Spring 4-11-2018

Implementing Agile Methodology Techniques in Automobile Industry

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Chapter 1.0: Introduction

Automotive industries have continued to expand, as they cut on costs by regulating efficiency, grow and make profits. The factors that have continued to change the industry include marketplace growth, outsourcing for product development, customers demanding for improved reliability, development of human-vehicle software and have continued to change the automotive industry. As a result, companies have continued to face numerous challenges to manage the factors. The challenges include managing volatility, experiencing massive uncertainty, as well as reduced predictability of future businesses. Other challenges include handling a complex and interconnected industry and the need to form joint ventures and maintain successful supplier relationships.

The Automotive businesses must change their operating models to advance agility. An example includes ensuring OEMs is flexible to operate across the value chain and provide value-add, as well as personalized experiences. The Automotive companies must learn from Google and Uber that have embraced digital activities to market new business models that can promote innovation. The study conducted by Crute et al. (2013) showed that over 30% of automotive businesses are willing to invest in advanced business models likely to drive value from new capabilities. According to Elkins et al. (2014), having an advanced operating model permit digital abilities that could reduce costs and support growth.

While rethinking of an operating model, the automotive companies must choose the ones that are digital to help them improve efficiency as well as agility. According to Hallgren and Olhanger, (2009), when companies operate on lean strategies, then they free up costs that could likely to be reinvented to other significant fuel growth strategies and maintain a competitive advantage in the industry. When companies invest in new business models and advanced digital abilities, then they

engage in aggressive growth. An example includes automotive firms moving beyond manufacturing of vehicles to join the wider ecosystem that opens new business opportunities to build new capabilities, collaborate with other partners to invest heavily in innovation (Poppendieck & Cusumano, 2012).

The focus is on improving customer experiences through expansion strategies that include joint ventures or acquisitions. It is impossible for companies to enhance efficiency and performance without having a talented staff that is committed to the delivery of quality products and services. Digital activities and innovation-driven automotive industry have increased stakes for company processes across the value chain. Devadasan (2012), therefore believes dealerships, OEMs, and manufacturers of vehicle parts require individuals that are digital savvy to initiate transition to digital corporations (Tuck et al. 2006). The techno-savvy employees use digital strategies to improve customer experience, leading to many companies to invest in human resource practices such as training of employees.

1.1 Problem Statement

For the longest time, APM was restricted mainly in the software industry and few automotive companies have adopted the same in auto industry. It is likely that APM in the manufacturing industry and specifically Automotive creates major challenges; hence, the need to advance on the topic of agility and realize ways automotive companies can take advantage of the concept to enhance operations (Devadasan, 2012). The study is on US automotive industry because, for the longest time, the corporations have been facing unprecedented competition as they invest their capital heavily to compete with other global automakers. More so, Tuck et al. (2006) assert that US automotive companies have to meet the excessive government regulations touching on

emissions control, as well as safety. The burdens have fallen on an industry that has to cope with excessive losses caused by the recession and the fight for a market share (Silver et al. 2015).

Fuel consumption has not been major competitive factors in the market because the current reduced global gasoline prices have led to consumers concentrate more on vehicle prices, enhanced performance, comfort as well as style (Poppendieck & Cusumano, 2012). Nevertheless, firms with the ability to offer the above features, as well as improved fuel economy, must have unique benefits over those that lack the characteristics. According to Ward et al (2015), regardless of the future of fuel economy standards, it is time for U.S automakers to invest in agility practices that can help them compete globally. Banos et al. (2015) clarify that an effective fuel economy standard are not the only competitive disadvantage U.S automotive firms would face currently.

Other factors include the fuel economy standards that remain costly in implementation that are likely to distort a normal product cycle in the motor industry. The situation causes automotive firms to experience increased financial burden on the local automotive firms. Therefore, the impact on the automotive industry remains central to agility discussion that touches on enhanced economic targets and techniques that can improve the manufacturing sector. Without agility practices, it is likely that domestic manufactures in the US shall continue facing massive financial constraints caused by poor practices, changes in the fuel economy laws. According to Huckvale et al. (2016), US automotive industry is mature but cyclical, with the peaks and lows in vehicle demand going contrary to the country's economic situation. Today, Ford, General Motors, and Chrysler have continued to diversify by manufacturing foreign vehicles, as well as sales. Other strategies include nonautomotive diversification in financial services, vehicle production in Northern America, vehicle rental firms, and defense electronics, activities that show the companies have embraced agility.

The study is essential because most studies focusing on agility have only concentrated on software companies and those in the service industries, mainly internet-based and financial institutions ignoring the manufacturing industry because of its association with strategies that enhance sales and marketing and nothing to do with agility (Ward et al. (2015; Huckvale et al. 2016; Silva et al. 2015). Companies must change their paradigm to improve performance changes. It is time for automotive companies to align themselves with corporate beliefs that support quality, product design and development, all aimed at meeting customer needs, as well as expectations. Organizations could accrue improvement of "Key Performance Indicators" (KPIs) that include productivity, quality perceptions, timeliness, product and service flexibility, as well as quality perception (Poppendieck & Cusumano, 2012).

Agility practices encourage adoption of quality management paradigm a concept that has attracted the attention of many. The paradigm operates well for firms that have scarce resources, want market agility and desire to remain close to customers through improved services (Tuck et al. 2006). According to Poppendieck and Cusumano (2012), the automotive industry in the US experiences many challenges such as high training costs to develop talented staff and help them acquire organizational skills. Other challenges include corporate culture barriers, poor management styles, and emphasis on strategies that display how good the companies are, instead of what clients require (Banos et al. 2015). More so, companies must contend with the stiff competition in the global market, as well as strict government regulations.

Many researchersbelieve agility paradigms that concentrate on quality management could improve the industry through the maximization of firm effectiveness and efficiency. The improvements help firms to enhance competitive advantage and enhance market share (Jasti and Kadali, 2015). Huckvale et al. (2016) observed that manufacturing companies in Germany attained

better product positioning by integrating quality management concepts essential in strategy formulation. The companies successfully attained their KPI targets. Similarly, Ward et al. (2015), explained that automobile firms in Sweden managed competitive pressure from manufacturing companies overseas using new management technique in IT to enhance performance. Examples of such companies include Scania and Volvo that adopted changes in their automotive designs, as well as manufacturing processes that helped them manage costs and improve productivity.

However, the studies have failed to address the dynamics and factors that influence automotive industry performance, in relation to manufacturing, as they concentrate more on after-sales offers. To, therefore, bridge the gap, the study concentrated on providing agility practices in the manufacturing process, managerial paradigm and employee performance and the effect it has on company performance. It is essential to establish the relationship between the agility practices and company's organizational performance.

