | 0.000000 |
| Adjusted R-squared | 0.491868 | S.D. dependent var | | 1.032051 |
| S.E. of regression | 0.735681 | Akaike info criterion | | 2.224286 |
| Sum squared resid | 9974.271 | Schwarz criterion | | 2.226832 |
| Log-likelihood | -20496.35 | Hannan-Quinn criteria. | | 2.225122 |
| F-statistic | 3569.793 | Durbin-Watson stat | | 2.006517 |
| Prob(F-statistic) | 0.000000 | | | |

*5.8 Granger Causality/Block Exogeneity Wald Test*

The Granger tests are used to determine any causal association among the selected variables. Based on the p-value, one variable significantly contributes to forecasting the other variable, it can be infer that stock costs grange source with the exchange rate. Table 7 provides results regarding the Wald test, according to the probability values, all values are less than our significance level and the chi-square value is 306.188 with 2 degrees of freedom, which means that we reject the null hypothesis and conclude from the Block Exogeneity Wald test that there is a bi-directional causality association among the stock price and exchange rate.

Table 7: Granger Causality/Block Exogeneity Wald Test

| VEC Granger Causality/Block Exogeneity Wald Tests | | | |
|---|---|---|---|
| Included observations: 18433 | | | |
| Dependent variable: D(DEXCHANGE_RATE) | | | |
| Excluded | Chi-sq | df | Prob. |
| D(DSTOCK_PRICE) | 306.1880 | 2 | 0.0000 |
| All | 306.1880 | 2 | 0.0000 |
| Dependent variable: D(DSTOCK_PRICE) | | | |
| Excluded | Chi-sq | df | Prob. |
| D(DEXCHANGE_RATE) | 86.76234 | 2 | 0.0000 |
| All | 86.76234 | 2 | 0.0000 |

## II. CONCLUSIONS

This research investigated the long and short-run connotation amid the stock price and exchange rate. There are two variables, both of which are non-stationary at level, but after taking the first alteration all variables convert stationary. The Johansen co-integration approach reveals that two co-integration factors exist among the series. So, in each passé in the period stock costs and exchange rate change together and achieve durable equilibrium. Granger technique revealed that there is a bi-directional causality association among the variables in the short run as well as the long-run. VECM model revealed that a negative association exists among the stock costs and exchange rate. Any adjustment near the equilibrium in the long-period will take approximately one year. This research result revealed that if any variation arises in the stock price it will directly impact the exchange rate and vice versa.

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# FULLY CONNECTED TRAVELLING: A STEP TOWARDS SMART CITIES

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***Abstract*- Internet of Things (IoT) is the future of the Internet. It spins around the idea of interweaving of sensors, actuators and their interconnectivity. Many proposed models are on the way. One of the most promising platforms for envisioning Internet of Things is the Fog Computing. Smart city is one application domain where the Internet of Things is greatly impacting the human lives. A defining module in such a city would be its transportation system. In such a scenario, there would be an effortless intermingling of IoT enabled devices. Since the concept is still in its infancy, huge challenges lie ahead. The paper elaborates what are the bottlenecks in materializing such a concept. It further examines the Vehicle to Internet connectivity paradigm. It then proposes an architectural framework for connected travelling. The paper concludes by providing a detailed model to resolve few design issues.**

**Keywords:** Internet of Things (IoT), Fog Computing, Cloud Computing, Smart Cities, Connected Vehicle.

## I. INTRODUCTION

The idea behind the smart city is a recent and a modern one. There exist many attempts to define a smart city, yet none is completely agreed upon [1]. It is an application domain for Internet of Things. The focal point for a smart city is its seamless connectivity to the Internet. At present, metropolitan planning and its quality does not depend on physical infrastructure but also on communication infrastructure and real-time data analysis [1].

One of the defining modules for such a city would be its transportation system. In such a system the cars would be fully connected. A fully connected vehicle is a rich network of sensors, actuators and drivers, all connected through the Internet [2]. Each car must be uniquely identifiable. This identification is either through RFID[4] tagging or more recently through valid IP addresses. The most recent advancement in this regard is the IPV6, the extended IP addressing scheme that enable everything in the world to have valid IP. This facilitates location tracing, on the go Internet connectivity and tracking in case of sudden accidents. It is so since the car can be completely traced over the Internet. The cars need to be much more reliable for both the drivers and other travelers. A fully connected vehicle essentially must offer more fulfilling possession [3].

Much progress is already in the pipeline. Cars are progressively turning more intelligent. By 2018, it is expected that one in five cars would be self-aware. It implies they would be able to share their information. This information sharing would be among them and to the Cloud: the Internet Service Provider.

The introduction of 4G and consequently 5G networks will further facilitate the scenario. However, an IoT based solution providing uninterrupted Internet connectivity is the need of the day [3]. Further, it is expected that by 2020, 26 billion devices will be connected to the Internet. It is a defining leap since its beginning in 2009 [4], [5]. The availability of Internet based sensors for majority of devices by the end of 2025 is greatly anticipated [5].

Vehicular Adhoc Network (VANET) provide another view in the possible implementation of fully connected travelling. These are specialized cases of Mobile Adhoc Networks (MANET). This network specifies nodes as travelling, dynamic entities i.e.

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[4] RFID: Radio Frequency Infrared Detection

vehicles. The key feature of this topology is mobility. Moreover, vehicles not only communicate with each other but also to the cellular towers. The communication can provide updates on traffic conditions, infotainment and vehicle's individuality [6] . Again, these cellular towers could be the Cloudlets, the mini versions of the Cloud that provide internet connectivity on the go. These devices are essentially the Fog devices, another way in which the Internet of Things could be realized since there are many intermittent connectivity issues over the Cloud platform. Security concerns and data mishandling are another threat to Cloud mitigation. Moreover, Cloud services are hefty and are less flexible over the Client end.

The paper covers the model transportation in a smart city. It progresses to focus on the connected cars, the cars of the future. The research scope is a proposed framework for Vehicle-to-Internet connectivity

The paper is organized as follows: Section 2 covers the literature review. Section 3 covers materials and methods. Section 4 covers results and findings. Section 5 covers the discussion and future work.

## II. LITRATURE REVIEW

Smart cities are the cities of the future. They envision a concept of Urban Modernization and advancement in the living standards. It is essentially a concept that is near its realization. One of the main module in such a city could be its smart transportation. A connected car is to be considered a model for transportation in the below research. A model scenario in which the car automatically alerts the nearest police station in case of accident is discussed in greater length. Few implementation details are also defined.

### *2.1 Smart City-A Glance*

The concept of "Smart City" is a recent and novel one. There is still ambiguity over its common definition. Many definitions exist in literature. Historically, the greatest focus was given to the communication infrastructure of the city. This was early 1990s when information technology and communication industry were merging. According to a research conducted at Vienna University of Technology, six focus areas /axes measure the "smartness" of a city. These include:

- Smart Economy
- Smart Mobility
- Smart Environment
- Smart people
- Smart Living
- Smart Governance [1]

As described in the literature, the concept is being used throughout the world with varying meanings and perspectives. The word "smart" is assumed synonymous with "digital" "intelligent" or "connected" [7]. Smart city is also termed as "knowledge city", "virtual city", "ubiquitous city", "sustainable city", "wired city" or "digital city" etc. In short, city connected with an infrastructure based on ICT is termed as a Smart City [8].

The literature concludes that a smart city is essentially an Internet-connected city, wherein every element is uniquely identifiable and addressable over the Internet. It is illustrated in detail in Figure 2.1 below.

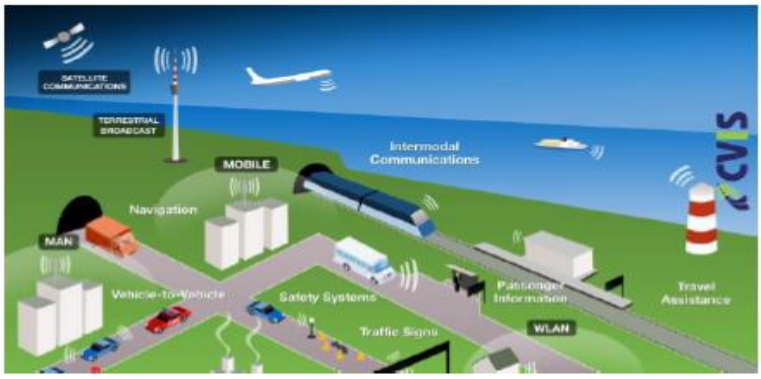


*Figure* ***Error! No text of specified style in document.****..1: The Conceptual Smart City* [9]

Smart cities as latest research topics are further supported by advancements in technologies such as Artificial Intelligence and Communication technologies [10].

*2.2 Connected Travelling*

Connected travelling is a concept that forms the core of transportation system in a smart city. To envision such a city, there are many bottlenecks. One of them is the issue of traffic congestion. It has a severely negative impact on the daily lives and work routine of the citizens. Urban planners are deciding every possible solution to avoid traffic congestion. Another major problem is that of information monitoring and updating in case of vehicle accidents [11].