1.2 Study Purpose

The researcher was motivated to conduct the current research because there is evidence that studies related to agile development and software advancement are limited (Corani & Pani, 2013). It is therefore important to advance knowledge in the field, including adherence to the most significant lean principles that regard continuous improvement (Poppendieck & Poppendieck, 2003). Wang et al. (2012) assert that limited knowledge on lean and agile application strategies in response to software development include developers tailoring lean strategies to suit only specific contexts. It was clear that there was no roadmap to apply the agile and lean strategies. As that applied to all industries, automotive industries were worse, with many big companies in automotive companies globally lacking a clear approach.

For instance, only Ahmad et al. (2013) conducted a systematic literature to disclose about Kanban lean strategies focusing on interests, challenges, and practices. The findings helped to clarify the benefits of kanban, challenges software developers face during application of agile techniques. The challenges identified include lack of specialized skills, training and difficulties in managing WIP, inability to select tasks based on priority and need for precise guidelines to understand all processes. It is possible to mitigate challenges if there is a roadmap to implement software development. Wang et al. (2012) emphasizes on the need to have detailed guidelines, with Corona and Pani (2013) reviewing state-of-art lean adoption strategies.

It is also clear that most information on agile techniques has come from practitioners' books, as well as web sources, with research community depending mainly on practitioners' books to make decisions. Practitioners' books remain subjective with an example of lean thinking being related to continuous improvement as a major aspect to attain leanness. Continuous improvement represents an example of a lean principle employed by Toyota production and has been emulated by many (Womack et al. 2008. More so, Poppendieck and Poppendieck (2003) indicate that continuous improvement played a significant role in lean software development.

It is essential to improve knowledge in software development, hence reacting to continuous improvement principles. It is important to learn more about continuous improvement, with the potential to engage in cross-disciplinary learning in manufacturing setting.

1.3 Study Aim, Research Objectives, and Research Questions

The researcher intended to respond adequately to study by Wang et al. (2012) and Ahmad et al. (2013) that focuses on the need to acquire additional knowledge on software development to ensure industrial engineering especially in auto mobile industry is a success. It is important to analyse important engineering and agile techniques information to enhance software and agile

development. The rationale behind the study include the need to seek an understanding of agile techniques in automobile industry as evident in various studies (Wang et al. 2012; Ikonen et al. 2011; Ahmad et al. 2013; Corona & Pani, 2013).

1.3.1 Research Questions

- ✓ What agile systems exist in the industry for automobile industries?
- ✓ What are the key performance indicators propagated by agile techniques?
- ✓ What are the current adoption stages, barriers, and limitations on implementation of agile methods in software development in automobile industries?

1.3.2 Research Objectives

- ✓ To understand the existence of agile systems in the automobile industry
- ✓ To understand the key performance indicators propagated by agile techniques
- ✓ To understand the current adoption stages, barriers and implementation limitations of agile methods in automotive industries

Literature Review

2.0 Introduction

The literature review shall define agility in automobile industries and expound on the paradigms related to quality performance that improve dimensions of performance. The literature shall also focus on quality management that can improve performance in the automotive industry. Furthermore, it shall explore studies and findings of other researchers that carried similar research in the field.

2.1 Agile Manufacturing

Agile manufacturing is a strategy that was introduced to solve business challenges and help firms to improve production performance by using it as a competitive strategy. Many studies have engaged in agile manufacturing and have managed to offer practical ways of implementing agility manufacturing. A study by Kastoo et al. (2014) explains that the impact of agile production abilities on production performance is more compared to the challenges. Another study focused on the relationship between features of agility, prioritizing others more. This study, therefore, intends to fill the gap in the field research using the casual modeling methodology and the impact of agility abilities of organizational performance. The casual approach is essential in identifying casual relationships between varied agility capabilities variables and production performance.

According to Jasti and Kodali (2015), productive performance involves product quality and flexibility. Ward et al. (2015) define product quality as an adaptation of product that has the desired features to clients reflecting in two production dynamics that meet customer needs by producing a product that fulfills customer desires. Ward et al. (2015) explain that flexibility in production volumes also plays a significant role to produce vehicles in accordance with customer demands.

Flexibility help reduce on cost and unnecessary time on producing vehicles not required in the market, hence the need for companies to invest in big analytics strategies (Poppendieck & Gusumano, 2012). Various researchers have focused on various agile strategies that include constructs, agile employees, agile links, and agile processes.

As explained by Banos et al. (2015), the agile strategy involves processes to understand the company and its position to conform to the accelerating market. The companies have to show the commitment of senior staff to attain agility and utilize employees to improve performance. Another element includes agility processes that involve the provision of manufacturing facilities and procedures necessary in promoting agility function in the company. On the other hand, agile links promote collaboration with clients, suppliers and other stakeholders to learn from the external environment (Banos et al. 2015). According to Silva et al. (2015) also mention agile staff necessary in improving quality, hence the need for firms to develop multi-skilled, flexible and expertise employees, in addition to developing a culture that promotes initiatives, creativity and organizational support (Ward et al. 2015).

2.2 Supply Chain Management

According to Huckvale et al. (2016), supply chain involves activities associated with the flow, as well as the transfer of products from raw materials state until the time the product is delivered to a consumer including information related to it. Supply chain management involves the integration of activities to enhance relationships established in the chain to attain sustainable competitive advantage (Huckvale et al. (2016). SCM objectives include satisfying customer demands by delivering products with quality, at a reduced price and client's desired time. Optimization processes in a chain require coordination among members in a chain to improve competitive advantage and enhanced relations (Banos et al, 2015). According to Banos et al

(2015), SCM enhances organizational performance through the establishment of strategic partnerships with suppliers, meaningful relationship with clients, improved information sharing, and quality of the information shared. Accordingly, Luthra et al. (2016), believe that agility capabilities in the supply chain strive towards attaining consciousness, which is the ability to identify changes, opportunities, threats and weaknesses. Bannos et al. (2015) assert that consciousness is a fast movement that changes in speed and direction to respond to the entire body, same to agility where players have to engage in required changes to improve performance.

2.3 Role of Quality Management in firm's Continuous Improvement

According to Huckvale et al. (2016), the consequent focus of companies on continuous improvement of processes and satisfaction of customer needs is a concept that distinguishes QM from the conventional management. Quality management is an important business concept automobile companies could use to bridge the gap between the traditional and human relation theories through the introduction of customer variable processes (Mojica et al. (2014). Quality management includes processes where companies introduce changes in its organizational systems, which align social, as well as technical applications. The paradigm focuses more on customers by fulfilling elements such as quality, product development and positioning, and product design.