The term "Connected" refers to the state of a vehicle (car in our case) that ensures its link and traceability to its surroundings [12]. This is ensured due to the presence of a large number of sensors, actuators and associated software infrastructure as well as the underlying network connectivity. The definition is similar to Auto Connected Cars. Here the software applications are numerous such as traffic safety and efficiency, infotainment, parking assistance, roadside assistance etc. Currently, the latest vehicles that include Interactive Driver-assistance Systems (ADASs) and Co-operative Intelligent Transport Systems(C-ITS) qualify for the definition of connected vehicles [12].

A major advantage of the connected vehicles is their ability of context and location awareness. These features ensure that the automobile under consideration is safer and more reliable. This feature is ensured through vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications. This enhanced technology can be based on vision/camera systems, sensor technology or vehicle data networks. Supporting characteristics include adaptive cruise control; automate braking, connectivity to the smart phones and driver alerts [2], [12]. It is discussed in detail in the subsequent section.

According to a research conducted by Centre for Automotive Research, "the average car now contains 60 microprocessors and more than 10 million lines of software code-more than half the lines of code found in a Boeing Dreamliner airplane". That is huge leap since the advent of the automobile industry. Consequently, the introduction of Wireless networks, WiFi and4G-LTE networks have further improved the possibility of having connected vehicles [3]. Another important concept in this regard is that of intelligent vehicles and vehicular cloud.

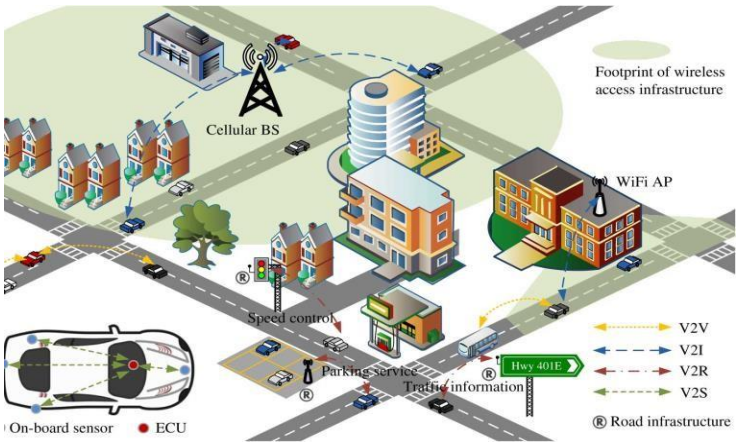


*Figure* ***Error! No text of specified style in document.****..2: Connected Travelling* [13]

Intelligent vehicles or intelligent connected vehicles face major implementation issues, such as security threats and intermittent connectivity. These vehicles are phasing out the traditional vehicles gradually [14] .

*2.3 Co-operative Intelligent Transport Systems(C-ITS)*

Cooperative Intelligent Transport System(C-ITS) is a system of interconnected vehicles communicating wirelessly. It is so to avoid the hazardous conditions and prevent traffic accidents. It is an ongoing field of research and development. It is broadly classified into two major classes: the short-range communication technology IEEE 802.11p and cellular networks (3G) or long-term evolution (LTE). There are key differences among them. IEEE 802.11p works on providing direct communication between nodes, thereby forming a VANET. There is no access point present in 802.11p but intelligent devices (ITS-enabled roadside units) can act as broadcast units sending mobile services to nodes (vehicles in our case). Cellular networks on the other hand follow a centralized topology, thereby routing all the data to pass through a Base Station (BS). C-ITS is broadly classified into three major categories: road traffic safety, traffic efficiency and value added services. Each has requirements of their own. Speaking particularly of road traffic safety, these parameters are low latency and high reliability. Their adhesive protocols are developed in US and Europe. Examples include lane changes, emergency vehicles approaching and road conditions etc. A common linking ground for these stacks are communication technology 802.11p and other relevant protocols with lower overhead. Efficiency applications and value-added services combine 802.11p, 3G/LTE with network protocol (IPv6). Examples include channeling road traffic flow and reduced gas emissions. Value-added services may be announcements of business services such as promotions etc. Notable examples are traffic-light optimization and enhanced route guidance.

Road traffic safety and efficiency are overlapping in certain cases such as in case of a road accident. Here if a vehicle suddenly halts in the middle of road, drivers can receive guidance from enhanced route guidance application for an alternate route . Thus safety applications can trigger efficiency applications and vice versa. It is important to mention here that 3G/LTE and IEEE 802.11p are supplementary technologies in this case and not contrasting ones. Each has their own features. As already mentioned, 802.11p is independent of BSs to send information.

Information can also be sent on a targeted direction using georouting. Moreover, latency can be minimized by deploying the Ad Hoc communication mode of IEEE 802.11p. Applications that are not latency sensitive can be routed further to utilize 3G/LTE. An ideal scenario would be when a fixed ITS station utilizing 3G/LTE acts as information transmission source. It can

send service update beacons to the surrounding nodes (vehicles in our case). These nodes in turn can tune in to 3G/LTE networks to receive more detailed information [13]. [6]

*2.4 DSRC –Dedicated Short Range Communication*

An origin of the 802.11p protocol is found in IEEE Wireless Access in Vehicular Environment (WAVE). In 2003, IEEE picked the former work done in this regard by ASTM. The enhanced work included extension of the protocol stack for supporting Internet access. The initial WAVE protocol stack included layers such as physical, datalink, network and transport. It is further sub divided into two major classes: safety applications and non-safety applications. Safety applications use unified protocol for transport and network layers, WAVE short-message protocol. It is derived from IEEE 1609.3 and 1609.2. The non-safety applications utilize traditional Internet Protocol (IPv6), UDP for connectionless services and TCP for connection-oriented services. IEEE 1609.4 for multichannel operation according to FCC frequency regulations is used at datalink layer. The MAC and physical layer are derived from IEEE 802.11-2012.Both safety and non-safety applications share same data-link and physical layer for transmission. The 'p' in 802.11p stands for vehicular "profile", which was incorporated in latest version of IEEE802.11-2012 [13], [6].

To dig deeper, IEEE 802.11-2012 comprises of two further topologies: infrastructure basic service set (BSS) and Independent BSS (IBSS). BSS ensures that the data is routed centrally through a central access point even when the two stations are in physical proximity. IBSS, on the other hand comprises of directly communicating nodes forming an Adhoc Network. Both topologies support roaming services and require timing signals to synchronize between the participating nodes via beacons. The identification is done using a unique BSSID. Association and authentication is not required in Adhoc mode. Here the communication can take place in unauthenticated mode. It is quite contrary in case of IBSS. Here credentials are of utmost importance. At the MAC sublayer, authentication, association and security are disabled in 802.11p (Adhoc) mode. The purpose of avoiding these is to speed up the process of information exchange in a VANET since validation is a costly procedure [13], [6].

This method is highly effective in case of VANETs as nodes in a VANET are highly mobile and operational at high speeds. Moreover, if a transition begins, nodes may run out of range before it is completely executed. Another point worth considering in this case is the scanning restriction. It implies that active and passive scanning of BSS and IBSS are halted. Thus, there is no scanning frequency for stations to join a specific network. A fixed, agreed-upon frequency channel for implementation of 802.11p is decided early. Quality of Service (QoS) is provided at the MAC sublayer. It is achieved using Enhanced Distributed Co-ordination Function (EDCF). This DCF is based on Carrier Sense Multiple Access (CSMA) with collision avoidance algorithm. It is important to note that IEEE 802.11p uses Orthogonal Frequency Division Multiplexing (OFDM) on the physical layer that supports the QoS [13].

Another term used for IEEE 802.11p or Adhoc part of WAVE is Dedicated Short Range Communication (DSRC). This term is more common in United States or Australia. Another term interchangbly used is Electronic Toll Collection (ETC). This term is more commonly used in Europe or Japan. DSRC is essentially a master-slave system functioning on 5.8-GHz frequency band. Its components include a fixed roadside unit (RSU) and short-range communications. It is important to note that after the introduction of WAVE, DSRC generally refers to IEEE 802.11p-centred VANET working with frequency range 5.9GHz. Master-slave ETC system is referred as CEN-DSRC. The operational frequency here is 5.8GHz [12], [6].

*2.5 Vehicle-to-Internet Connectivity: Drive thru Internet*

Internet connectivity is a mandatory feature of the modern vehicles. It is a recent field of research. The automobile industry has timely evolved to meet this essential requirement. There are many off-the-shelf technologies and developments targeting uncaptured market of Internet-Connected Cars. Equivalent developments in academics focusing on development of accurate and up-to-the-mark solution discovery are on the way. There are many different names for the same technology: "The Internet Multimedia on the Wheels", "Web on wheels" and "the Network Vehicle [13]." Due to wide-scale research in fields such as automobile industry, telecommunications and electronics, this concept is near visualization.

A promising field in this regard is that of Wireless access technologies. It is one of the major implementation scenario for visualizing Drive thru Internet. Two sub areas include Cellular networks and WiFi. Cellular networks e.g. 3G or 4G-LTE can provide fast, cheap and trustworthy Internet connectivity. However, these services come with a cost. Another perspective could be the installation of low-cost roadside Access point (AP) for roadside Internet connectivity. This approach has been demonstrated in many researches. Connecting vehicles to the Internet using a cellular network is discussed here in detail. There are two wider approaches to this: brought-in or built-in solutions as considered by the automobile industry [13].