Quality is a significant concept that adds value to company operations and specifically aims at satisfying client needs. Quality encompasses the entire company because all functions enhance product quality, hence affecting all departments of the organization. Silva et al. (2015) focused on factors that drive competitive advantage in the manufacturing industry, with much emphasis on quality, timely delivery, and responsiveness that impacts positively on company performance. In return, the processes help companies to build their brand image and retain customers.

2.4 Customer Retention

According to Ward et al. (2015), quality management help reduces production costs in a company, particularly through rework, warranty costs, field services and management of scrap. Other benefits that accrue from the reduction of costs are transferred to the clients that purchase goods and services at reduced costs leading to permanent loyalty. The quality process represents a continuous process that starts with a client and ends with a client. More so concentration on quality includes quality shifts that encourage process-driven discipline to a customer-oriented discipline.

2.5 Culture of automobile industry

The automobile industry is renowned for its success in the development, production, and the marketing of motor products at the global level. This achievement can be attributed to the proper coordination of international development, efficient products, and the effective marketing activities (Bannos et al. (2015). This implies that the corporate culture of the internal networks of the industry is playing a key role in striking a balance between globalization and localization. Due to increased globalization, the various companies in the automobile sector have continuously spread their competencies in terms of production, development, and the marketing processes (Poppendieck & Cusumano, 2012). As such, comprehensive coordination and the international value chains have always been very critical to the success of the industry. Additionally, the competition in the automobile industry has ever gotten tougher every day. This has made the companies operating under the industry to face major challenges in trying to optimize the global value chains. Various studies have indicated that the challenges have always been solved by applying some methods of coordinating internal activities. These include the decentralization/centralization of the decision-making process, formal coordination, social

networks, direct personal control, output control, and the informal coordination (Jasti and Kadali, 2015). The consideration of all these alternatives has been key to the success of the companies.

Fostering of the corporate culture and networks of the companies is another factor that has led to the international success. The most important part of nurturing the culture is to keep strong internal company networks that enable the employees to freely share information and opinions. This communication should be established outside the existing hierarchies and across all the departments and functional teams. This has always been the norm in the automobile industry. Employees across various departments do work together to accomplish various projects as they find it convenient (Poppendieck & Cusumano, 2012). Managers are rotated through various departments and locations, and this contributes to the efficient networking within the companies. This has led to the growth of a corporate culture of the values, vision, and mission statements that are shared by all the employees.

2.6 Auto Market

The automobile industry together with the banking industry has had some good times as well as bad times in the market due to the fluctuating credit conditions (Jasti and Kadali, 2015). However, the US auto market has capably managed the moving up and down of the of the market dynamics. Since the development of the financial crisis in the US, the auto sales have been greatly boosted over time (Bannos et al. (2015). The existence of the uptick in rates together with the Federal Reserve Policy ifs feared to constrain the subprime loans. The lowering of loan volumes will be a justification for the critics of the automobile industry to make arguments that the market is tanking. However, the industry has always been able to handle this situation through the act of pushing their transaction process up. Although they will sell few cars, they will have charge more and end up selling them to the borrowers who are credit-worth.

Over the past years, the self-driving cars have received the biggest sales ever in the market. The auto products such as Uber, Waymo, General Motors, Tesla, have made substantial progress in the market pushing into the best-selling automobiles (Jasti and Kadali, 2015). This is undoubtedly a great achievement. However, autonomy is not sustainable in the industry. The existing technologies of the automakers and the tech companies will organize the next move and overthrow any achievements made in the self-driving cars. This competition is healthy and is likely to become more severe with time (Poppendieck & Cusumano, 2012). As such, agile remains to be the only solution to the existing market dynamics.

2.7 Demands of Auto Industry

The demand in the automobile industry is determined by several factors which include the price of the products. The demand for the products is greatly reduced when the prices are higher than expected (Jasti and Kadali, 2015). This is also coupled with the second factor of the availability of finance. If the customers have an option of getting funds from credit firms, they are likely to have a higher demand for the products because they can access the funds and pay for the products. Thirdly, the income of people plays a great role in determining the demand for the products (Bannos et al. (2015). As the income increases, the demand also goes up because of the availability of funds. Forth, the presence and quality of public transport will tend to lower the demand for personal automobile products. The price of petrol also determines the demand for automobiles. This is because the automobiles will always be operated by petrol. If the income of a country is more distributed among the rich class, then the demand for the automobiles will be higher. Lastly, the economic growth and development lead to the improved lifestyles that increase the demand for automobiles.

For the supply of the automobiles, one of the determining factors is the price of the automobiles. The higher the price of the automobiles will always lead to the higher rate of supply. Secondly, the cost of the inputs such as labor, steel, machinery, and many others will directly lead to a decline in automobile supply (Poppendieck & Cusumano, 2012). Thirdly, the technological advancement is another factor that will make the production of the automobile products more profitable (Jasti and Kadali, 2015). Therefore, more of the products will be produced increasing the supply. Lastly, the change in government policies concerning the automobile industry does affect the supply of the products. For instance, the reduction custom duty imposed on the purchase of raw materials will automatically lead to the increased supply of the automobiles.

2.8 Trends in automobiles

Over the last few years, the automobile industry has been challenged more than what people have always thought. At the look of the operations, the industry is seen to be operating normally, and the performance is so strong. However, the industry is in serious trouble. First, the total shareholder return (TSR) has drastically reduced (Bannos et al. (2015). This has painted the industry as a less attractive investment compared to other industries. As such, there is a likelihood that there will be few winners in the industry in the coming years. Most of the potential investors are likely to flee the industry leading to limited capital resources for possible growth. Secondly, the developments in the automobile have constantly made the products exceptionally expensive. Many of the vehicles are made with new exciting features that require enhancing the expertise of software engineers to assemble (Jasti and Kadali, 2015). This has always made and is likely to make the products very expensive for the many people to afford. As a result, demand has reduced with time leaving the industry in jeopardy. This calls for Agile Manufacturing to improve the process of decision-making in the industry and maintain its competitiveness.

2.9 Innovation in auto industry

Now, the automobile industry is undergoing major innovations aimed at coping with the advanced world technology. One of such innovations revolves around the production and delivery of the products (Jasti and Kadali, 2015). Sometimes it becomes so difficult for the companies to deliver the required products to the customers on time. This problem can be solved by predictive analytics. It involves a scientific study of the customer requirements and deliver exactly what is needed in the market. This is a driving force in the efficient production of a better managed supply chain that will be translated into new desirable vehicle designs. Secondly, there are innovations intended to keep the drivers safe with increased connectivity and automated driving. The innovations in regard will be meant to protect the personal data of the driver and ensure that there is no hacking of the infrastructure, the vehicle, and the routes are taken (Poppendieck & Cusumano, 2012). Thirdly, waiting for vehicle repair or refueling of the vehicles would not keep the driver waiting for too long. It will be exceedingly easy to do so given that the innovations cater for that.

The fourth innovation involves the customers getting involved in the vehicle design (Bannos et al. (2015). This will go beyond selecting the options in the catalog on the preferred designs. The specific requirements of the customers will be captured for customized vehicles. This will lead to more satisfied clients than ever before. With the increased internet connectivity, technology will also render it extremely difficult for the vehicles to get lost. Tracking objects can be designed and implemented to safeguard the products.

Chapter Three

Research Methodology

3.0 Introduction

In this chapter, the researcher established the epistemological and ontological views the research established. The researcher employed action research, thereby discussing the history and procedures of agile methodology techniques employed in auto mobile industry. The aim of the research includes analyzing the research framework and the implementation process, laying foundation for the data analysis chapter. The methodology adapted the researcher includes systematic literature review. According to Fink (2005), systematic literature review represents a research methodology used in identification, evaluation and analysis of existing literatures. In this study the literature selected will be on agile methods employed in automobile industry.

The major key words used by the researcher include agile technology, auto mobile industry, Agile methodologies, Automotive Research and Development, operationalization strategy, efficiency, agile strategies, performance outcome, adaptive automotive development, drivers for agile R&D approaches, and agile development theory. Others include quality design, product design tools, lean design and agility in design. The search engines used for the research included project management journal, "Manufacturing Engineering and Technology Group Center for Automotive Research", International Journal of Production Research, White Paper, Information and Software Technology, and International Journal of Micro Air Vehicles.

The research range included studies from 2007 to 2017, hence the search strategy implemented a strict criterion of papers produced in the above-mentioned journals and between 2007-2017, all of them being peer reviewed. More so, the papers should have included automobile

companies and employees of the same as main participants engaged in implementation of agile methodology techniques. Another consideration includes studies happening in an automotive setting, automotive mobile companies and agile technology centers. Moreover, studies published before 27 and those in any other language apart from English were excluded from the research. The study also considered additional inclusion including journals that have a precise methodology and actual agile automobile projects done over the years.

3.1 Planning the Review

The planning phase is essential in comprehending the review objectives that supports the review protocol. The review protocol was essential in defining the research questions and implemented research strategy. The researcher conducted a brief review using industrial engineering literature, which enhanced definition of keywords search such as constant work in progress. The studies reviewed during the initial stages included Mukhopadhyay and Snahker (2005), Anderson (2010) and Jones (2008) offering the researcher initial understanding of agile techniques.

Table 1: Research Questions

RQ	
RQ1	What agile systems exist in the industry for automobile industries?
RQ2	What are the key performance indicators propagated by agile techniques?
RQ3	What are the current adoption stages, barriers, and limitations on implementation of agile methods in software development in automobile industries?

3.2 Procedure used to Collect Literature

The systematic review relied on advanced literature search on global books, journals, reports, websites, project and newspaper articles. It was also important to review secondary analysis of agile technology in automobile industries, as well as other industries to see the comparisons. More so, the organizational structure of firms involved in the study was not standard, leading to some challenges as well as customizations required as the study progressed. The researcher utilized pseudonyms to ensure privacy of confidential information collected from companies and employees involved in the previous studies. The corporate publications used were unique for automotive companies and included tools like the marketing brochures, coffee-table journals and books, yearbook detailing company efforts in agile production.

The researcher had the discretionary power on understanding how companies through reviewed literatures achieved IT and agile objectives by analyzing projects implemented with reduced lead time. With the research, the researcher managed to modify project management procedures in some companies such as General Motors with ease because they provided information easily. However, Ford company provided less information making it hard to understand implementation of agile technology in the company with the limited information. Despite the two companies being global brands, Ford was not ready to share a lot of information about its projects therefore limiting flexibility.

It made General Motors flexible, allowing the researcher to systematically review its projects, establishing functionality of the agile technologies within the constraints of the company. Accordingly, the researcher did a mapping exercise on major automotive companies in the US,

with the exercise being hard because available data on overall and general agile projects in the US was limited.

3.3 Literature Search Findings

Initially, the research produced 2450 papers, where 10 research papers were on agile development in auto mobile industry (Khastoo, Dori & Raad, 2014; Kováč & Kováčová, 2016; Silva et al. 2015). Other studies focused on lean production in automotive industry (Jasti & Kodali, 2015; Holweg, 2007; Nordin et al. 2010; Pettersen, 2009; Thun & Hoenig, 2011). Other studies were on design implementation (Banos et al. 2015), mobile app implementation (Huckvale et al. 2016; Mujica et al. 2014). The researcher also reviewed reports by automobile companies and industry globally, with major emphasis in USA, UK, Australia, China, South Korea and Japan, because of their higher ranking in terms of automobile industry. The tickles were essential in comprehending historical and current statistics of agile technology development in the US in particular. The researcher also examined more secondary sources, documents and documentaries.

3.4 Search Term Definition

Depending on the research objectives and aim of the study, the researcher developed various definition terms as shown in the table below: -

Search definition Terms	**Rationale**
Product Design	In this research, product design refers to the process of transforming unique technical ideas that fit into the market requirements and opportunities to advance new products in the market. On the other

	hand, "product development and management Association (PDMA) defined new product development as a general strategy procedure organization employ, concept generations, product as well as marketing plan development including the evaluation or commercialization of the new products.
Deign Quality	Banos et al. (2016) defines design quality as procedure of activities done to allow manufacturers of product to meet client needs. It is also the effectiveness level of design function used in establishing product operational needs, as well as incorporation in design needs, with ability to be converted into a final product (Jasti and Kodal, 2015). Product design quality procedure permits engineers to identify plans and control factors that affect system robustness, as well as reliability especially for upfront procedures in design procedures. It involves measures that help in quantifying how best design functions attain specific objectives. The objectives relate to the product and organizational ones. Examples picked for the study include Number of variations observed in similar product parts, carryover product parts and their usage, change management, cost avoidance, ability to save costs, viable technical changes.
Design Process Efficiency	It involves design measures or metrics significant in the quantification of efficiency to support cost effectiveness of design procedures of all engineering designs. They are referred to us

	efficiency measures with an example of Productivity= (Sales less Materials of Engineering Labor.
Lean production Design	Lean purpose includes eliminating wastes in all areas of production and product development associated with procedures that start even before the production. The term was developed from lean manufacturing, which is a starting point of customer needs, establishing value added. Any activity that does not add value to customer satisfaction, yet the client pays for is reffered to as waste. The companies therefore has to identify features of products with additional value, eliminate activities without value and include clients in product development stages.
Agile technology	It represents a specific methodology employed in project management and used in software development. It si important in helping companies respond to unpredictability of developing the software and always uses incremental, iterative work processes refered to as sprints.