*Brought-in Connectivity* implies that users are tethering their smart phone to the car. It means there is no in built mechanism inside the car. Rather, an outside agent brings in Internet connectivity using 3G/4G cellular packages. A popular tethering technology is MirrorLink and is supported by Car Connectivity Consortium (CCC). It is an organization that calls leading automobile developers (e.g. Toyota) and ICT manufacturers (e.g. Sony) to develop a "phone-centric car connectivity." Using MirrorLink, a Wi-Fi enabled device (such as a mobile phone) can connect to the Vehicle Infotainment system. The resulting Internet connection would enable the vehicle to gain immediate and limited access to the Internet. A major advantage of using aftermarket services is the absence of pre-embedded infotainment system [13].

*Built-in Connectivity:* This option is largely left unexplored. This option implies that the cellular service and the on-board Infotainment system are integrated. Here the connectivity to the Internet in embedded into a cellular connectivity module. BMW ConnectedDrive combines objects from different online applications such as driver assistance and call center services etc. to provide Internet connection for In-Vehicle Mobile Services. Another related fine example is AudiConnect. It connects topmost available cellular technology 4G LTE to connect the cars to the Internet. This concept of connecting cars to the Internet is termed as "Drive-Thru Internet" [13].

The concept of "Drive-Thru Internet" is an interesting one. Here Wi-Fi, a popular broadband wireless technology offers the "last-hundred meter" backhaul connectivity. With millions of Wi-Fi hotspots deployed throughout the world, Wi-Fi can offer a possible solution to vehicular Internet access at a reduced cost. Few of the experiments conducted with respect to feasibility of Wi-Fi are discussed here. The in-built Wi-Fi radio or Wi-Fi-enabled mobile devices can be connected to the Internet while they are in the coverage area of Wi-Fi hotspots. This is the ground concept behind "Drive-thru Internet." This concept is elaborated in figure 2.3 below.

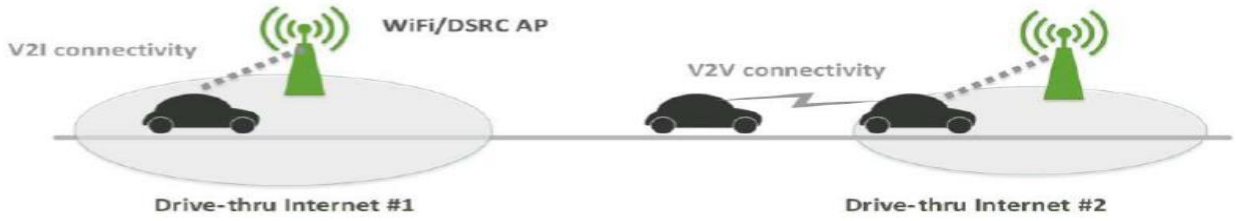


*Figure **Error! No text of specified style in document.**.3: Drive-thru Internet [11]*

As can be seen, this type of Wi-Fi access can provide a low-cost data pipe for the vehicles. Further, recent advances in Passpoint /Hotspot 2.0 improve performance of Wi-Fi for connectivity and seamless roaming. The hotspots and the Wi-Fi for providing the Internet are mushrooming, thereby ensuring the possibility of a large-scale, Urban Wi-Fi network. Mountain View has an Internet-based City network, Google Wi-Fi.

*Characteristics and Challenges*: The indoor Wi-Fi network serves stationary or slow-moving users. It is not scalable for large number of users and rapidly changing topologies. To elaborate further, moving vehicles usually with high speeds provide a limited and short time period for connection. This is ideally a fraction of several tens of seconds. This greatly limits the amount of data transferred in a single instance. To understand fully, few parameters are used as reference. The overall connectivity radius for a roadside Access Point is nearly 500-600m, corresponding connectivity time of about 18-21 sec for a vehicle moving at 120km/h. To add further, time spent in Wi-Fi connectivity, association and IP configuration is also to be considered. Secondly, significant factor is the high degree of channel fading and shadowing, resulting in significant wireless loss. Thirdly, Wi-Fi protocol stack is not significantly designed for a highly mobile environment [13].

*Improvement Strategies:* As discussed above, the average throughput of the drive-thru is limited in the real world. Contributing factors are high automobile speed, intermittent connectivity issues and potential channel contentions. It influences the Quality of Service negatively.

To counter balance these effects, few solutions in the literature include:

- Reduction in connection establishment time
- Improvement on the transport layer protocols to deal with intermittent connectivity issues and wireless transmission losses
- Enhancing MAC protocols for high mobility
- Designing tradeoffs to deal with frequency interruptions
- Using a multihop vehicle-to-Vehicle communication capability for data traffic relaying
- Optimal deployment of Wi-Fi access points. [13]

*2.6 Internet of Things (IoT) and Internet of Vehicles (IoV)*

There are currently 20 billion connected devices on the earth. It is a concept that gives rise to “Internet of Things” or more recently “Internet of Everything”. It implies effortless weaving of sensors and actuators in an environment that is context aware, intelligent and flexible. One sub area of interest in this paradigm is that of Internet of Vehicles or Vehicular Cloud [15].

A smart and connected vehicle is equipped with sensors that generate huge amount of data in fraction of the time. Simultaneously, the road is fine grained with smart dust components, identifiers and microcontrollers. These elements together

make up a "Vehicular Grid" or a "context-aware" transportation system. This is a baseline concept for Internet of Vehicles or Vehicular Cloud. Vehicular Cloud is an abstraction that encompasses all protocols, services and communication platform required by the grid to perform effectively. Futuristic approach suggests that addressing and access to the neighboring devices, context awareness and inter vehicular communication will enhance system performance and driving accuracy by many folds. This will provide a well-coordinated platform for data aggregation, fusion and sharing [15].

These demands are due to increased data volume. A key concept in this regard is that of Automotive IoT or Internet of Vehicles. Broadly speaking, the Automotive IoT is classified into five further sub-classes:

- Infotainment :entertainment and information based on personal preferences
- Navigation: information about traffic routes, updates and route planning
- Safety: Smart SOS, roadside assistance
- Cost-efficiency: Insurance updates, maintenance
- Payment: Electronic toll collection, parking reservation and payment [3].

The concept behind Internet of Vehicles stems from the main concept of connecting "things" through Internet. Here the concept is applicable to all automobiles and communication entities that are connected through an all IP-based network [16]. Such a network ensures information exchange capability and resolution of contrasting issues resulting in an efficient, safe and eco-friendly transportation. To materialize this concept completely, following areas need to be considered:

- An event-based approach that can be procured through the analysis and study of various Internet connected interactions and scenarios.
- Energy Saving and Fuel Efficient vehicles in terms of security and traffic management. Smart algorithms for such a system are yet to be developed.
- Versatile data acquisition and aggregation from varied input sensors and platforms. These input devices may or may not be connected directly to the network.
- Modelling the scenario using stakeholders such as driver, vehicle and environment modelling.
- Producing outputs as per scenario basis for enhancing the performance of these Internet-connected vehicles. These outputs must be service oriented effective solutions for a huge, high-speed Internet connected network namely Internet of Vehicles.
- A complete functional and system architecture for IoV based on existing standards and further extensions if needed [16].

*2.7 Fog Computing*

Fog is a cloudlet located nearer to the ground. It is essentially a mini-cloud, focused on sending and receiving data over the Cloud. The concept of fog is to entertain majority of device requests locally instead of sending them over the Cloud. The Fog networks become significant as Cloud services face issues of latency and delay. Moreover, Cloud services face issues of latency and delay. Fog computing implies computing at the edge of a network.

Key attributes of the Fog include:

- Low latency and location awareness
- Wide-spread geographical distribution
- Mobility

- Very large number of nodes
- Importance of Wireless networking
- Heterogeneity [17]

These features make Fog an ideal platform for enabling Internet of Things. Thus, Fog networks are providing an ideal platform for enabling Internet of Things. Other applications include Smart Grid and broadly speaking a Wireless Sensors and Actuators Network (WSAN). These all are major applications to be deployed in a Smart City [17].

The figure below envisions the Internet of Things and Fog computing. As discussed above, Fog computing provides a modular and efficient platform for envisioning Internet of Things. It is important to notice here that Fog has certain features that make it a non-trivial extension of the Cloud [17].

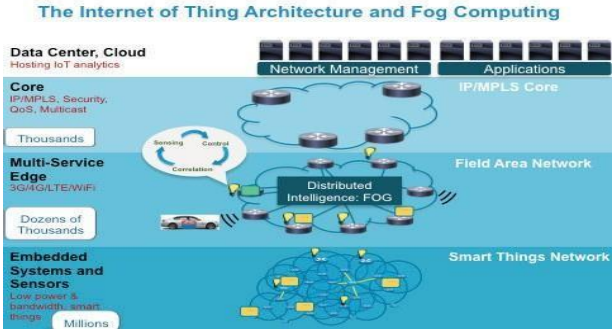


*Figure* ***Error! No text of specified style in document.****.4: Internet of Things and Fog Computing* [17]

*2.8 Fog Computing and the Internet of Things*

This section concludes the literature review by describing the Fog as a possible platform for enabling Internet of Things. There are multiple application areas where Fog can be significant. Major areas of Interest are as follows:

- Connected Vehicles
- Smart Grid
- Wireless Sensor and Actuator Networks [17]

A specific scenario of interest is that of Connected Vehicle. A connected vehicle in itself is a rich network of sensors and actuators and their interconnectivity. These include vehicle-to-vehicle, vehicle to access points and access point to access point. Fog stands as a major communication interface in this scenario [6]. These include mobility and location awareness, low latency, heterogeneity and high speed for Real-time connections. Another context is the smart traffic light system. A smart traffic light system could detect the presence of pedestrians and bikers and can determine the distance and speed of cars. This information can be analyzed to estimate time for red light or the green light. A co-ordination with neighboring sensors can be deployed to do the Real Time analysis (altering the cycle time based on traffic conditions).The clustered data could be sent to the Cloud for Long-term storage and analysis. The modular and modifiable architecture of Fog makes it an ideal candidate for providing Internet connectivity to connected vehicles and envisioning Internet of Things [18].There are key challenges in traffic management against which Fog can be an ideal solution provider. These include:

- Slower emergency response time in case of accidents
- Unpredictable scenarios such as accidents and weather conditions.