Table 1: Search Term Rationale

3.5 Broad Search Items

From the start, the researcher developed broader search strings utilizing Boolean connectors that include (and, or and not). The three main terms include agile technology, lean production, product development. With the study focusing on agile technology, the researcher run the search strings in various database and obtained massive hits. The researcher picked on databases with more hits to ensure they have maximum coverage. Utilizing the criterion, the researcher picked on most common databases as shown in the table below: -

Agile Technology* AND Lean Production* OR Product Development in automotive companies* NOT Massive Production.

Table 2: Search Strings alongside Boolean Connectors

Data Base	International Journal of Production Research	Manufacturing Engineering and Technology Group Center for Automotive Research	Information and Software Technology	**Xplore**	International Journal of Micro Air Vehicles	Scopus and ACM	IEEE	project management journal	Web of Science	
Hits Reached	**700**	**167**	**250**	**330**	**403**	**500**	**200**	**230**	**130**	

Table 3: Summarizes of database records generated from the broad search strings.

Quantitative Methodology (Questionnaire)

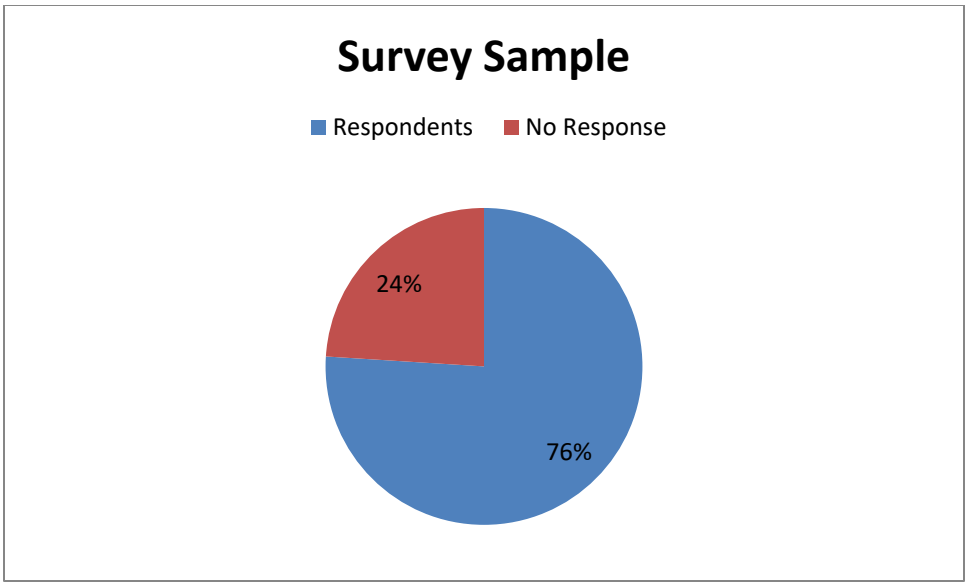
Apart from reviewing past literature the researcher also used online surveys to understand if project managers in various companies had successfully implemented agile methodologies in their operations.

Chapter Four

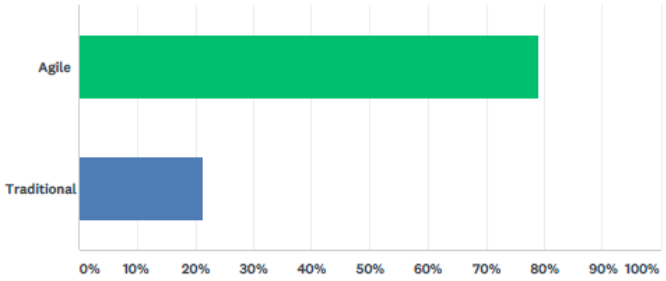
Results and Findings

Based on the online survey questions that were asked to 25 individuals who are working in the automobile sector, the responses from individual's shows how the organizations are adapting to Agile Techniques over Traditional methodologies. Below is the list of 14 survey questions that were sent to 25 individuals with 19 individuals responding.

1. Which project management methodology do Project Managers in your organization use?
2. If you used Agile, would you consider it to be successful?
3. What are the challenges faced in traditional methodologies?
4. Which Agile methods and practices do you use in your organization?
5. What is the scope of agile implementation in your organization?
6. Which roles are used in your agile project(s) and how much time is spent on those roles?
7. Were "organizational" or any other kind of changes necessary during the introduction of Agile?
8. Do you have a project manager that manages a team?
9. What are the organizational preconditions for successful agile transformation?
10. Which phase of the agile implementation is your organization currently in?
11. How do you rate your PMO's ability to support and effect change in your organizations?
12. Is the delivery of projects within your organization co-ordinate by a Project Management Office (PMO)
13. Does your organization manage projects within a portfolio structure?
14. Agile in Automotive is defined as sum of agile practices.

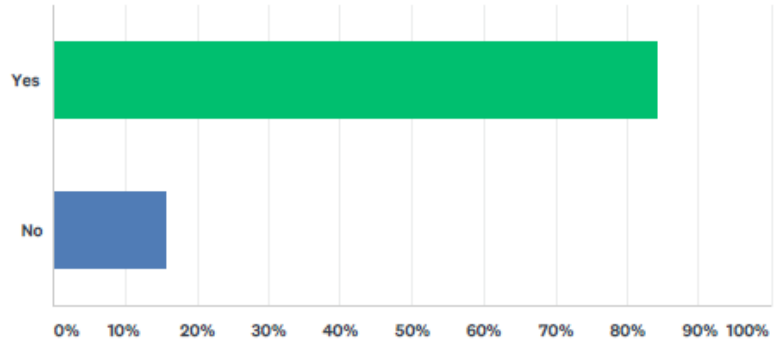


When asked "Which project management methodology do Project Managers in your organization use"?, 15 individuals indicated that agile is being used and 4 indicated that they are still using traditional waterfall methodology. With 79% of the participants using agile methods, it was clear that agile methods had continued to gain popularity.