- Data is distributed among various departments and is thus scattered.
- Stringent bandwidth and increasing complexity [19]

Possible solutions for these challenges can be:

- Fog architecture has flexibility to connect all different unconnected services and devices, roadside sensors and on-board devices.
- Every authority involved in traffic management and monitoring could set up their individual Fog networks.
- Gateways can share information effectively among each other.
- Fog nodes can reduce cost by accumulating various requirements such as storage and security under a single roof [19].

Technological possibilities provided by the Fog are:

- Automotive-based nodes can gather data from different sensors present in the car and connect to other Fog nodes e.g. EMS Cloud.
- Roadside nodes can collect data from the vehicles and connect to other Fog nodes.
- Regional nodes can aggregate big data for sending to the Cloud for long-term analysis [19].

*2.9 Vehicular Cloud Computing*

VCC is an adaptation of the Mobile Cloud Computing that stems from original Cloud Computing. There are obvious advantages to this approach. The traditional approach requires uploading all contents to the Internet. This would be costly and time-consuming. A similar approach is applicable in terms of downloading and searching contents over the Internet. Vehicular Cloud Computing approaches the problem differently. It focuses on developing Clouds for the Vehicles wherein the data is collected, maintained and consumed locally or to the nearby, neighboring vehicles [15]. A model for connected travelling, a connected car is shown in the Figure 2.5.

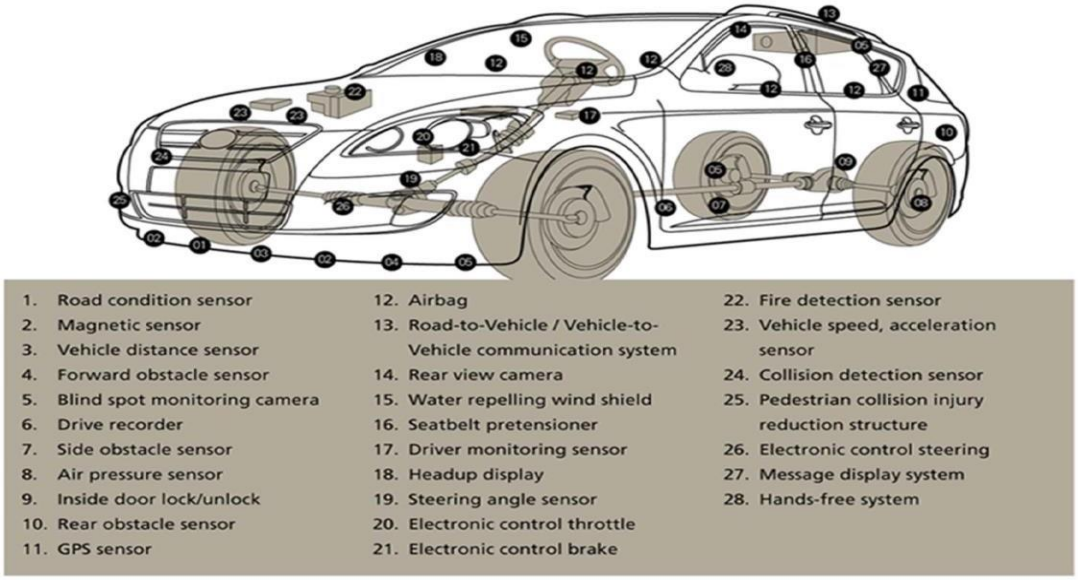


*Figure* ***Error! No text of specified style in document.****.5: Connected Car-A Model for Connected Travelling* [9]

As can be seen from the above figure, the car has as rich collection of various types of sensors. The future cars would be a rich network of such sensors. Their interconnection with each other and to the Cloud would form Internet of Vehicles: a subsystem of Internet of Things (IoT).

*2.10 Mobile Ad hoc Networks (MANETs) and Vehicular Ad hoc Networks (VANETs)*

Mobile Ad hoc Networks (MANETs) have several distinguishing features that make them ideal for envisioning a connected vehicle concept. Characteristics such as ever changing logical lay out, limited bandwidth and battery stringency are the defining features. Such features are truly an embodiment of the road and the vehicles. Since MANET is an autonomous system, participating nodes could be located anywhere, on any vehicle. In our case, a connected car is the dynamic node. MANETs can be formed as Inter-vehicle communication network .They can also be envisioned as Vehicle-to-Internet connectivity network. A special case of MANETs is VANETs where the nodes are the connected vehicles. Such a network dose not assume an end-to-end connectivity. Here the node-to-node connectivity is extravagance.

It must be noted that VANETs are not completely dynamic. The movement of automobiles and their position is relatively predictable as it is confined to the road on which the vehicle travels. This ease of predictability enhances improvement in the link selection. On the down side, the linear arrangement reduces redundancy. Bandwidth issues also arise due to traffic jams and presence of buildings, especially in the metropolitan network. VANETs can also grow potentially in size especially in the case of traffic jams [20].According to another research VANET are described differently. Nodes in a VANET must be enabled for faster data transmission. They must be productive in terms of internode communication. Broadly speaking, VANETs are classified into two major categories:

- Safety Applications
- User Applications

***Safety Applications*** increase road and travelling safety. Deploying these applications over the VANET can significantly reduce the traffic accidents. According to some studies conducted in this regard, nearly half of the accidents could be avoided if a driver were provided with a warning just half a second before the moment of collision. Vehicular safety could play a significant role in three significant directions.

*Accidents:* High speed travelling is the talk of the day. The average travelling speed of the vehicles today is far more increased than past. This trend is expected to grow further. This poses safety threat to the drivers as they have very little time to react to a changing stimulus i.e.an approaching vehicle. If the vehicle could alert the driver of early warnings and signs, the accident can be avoided altogether.

*Intersections:* Intersections and driving at them are a major challenge for Drivers. According to U.S Department of Transportation, 45% of major crashes and 21% of fatalities are due to intersection in 2003.These numbers can be reduced significantly if the drivers were alerted of the near danger [20].

*Road Congestion:* Traffic congestion is another bottleneck in the current system. Safety applications could be useful in guiding the drivers on paths of least congestion. This in turn

would lead to smooth flow of traffic and indirectly lead to lower probability of roadside accidents.

***User Applications*** ensure value-addition to travelling. They can supply information, entertainment and latest updates depending on the individual choices. They are further classified into following two sub classes:

*Internet Connectivity*: Persistent Internet connectivity is the need of the day. Most of the users demand and expect the Internet to be fully available while travelling. It implies that occupant could continue their work over the Internet even while driving. This eliminates the need for a specific location for business purposes.

*Peer-to-Peer Applications*: The idea here is to share music, videos and play online games while being on the move. Movies from specified servers and other user-centered applications can also be played [20].

To conclude the discussion about VANETs, users must remain completely unaware of the problems inherent in VANETs. VANETs present a promising field of development and research.

## III. MATERIALS AND METHODS

The research approach adopted here is qualitative research supported by literature review, analysis and architecture. This pattern facilitates an almost realizable and nearly predictable design for model transportation in a smart city. Majority of the papers published are during 2015-2021.This section explores and proposes an architectural model for a connected city. It begins with the detailed analysis of the proposed architecture. Next, it proceeds to explain the various architectural views. It concludes by providing a possible list of hardware, software and networking tools that can be helpful in the final implementation.

### *3.1 Architectural Goals and Constraints*

The proposed architecture for the system has following goals:

- To provide a sustainable transportation model for a smart city
- To facilitate the design process for such a vehicle
- To make roadside travelling more secure and reliable
- To provide internet connectivity to the entire area within the radius of the system
- To facilitate the location tracing of any vehicle in case of an accident
- To automatically send the relevant information about the driver/passengers in case of an accident to the nearest police station.

The major design constraints are:

- High availability
- Interoperability
- Performance
- Scalability

### *3.2 Architectural Design Pattern and Tactics*

The design pattern used for this framework is *Broker Design Pattern*. This design pattern is ideal when there is a collection of services distributed among multiple servers. Visualizing such systems is complex as the major design concerns are interoperability, connectivity and performance. A driving question is the structure of the distributed software. It should be designed such that users do not need to know the location of the service providers but are able to switch dynamically from one access point to another [21].

To achieve this functionality, the broker pattern introduces the concept of an intermediary. It separates the users of the service (clients) from the providers of the service (servers) by providing an intermediary. The client queries the server via a broker. The broker then forwards the request to the server to be entertained [21].

Figure 3.1 explain the broker pattern in detail.

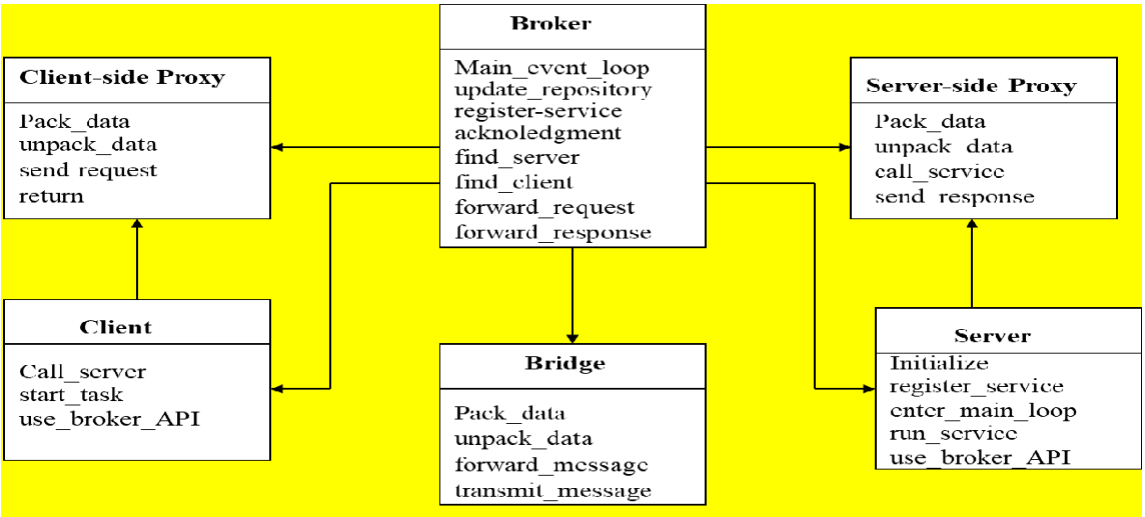


*Figure **Error! No text of specified style in document.**.6: Broker Pattern and Its Major Classes* [22]

- Six different building blocks of the pattern include :
  - Client
  - Server
  - Broker
  - Bridge
  - Client-side proxies
  - Server-side proxies [22]

*Table 1: Broker Pattern and responsibilities* [22]

| Participating Component | Responsibilities |
|---|---|
| **Servers** | application specific servers |
| **Client** | applications that access servers |
| **Broker** | acts as a messenger to transmit requests from clients to servers and transmits response and exceptions to client |
| **Bridges** | layer between two brokers, used to hide each side implementation details |
| **Client-side proxies** | represent layer between client and bróker to provide transparency |
| **Server-side proxies** | responsible for receiving requests: unpacking messages ,unmarshalling parameters ,calling appropriate service, marshalling results and exceptions to client [22] |

As can be seen above, the client in this case is the connected vehicle that wishes to connect to the Server requesting for a specific service. A special case could be the location update in case of an accident. There is one common module among three participants: Use BrokerAPI ().All these modules are explained in detail in the next section, which covers the different architectural views.

*3.3 Architectural Representation*

Accurate modelling of the framework requires that it be viewed from different implementation angles. A number of varied views permit a reliable design. Due to these reasons, the proposed framework is studied from five different approaches. These approaches are depicted in Figure 3.2 below. These include Use-Case View, Design View, Process View, Component View and Deployment View.

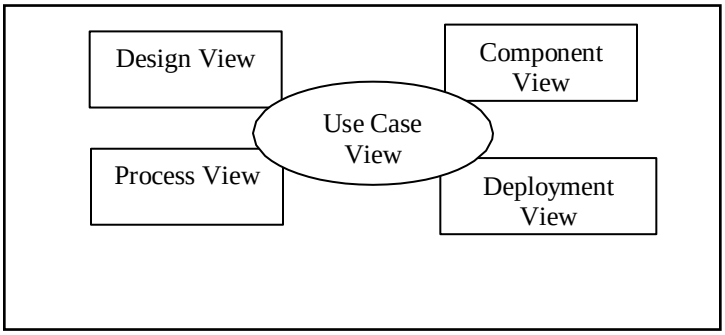


*Figure **Error! No text of specified style in document.**.7: Different Architectural Views*

*3.3.1 Architecturally Significant Functional Requirements-Use-Case View*

There can be multiple use-case scenarios of the system. This section deals with the core Use Case that define the Broker Pattern for the Architecture. The Figure below depicts the functional requirement of the framework.

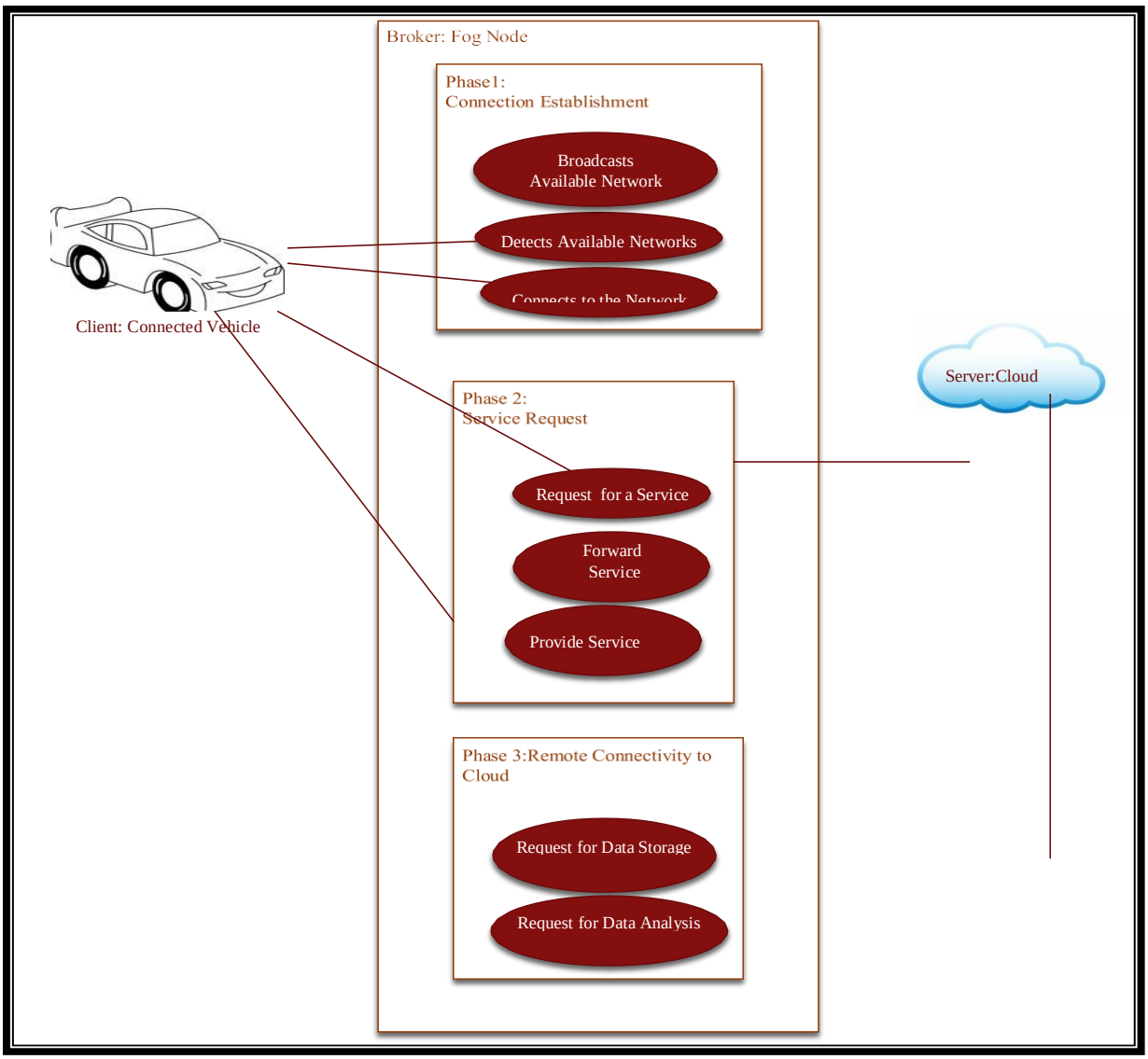


*Figure **Error! No text of specified style in document.**.8 Use-Case View*

The sequence of services is as follows:

Phase 1

- The Fog node broadcasts the available networks.
- The Connected Vehicle detects the available networks.
- The Vehicle requests for a connection establishment.
- The Fog node approves the connection.
- The connection is established.

Phase 2

- After connection establishment, the Connected Vehicle requests for a specific service.
- Depending on the type of service, the request is either entertained locally through a local Wi-Fi network.
- If the request is a bandwidth intensive application, the request is routed to the Cloud data server (Cellular Network).

Phase 3

- Applications that are less sensitive to latency are sent to the Cloud.
- These applications may include requests for data storage and analysis.

*3.3.2 Architecturally Significant Non Functional Requirements-Utility Tree*

These requirements have a profound impact on the quality of the proposed framework. These quality requirements are captured using the Utility Tree Diagram. Figure 3.3 below describes the quality attributes of the system under consideration.