ANSWER CHOICES	RESPONSES	
Agile	78.95%	15
Traditional	21.05%	4
TOTAL		19

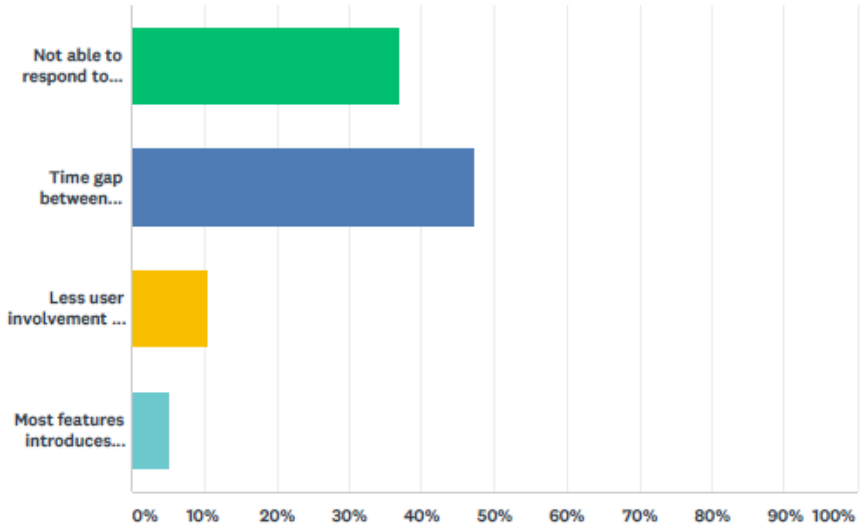
When asked "If you used Agile, Would you consider it to be successful"? , 84.2% responded agile to be successful as it is more flexible than traditional waterfall model. Agile model is widely becoming popular for minimizing the development time and producing a product within the scheduled time frame.



ANSWER CHOICES	RESPONSES	
Yes	84.21%	16
No	15.79%	3
TOTAL		19

When asked “What are the challenges faced in traditional methodologies”? , The results showed that 47.4% indicated time gap between requirement elicitation and end product delivery, 36.8% indicated that the teams were not able to respond to the constantly changing environment, 10.5% indicated less user involvement in project process, while 5.3% indicated features that are

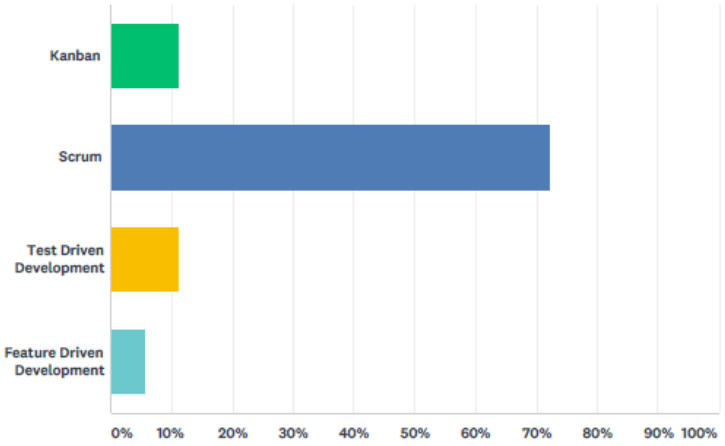
initially introduced may not be used by end customer.



ANSWER CHOICES	RESPONSES	
Not able to respond to changes in constantly changing environment	36.84%	7
Time gap between requirement elicitation and end product delivery	47.37%	9
Less user involvement in project process	10.53%	2
Most features introduces initially may not be used by customer	5.26%	1
TOTAL		19

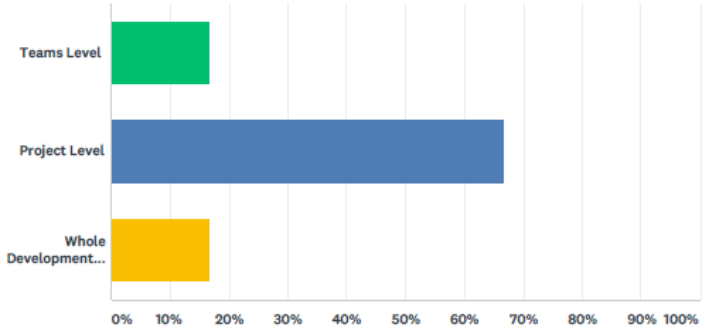
When asked “Which Agile methods and practices do you use in your organization”? , Results indicated that 72.2% responded scrum when compared to other practices. In scrum the projects are split into multiple sprints where the entire team needs to collaborate and work collectively to complete the scheduled tasks on time. Another advantage of choosing scrum is that the team is accountable as all the members move quickly to be on the same page and this leads to

transparency of the project.



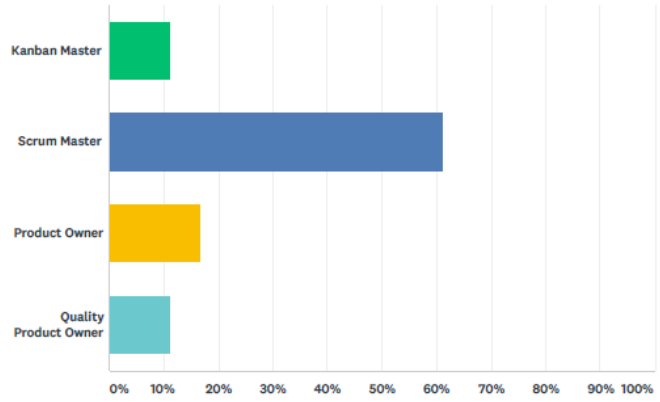
ANSWER CHOICES	RESPONSES	
Kanban	11.11%	2
Scrum	72.22%	13
Test Driven Development	11.11%	2
Feature Driven Development	5.56%	1
TOTAL		18

When asked “What is the scope of agile implementation in your organization”? , The results show 66.7% indicated that the agile was implemented at the project level.



ANSWER CHOICES	RESPONSES	
Teams Level	16.67%	3
Project Level	66.67%	12
Whole Development organization	16.67%	3
TOTAL		18

When asked "Which roles are used in your agile project"? , The results show that 61.1% have chosen scrum master as the role that is being used in the agile project. The scrum master is not responsible for the project outcome when compared to project manager. The scrum team as a whole is responsible for the project outcome. Scrum master is someone who makes sure the team is focused on day to day activities such that the tasks are completed on time.



ANSWER CHOICES	RESPONSES	
Kanban Master	11.11%	2
Scrum Master	61.11%	11
Product Owner	16.67%	3
Quality Product Owner	11.11%	2
TOTAL		18

Agile Techniques in Auto Mobile Industry.

Management Frameworks

Feature Driven Development (FDD)

FDD represents a type of agile methodology developed between 1997 and 1999 by Jeff Luca in Singapore (Ward et al. 2015). Asks are divided in small functionalities to pulverize work under five basic principles. The principles include developing an overall model; building features

lists, planning by feature, designing by feature and building by feature. The main benefits of FDD arise because every feature represents a minimum unit of the entire project. It is an indication that each task, description, test, as well as changes remain minimal allowing the processes high agility levels that cost less in terms of time and human input.

Extreme Programming

Also known as XP, this kind of agile management was developed in 1997 to concentrate on engineering practices. It is therefore common that software development aims at optimizing quality and responses to customer needs, as well as requests. The principles include simplicity that helps in removing unnecessary functions. Another principal include feedback that entails frequent contacts with clients, testing products and receiving significant suggestions. Another principle involves changes that involve constant adaptations in the product up to the final stage. XP methodologies represent an ideal situation where clients fail to understand what they want; however constant support from experts supports agility to ensure product changes.