The utility tree is further broken into sub module. Each node describes in detail the impact of each quality factor precisely.

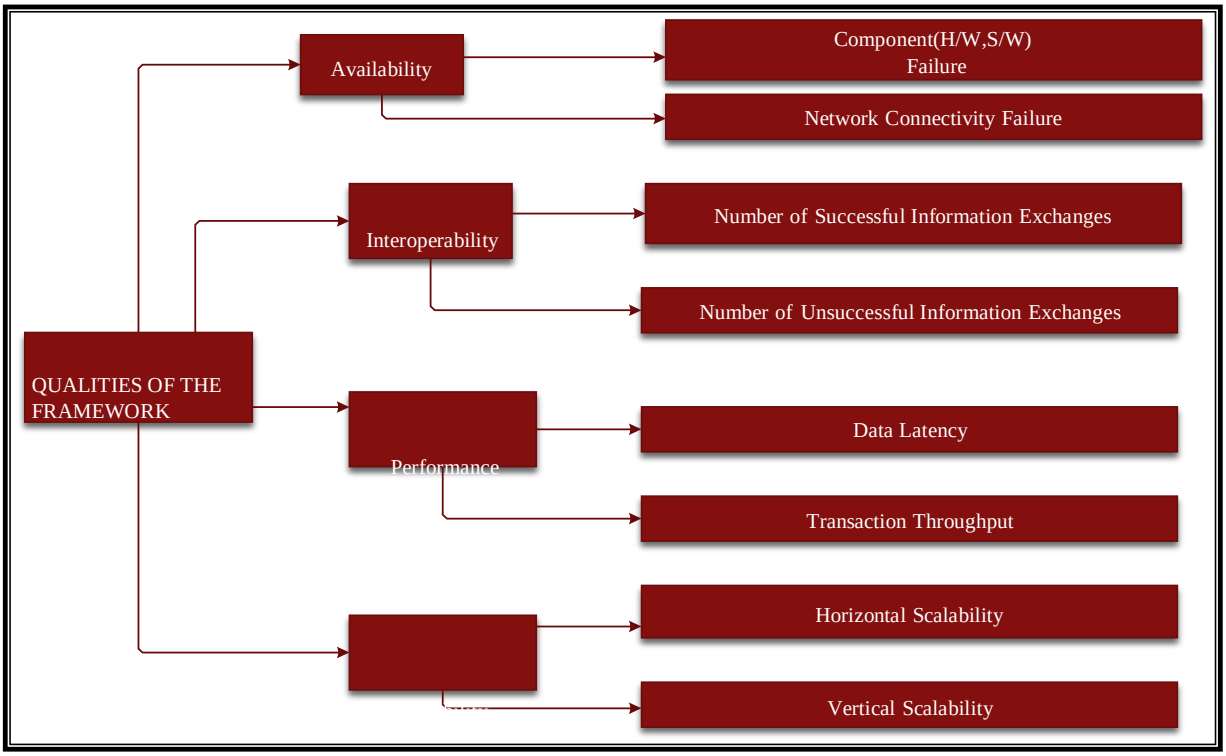


*Figure **Error! No text of specified style in document.**.9: Utility Tree of the Framework*

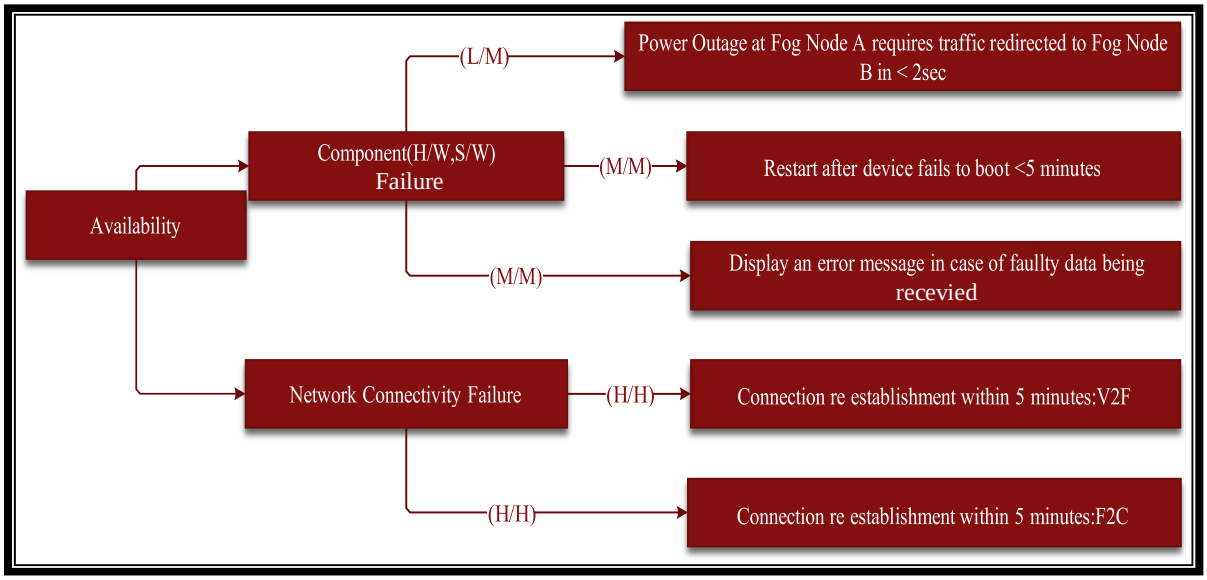


*Figure* ***Error! No text of specified style in document.****.10 Utility Tree for Availability*

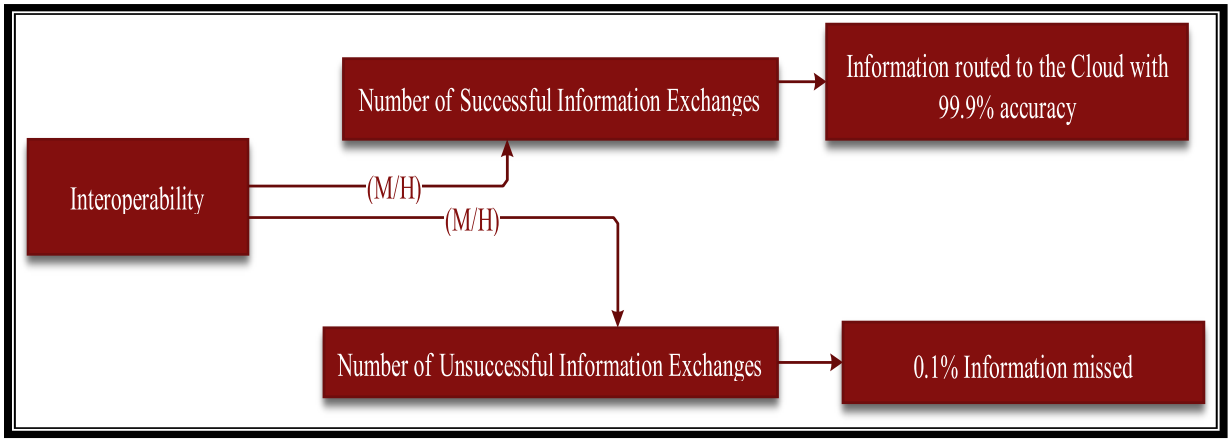


*Figure* ***Error! No text of specified style in document.****.11: Utility Tree for Interoperability*

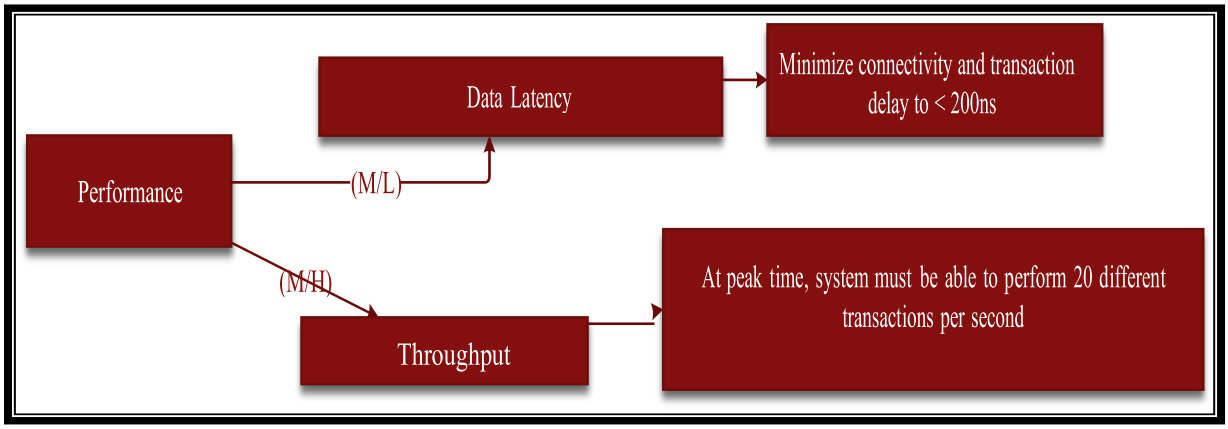


*Figure* ***Error! No text of specified style in document.****.12: Utility Tree for Performance*

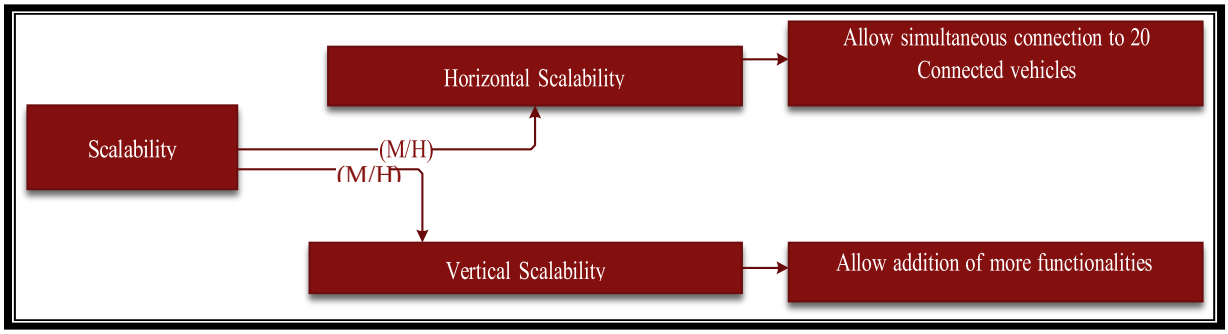


*Figure* ***Error! No text of specified style in document.****.13: Utility Tree for Scalability*

*3.3.3 Design View*

*Broker Solution-1:* This specific design pattern defines the runtime component, broker. In case of a Connected Travelling, this broker is essentially a Fog node that acts as an intermediary between the Connected Vehicle and the Cloud. The user of the service (client) is the Connected Vehicle and the provider of the service is essentially the Cloud. Thus, the continuum from the Vehicle to Cloud can be established successfully. One of the drawbacks of a broker pattern is that it introduces latency. Hence, it could act as a performance bottleneck. Moreover, it could be the single point of failure, target for security attacks and sometimes difficult to test.

A significant design tactic for performance is to increase the available resources. This in turn may lead to increased cost. However, the increase in cost is marginal with respect to the boost in performance in this scenario. Another design tactic is the efficient use of resources by deploying the scheduling policy. Here the large number of Fog nodes would limit the scheduling overhead. Modifiability too can be easily incorporated in such a design. Figure 3.8 and 3.9 describe the design view in detail.

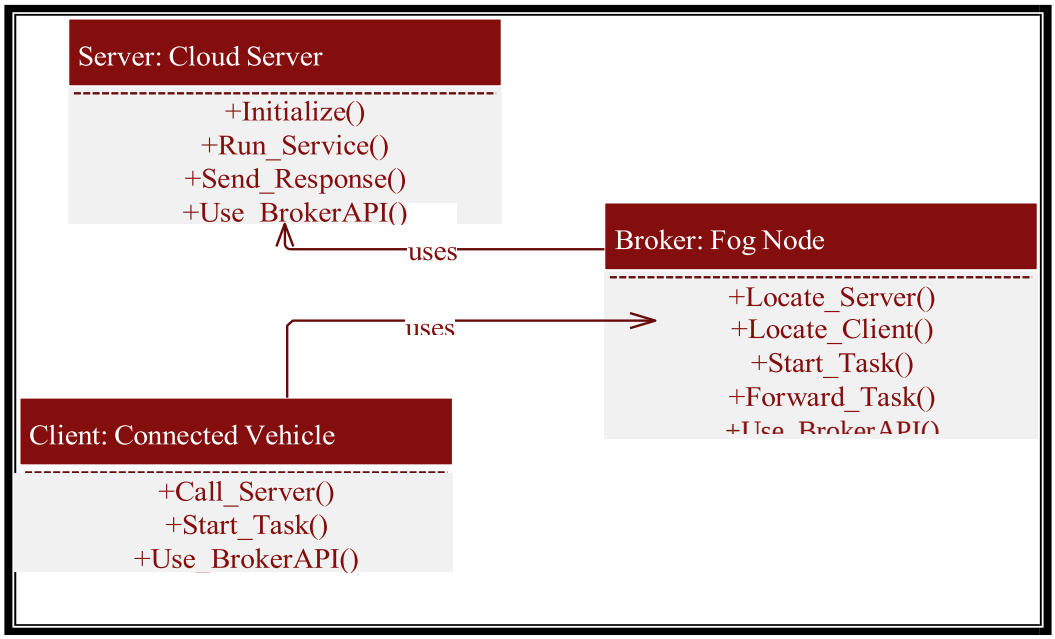


*Figure* ***Error! No text of specified style in document.****.14: Design View for Framework* [22]

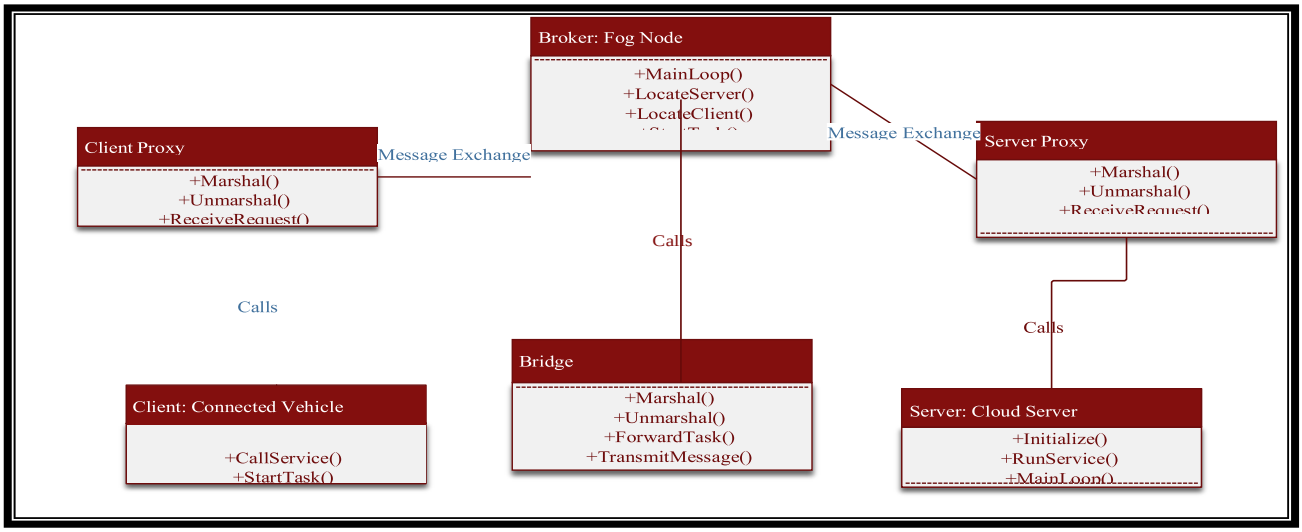


*Figure* ***Error! No text of specified style in document.****.15: Detailed Design View* [22]

### *3.3.4 Process View*

Sequence and activity diagrams below depict this view.

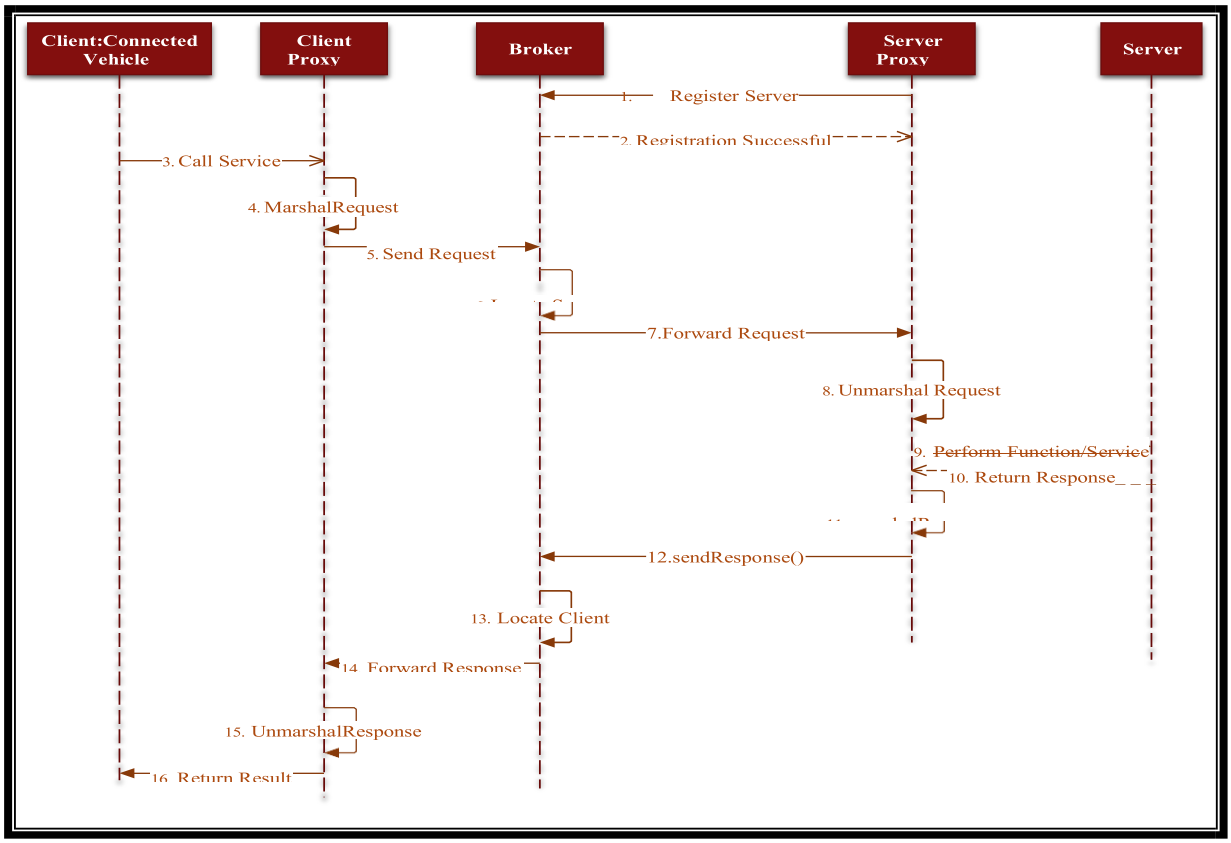


*Figure* ***Error! No text of specified style in document.****.16: Sequence Diagram* [22]