SCRUM

Jeff Sutherland developed scrum during the 1980s and it is interactive and incremental in all the development procedures. It is the most popular method in agile methodology implementation. It relies on breaking development in different parts completed through periodic sprints. There are fixed stand-up meetings essential in tracking progress and report changes. Sprints last for over four weeks and implementers hold meetings daily including the 15-minute daily-scrums (Ward et al 2015; Silva et al. 2015; Luthra et al. 2016). The methodology has specific features in human components involved in the development procedure. The benefits include

possibility to work with low-level client participations. More so, scrum helps to ensure teams remain motivated and prioritize quality with short deadlines.

Stack Methodology

According to Khastoo et al. (2014), Franklin Valadares the founder of Run tried implementing numerous agile methodologies by book during the management of teams for mobile development. In the end, he established that most of the projects were rigid and complex, with implementation suffering many setbacks, with many employees lacking enthusiasm for the same. It was therefore necessary to implement stack methodology as an alternative that proved successful in motivation of teams. The methodology fit diverse and varied activities and company projects that teams engage in. More it supports continuous delivery, as well as the fundamental agile principle. The team prioritizes tasks that have significant impacts and returns thereby optimizing use of time.

Chapter 5.0 Discussion

During the analysis of the results, the studies show many similarities and differences as well. The similarities were shown in difficulties engaged in adopting agile methods. Another similarity aspect includes organizational culture in disagreeing with agile values and lacking necessary skills and expertise with agility methods. The studies show that the main challenge involved in full adoption of the agile methods includes employees lacking the required experience. The possible causes include employees lacking necessary training in effective agile methods, because of opinions expressed by individuals related to agile community in automobile companies.

In three areas, the results showed similarities to those achieved that include the size of the technology team, time the company had been engaging in agile methods as well as most utilized method (scrum). However, the major difference included percentages of projects carried out using agile methodologies. In survey studies, most respondents included developers and they indicated that their greatest concern include software quality at the time the new method was adopted (Ward et al. 2015; Jasti & Kodali, 2015; Nordin et al. 2010). Other reasons provided by developer respondents included inability to climb, with some resisting changes.

While considering software quality, it could be linked to lack of knowledge, no additional training under the provided agile methods and techniques, because the nailed aspects require better alignment with client to ensure effective delivery to a client. It is however significant to know that it is hard to generalize the statistics as it corresponds to the preliminary study aimed at complementing with huge data sets. It is significant in permitting concrete visualization of mentioned scenario (Ward et al. 2013). The automobile industry is undergoing major innovations aimed at coping with the advanced world technology. One of such innovations as shown in the reviewed literature revolves around the production and delivery of the products (Jasti and Kadali, 2015). The studies indicated that sometimes it becomes difficult for the companies to deliver the required products to the customers on time.

The solution includes predictive analytics that includes scientific studies of the customer requirements and deliver exactly required in the market. Predictive analytics is a driving force in the efficient production of a better-managed supply chain that will be translated into new desirable vehicle designs. More so, there are innovations intended to keep the drivers safe with increased connectivity and automated driving. The innovations in regard will be meant to protect the personal data of the driver and ensure that there is no hacking of the infrastructure, the vehicle, and the

routes are taken (Poppendieck & Cusumano, 2012). Furthermore, waiting for vehicle repair or refueling of the vehicles would not keep the driver waiting for too long. It will be exceedingly easy to do so given that the innovations cater for that.

The fourth innovation involves the customers getting involved in the vehicle design (Bannos et al. (2015). This will go beyond selecting the options in the catalog on the preferred designs. The specific requirements of the customers will be captured for customized vehicles. This will lead to more satisfied clients than ever before. With the increased internet connectivity, technology will also render it extremely difficult for the vehicles to get lost. Tracking objects can be designed and implemented to safeguard the products.

5.1 Auto Motive Industry Trends, Market and Innovation

The US auto market has capably managed the moving up and down of the of the market dynamics. Since the development of the financial crisis in the US, the auto sales have been greatly boosted over time (Bannos et al. (2015). The industry has always been able to handle this situation through the act of pushing their transaction process up. Although they will sell few cars, they will have charge more and end up selling them to the borrowers who are credit-worth.

Over the past years, the self-driving cars have received the biggest sales ever in the market. The auto products such as Uber, Waymo, General Motors, Tesla, have made substantial progress in the market pushing into the best-selling automobiles (Jasti and Kadali, 2015). It is a great achievement (Poppendieck & Poppendieck, 2003). However, autonomy is not sustainable in the industry, because existing technologies of the automakers and the tech companies will organize the next move and overthrow any achievements made in the self-driving cars. The competition remains healthy and is likely to become more severe with time (Poppendieck & Cusumano, 2012). As such, agile remains to be the only solution to the existing market dynamics.

Accordingly, several factors, which include the price of the products, determine the demand in the automobile industry. Product demand reduces when the prices are higher than expected (Jasti and Kadali, 2015). The second factor includes finance availability, where customers have an option of getting funds from credit firms, they are likely to have a higher demand for the products because they are able to access the funds and pay for the products. Furthermore, people's income plays a great role in determining the demand for the products (Bannos et al. 2015). Presence and quality of public transport will tend to lower the demand for personal automobile products. The price of petrol also determines the demand for automobiles because most automobiles operate using petrol. If the income of a country is distributed mainly among the rich, then the demand for the automobiles will be higher. Lastly, the economic growth and development lead to the improved lifestyles that increase the demand for automobiles.

Over the last few years, the automobile industry has been challenged more than what people have always thought. At the look of the operations, the industry is seen to be operating normally, and the performance is so strong. However, the industry is in serious trouble. First, the total shareholder return (TSR) has drastically reduced (Bannos et al. (2015). This has painted the industry as a less attractive investment compared to other industries. As such, there is likelihood that there will be few winners in the industry in the coming years. Most of the potential investors are likely to flee the industry leading to limited capital resources for possible growth. Secondly, the developments in the automobile have constantly made the products exceptionally expensive. Many of the vehicles are made with new exciting features that require enhancing the expertise of software engineers to assemble (Jasti and Kadali, 2015).

For the supply of the automobiles, one of the determining factors is the price of the automobiles. The higher the price of the automobiles will always lead to the higher rate of supply.

The cost of the inputs such as labor, steel, machinery and many others will directly lead to a decline in automobile supply (Poppendieck & Cusumano, 2012). Moreover, the technological advancement is another factor that will make the production of the automobile products more profitable (Jasti and Kadali, 2015). Therefore, more of the products will be produced increasing the supply. Lastly, the change in government policies concerning the automobile industry does affect the supply of the products. For instance, the reduction custom duty imposed on the purchase of raw materials will automatically lead to the increased supply of the automobiles.