*3.4 Possible Devices and Their Specifications* [23]

Connected Roadways solves common safety, mobility, and operational challenges

Cisco product Description

• Vehicle router connect onboard systems to wireless DSRC onboard unit (OBU) and roadside unit (RSU)

• Ruggedized Ethernet switches provide transport connectivity to the roadside equipment components

• Hub switches for maintenance yard networks

- Cisco ASR 900 Series Aggregation Services Routers
- Cisco IE 4000 Ethernet Series Switches

Cisco 829 Industrial Integrated Services Routers

• Provides hub routing functionality management of mobility for and communications to and from vehicles

Cisco Nexus switches

• Network foundation of the Cisco Virtualized Multiservice Data Center (VDMC) solution, which provides the data center platform for all Connected Roadways back-office and centralized systems

Cisco Kinetic

• Makes it easy to connect distributed devices ("things") to the network, then extract, normalize, and securely move data from those devices to distributed applications. Consists of three modules:

- Gateway Management Module (GMM): provides cloud- based management and provisioning of the IR 829 gateways

- Edge Fog Module (EFM): Open architecture platform that enables immediate processing of data from the fog to the edge of the network

- Data Control Module (DCM): Enforces policy and is responsible for getting the right data to the right apps at the right time

## IV. RESULTS AND FINDINGS

This chapter highlights the results and the findings as inferred from the literature review and comparisons. The alternate framework and its significance is discussed here in detail. As mentioned earlier the proposed framework will enhance the Vehicle-to Internet connectivity and provide drive-thru Internet to the vehicles. A software pattern, namely the broker pattern is deployed here to meet the intermittent connectivity bottleneck. Moreover, the device requests that can be entertained locally are processed at the Fog edge instead of being routed to the Cloud. Fog devices can act as broker in the system there by enhancing and enabling high speed Internet connectivity.

*4.1 Findings from Literature*

Some of the major findings from the literature sum up as follows:

- Still no common agreed-upon architecture exists that guarantees 100% Internet connectivity to the vehicles on the go.
- Many automobile developers and manufacturers are working towards individual implementations of connected vehicles. Most notable ones include Connected drive by BMW and AudiConnect by Audi [13].
- Brought-in Internet connectivity is much in practice as compared to the built-in connectivity.
- Built-in Connectivity ensures platform independence in terms of vehicles and their manufactures.
- Few experiments conducted for built-in connectivity did not yield highly positive results.
- A related experiment yielded following results (few parameters are used as reference):

- The overall connectivity radius for a roadside Access Point is nearly 500-600m, corresponding connectivity time of about 18-21 sec for a vehicle moving at 120km/h.
- To add further, time spent in Wi-Fi connectivity, association and IP configuration, channel fading and limitations in the Wi-Fi protocol stack is also to be considered [13].
- Another experiment conducted in this regard eliminated the inter vehicular communication.
- Its focus was to analyze the impact of backhaul capability on the Drive Thru Network.
- *It was evident that backhaul compatibility was the limiting factor for the network performance*. For example, with a 1Mb/s bandwidth, the drop in data volume is from 92 to 25MB.
- To add further, a 100ms one-way delay notably reduces performance. This delay is due to request/response delay penalty of HTTP. *These factors play a critical role in determining the performance of a backhaul channel.*
- Another experiment focused the Internet connectivity for large-scale urban scenarios. It was concluded that with a fixed 1Mb/s data rate on the channel, vehicles can gain a median throughput of 20kb/s and a median uploaded data volume of 216Kb.
- The average interconnection and connection establishment time were 75 and 13 sec respectively.
- The experiment yielded a long-term throughput of 86kb/s over the average of interconnection and connection establishment period [13].

*4.2 Comparison of Existing Framework with Proposed One* [24] [25]

A deeper look into the device specification sheets for the Cisco Kinetic series yields following statistics:

- Cisco kinetics makes use of Cloud security features for delivering services such as data storage, multitenancy and cross platform compatibility within a moderate budget.
- The open architecture enables easier integration of varied services. This platform caters citywide data, thereby permitting usability by a large number of heterogeneous devices.
- The Cisco Kinetic architecture provides complete support for Multitenancy and usability.
- A specialized database at the Fog layer is mandatory to capture recently captured data.
- A great advantage of entertaining device requests locally over the edge is speed and closed-loop supervisory. The data remains within the local loop.
- In case of data being routed to the Cloud, it must be serialized and filtered before being sent northwards.
- Data might need to be timestamped before being sent to the Cloud. It might be needed for time-based analysis. This accuracy is best achieved if the time stamp is recorded as close to the generating device as possible.

In the proposed architecture, the Fog device acts as local data center that stores, processes and analyzes the data. This is the essence of the proposed broker pattern. There are very definite requirements for this data center. These include:

- It must support large, heterogeneous type and volumes of data. It must be fast enough to capture data quickly since the generating devices may not hold data for long.
- It must offer greater flexibility and security than a traditional, relational database management system.

Thus, the requirements are varied and cross functional. A typical case occurs when the fog device needs to collect and aggregate data from multiple nodes. Waiting for the individual device can be cumbersome and time consuming. An alternate solution would be a single query that is geo-distributed. This enables the fog node to propagate a single query across multiple devices,

thereby enhancing speed. Moreover, Fog is the best place to ensure data transfer to the Cloud is within the specified format, uniform for all devices and platforms.

*4.3 Minimum System Requirements*

The minimum system requirements, especially for the Fog devices are as follows:

Hardware: Single core

Disk space: N/A

Memory 256 MB

Software: Ubuntu .Linux red hat etc.

Table below sums up the comparative analysis between the traditional approach and the proposed one.

*Table 2: Comparative analysis between two approaches*

| Attribute | Traditional Approach | Proposed Solution |
|---|---|---|
| Device Heterogeneity | Not supported | Fully Supported |
| Connectivity Time | 18-21 sec | 5-10 sec |
| Authentication/Connection Establishment | Significant delay | Insignificant delay due to common authentication database |
| Backhaul Compatibility | Not observed leading to data drop from 92 to 25MB | Complete backhaul compatibility leading to insignificant data loss |
| Average Data Transfer rate | 86kb/s | In range of multiple GB |

## V. DISCUSSION AND FUTURE WORK

As already discussed, the alternate architectural pattern approach can greatly facilitate the vision of the fully connected travelling. If enabled and envisioned correctly, fully connected travelling ca n influence the way people travel. It can result in increased productivity and increased citizen satisfaction. A fully connected vehicle, traceable over the internet can serve many purposes. These include automatic update in case of a car accident to the nearest police station, automatic update to the nearest hospital in case of a health emergency or update to workplace in case of traffic jam. Following section describes the few of its major applications.

*3.1 Update In Case of a Traffic Accident*

In case of a traffic accident the on board unit (OBU) can communicate with the roadside unit (RSU) to indicate the exact time of the accident. Using Cisco Kinetic series, the Data control unit can send this received data to appropriate app using the Edge Fog Module (EFM) [24]. An ideal app to send and receive this data could be *Cisco WebEx Meetings.* The code from design can be generated using Visual studio, C, C# etc. *Cisco WebEx Meetings* is an online meeting app that allows the user to stay online. Details that can be included further may include Driver's Name, Passport number, Emergency contact number and the location of the accident. Furthermore, updates to the local authorities such as nearest hospital and fire stations can be sent.

Moreover, a fully connected network could also provide location updates for broadcast. This in turn could enable the incoming traffic to be routed to a diverged path. Thus leading to smarter traffic management and reduced chances of accidents. A more detailed implementation could lead to automatic rerouting to backup/secondary links.

*3.2 Update In Case of Health Emergency*

In case of a health emergency, similar scenario can be deployed. The connected vehicle is a rich embodiment of sensors and actuators. Apps can be developed that transfer the patient's heart beat and pulse rate to the nearby hospitals. Updates can be sent regarding the possible first aid treatment that can save a person's life. Moreover, the route for the least congestion can be selected for critical emergencies. These enhancements can have a valuable impact on saving a patient's life.

### *3.3 Update To Workplace In Case of Traffic Jam*

Another notable update could be an email sent or an update sent to the workplace in case of traffic congestion. Updates about an employee's current position and relative work arrival time could be calculated too. To add further, the employee could continue utilizing the idle time in managing work from home.

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