5.2 Innovation

It is important to involve customers in the innovation process, specifically, the vehicle design (Bannos et al. (2015). It involves selection of options provided in a catalog on the preferred designs. The specific requirements of the customers will be captured for customized vehicles. It leads to satisfied clients. With the increased internet connectivity, technology renders it extremely difficult for the vehicles to get lost. Tracking objects can be designed and implemented to safeguard the products.

5.3 Benefits of Agile innovation in automobile industry

The reviewed literature shows that automotive sector is important, with an expenditure of over 66 billion pounds on a yearly basis on research and development only. More so, the motor sector employees over 12 million workers in Europe alone (Silva et al. 2015). However, the sector faces numerous challenges such as consumer behavior changing demand of the connected, smart, and autonomous autos. According to Anderson (2010), modern car represents a high-tech machine, and has led to many companies try to reinvent the driving experiences of clients. It means software will continue advancing as the industry progresses to full autonomous vehicles. Car design,

therefore has become complex that before. Every company is in a tech arm race to manufacture smart and autonomous vehicles.

Automotive companies must invent new methods of manufacturing, including simplifying vehicle development procedures, reducing development cycles through prototyping and agile and efficient ways. It is possible to achieve the agility through the creation of digital clones of new models that allow development and testing to happen in a virtual world. The processes accelerate design, tests and approve cycles (Petersen, 2009). The reviewed literature proposed automobile companies following various steps. Among them, include creation of a digital twin car by creating digital enterprise designs that foster innovation and attain quality product development (Kovac & Kovacova, 2016; Jasti & Kodali, 2015).

The most repetitive procedure includes clean-sheet design, an approach used mainly in aerospace. Aerospace companies host significant projects, teams, and even suppliers on a specific modular supported by integrated tools essential in reinventing every element of a plane. The companies use specific software applied in auto industry, an indication that the scope and ability in the auto industry need to change to reflect what is happening in the aerospace. It is necessary to co-ordinate change between varied functional sections to reduce on complexities. Tools should make the processes of uniting development packages easier using one product design and a simulation environment. Accordingly, one needs to develop and update technical documentation, configure and manage material bills, as well as coordinate individuals and procedure towards attainment of shared objectives (Huckvale et al. 2016; Ikonen et al. 2011).

According to Huckvale et al. (2016), the current era of of software is an indication that the industry is progressing towards autonomous vehicles, hence the need to invent and explore different software codes. Safety is an important attribute starting from the alert, then lane crossing

applications, as well as advancing driver observation systems. An example includes the wearable technology that can link the car system to observe stress and some tiredness levels. The vehicles take up additional tasks such as driving when the driver's alert levels become compromised. More so, during a crash, sensors could communicate the location, severity of injuries and occupants of the vehicle.

It is a complex automation, writing, testing and amendments of software code even in most time-intensive roles that should be simplified to ease change management and compress the existing development cycles (Jasti & Kodali, 2015; Banos et al. 2015). "Integrate Computer Aided Engineering and Computer Aided Design (CAD)," indicate that there has been an increased urge to align designs as well as engineering analysis, alongside the integration of vehicle testing, as well as simulation. Utilization of 1D and 3D digital models in vehicle prototyping time could reduce significantly, because of the challenge of validating physical components, designs and various parts in an iterative manner.

The integration of virtual and physical world help in understanding component performance before signing-off on the fabrication to reduce product development costs as well as timelines (Anderson, 2010). Modeling the software is important because of its role in automotive, making it imperative to create, document, store and ensure the running of tests and available codes (Nordin et al. 2010; Luthra et al. 2016).

When executing change, especially when handling many change requests happening in a launch of a global program, it remains significant to link engineering and manufacturing applications (Khastoo et al. 2014; Ahmad et al. 2013). According to Ahmad et al. (2013), engineering and manufacturing sectors must work jointly to understand the type of tooling and operational change required in handling varied vehicle configurations. According to Ahmad et al.

(2013), digital project management systems make it simple to combine product engineering, manufacturing, as well as the shop floor execution in available integrated applications.

The visibility and available control unite capabilities in a single interface to reduce on complexities to ensure the market is faster after the product launch, right procedures and process controls. Complexities in the control system are obvious including the technologies, because of complications in software interactions, which could also provide the required answer. Cohesive tool suite across different designs, testing, simulation, production, and execution analytics indicate it is easier to manage virtual teams, reduce costs, and automate development procedures.

Conclusion

Automotive industries have continued to expand, as they cut on costs by regulating efficiency, grow, and make profits. The factors that have continued to change the industry include marketplace growth, outsourcing for product development, customers demanding for improved reliability, development of human-vehicle software and have continued to change the automotive industry. As a result, companies have continued to face numerous challenges to manage the factors. The challenges include managing volatility, experiencing massive uncertainty, as well as reduced predictability of future businesses. Other challenges include handling a complex, interconnected industry, and the need to form joint ventures and maintain successful supplier relationships.

The Automotive businesses must change their operating models to advance agility. An example includes ensuring OEMs is flexible to operate across the value chain and provide value-add, as well as personalized experiences. The Automotive companies must learn from Google and Uber that have embraced digital activities to market new business models that can promote innovation. The focus is on improving customer experiences through expansion strategies that include joint ventures or acquisitions. It is impossible for companies to enhance efficiency and

performance without having a talented staff that is committed to the delivery of quality products and services. Digital activities and innovation-driven automotive industry have increased stakes for company processes across the value chain. Dealerships, OEMs, and manufacturers of vehicle parts require individuals that are digital practical understanding to initiate transition to digital corporations. The techno-savvy employees use digital strategies to improve customer experience, leading to many companies to invest in human resource practices such as training of employees

Recommendations

The industry has entered a time of intense investment and competition; hence, the need for smart innovation portfolio essential in helping automotive team designs. As seen from the research, an integrated software setting makes it simple to develop and manage the embedded software starting from the inception of projects to end of the same. The secret lies in making the processes integral in general vehicle development plan. It allows the managing of large-scale software deployments, while encouraging traceability and checking of errors. Its therefore recommended that the automobile industries take advantage of the booming agile methodology, to monitor the designs and come up with effective innovations. By so doing, they can make model designs and hence gain a competitive advantage.

The main finding from the research is that in recent times, automobile industries are facing the complexity of automotive software whereas they need to make the release cycles even smaller. These, coupled with the pressure to cut the production costs, have led to many plan-driven developments facing failures. It is therefore recommended that companies can adopt the latest agile methodologies to cut the costs of production, ease task switching and cut the communication chains as mentioned by the respondents. As such, processes will be faster and there will be high productivity. Further research on the same topic is also recommended.

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