ICONARP
International Journal of Architecture and Planning
Received: 01.05.2025 Accepted: 19.12.2025
Volume 13, Issue 2/ Published: 31.12.2025
DOI: 10.15320/ICONARP.2025.338 E- ISSN: 2147-9380
Research Article
ICONARP

The Impact of UXd in Lean Product Development and Design Processes; The Case of Automotive Industry

Fuat Ali Paker*

Abstract

In the last two decades, lean product development and design processes, which have rapidly penetrated the automotive industry companies with all their functions and spread globally, have come to life with measurements, benchmarks and flow maps on value creation or value addition in new product project stages. In the literature review, two customer-oriented approaches, namely lean product development and user experience design, have been widely adopted within the discipline of new product design. However, the lack of comparative efficiency measurements or studies addressing their integration in scientific publications constitutes the primary motivation of this research. Furthermore, the selection of the research scope and boundaries is based on convenience sampling, enabled by direct qualitative research with companies managerial or design positions in the Turkish automotive supplier industry. The main objective of this study is to conduct a comparative analysis aimed at integrating user experience activities with lean product development process flows, and to reveal metric values that enhance efficiency through overall system optimization. On the other hand, the most important recommendation of the study is that the basic process will benefit positively by including user experience activities, which are the most important application of customer-oriented design approaches, into the highly efficient lean product development flow. Therefore, the study conducted with the mixed research method was completed under the preference of quantitative face-to-face interview method in the in-depth questioning of the qualitative numerical data obtained by the questionnaire method. User experience activities, which are newer and less widespread than lean product development processes, have also revealed the frequency of project-based, customer-oriented design activities, along with the demographic organizational structure of the participating companies in the automotive industry, such as the age of establishment, number of employees, number of designers, etc.

Keywords:
Industrial design process, Lean product development process, User experian design

*Department of Industrial Design, Faculty of Architecture and Design, Konya Technical University, Konya, Türkiye
Email: apaker@ktun.edu.tr

To cite this article: Paker, F., A. (2025). The Impact of UXd in Lean Product Development and Design Processes; The Case of Automotive Industry. *ICONARP International Journal of Architecture and Planning,* 13 (2), 625-644. DOI: 10.15320/ICONARP.2025.338

INTRODUCTION

The main reason for the introduction of lean product development and design processes by automotive industry companies in the last half of the 1990's was to focus on the targeted users and their needs through new vehicle design or innovation on the product that the user will pay for (Womack, et al., 1990; Womack, and Jones, 1996; Liker, 1998; Paker, 2021). Therefore, in the lean product development processes that the Toyota group has put into practice from theory to practice, the fact that there is no loss in the new and innovation values that the customer or user accepts the price, and that it comes to life in the criteria involved in customer preference and acceptance, comes to life today with user experience activities.

A review of the literature on customer-oriented new product design processes reveals two dominant focal areas in contemporary practice: the first centres on lean product development, while the second focuses on user experience research. Accordingly, although these two approaches exhibit distinct focal points and process perspectives and are widely represented in the literature, their respective efficient aspects are measured in this study and proposed as a hybrid system. In addition, due to a convenience-based field access preference, the research population and boundaries are defined through face-to-face interviews conducted with project managers and product designers employed in the Turkish automotive supplier industry. The main purpose of this study is to compare the integration of user experience activities and lean product development process flow, and to reveal the metric values on the axis of optimization of the whole and increasing its efficiency. Furthermore, in the last two decades from the 2000's to the present, lean design processes and the accompanying optimized new product focus have led to new product and development phases that can dominate the market, thus bringing about severe competitive needs for automotive industry companies (Levitt, 1965; Jones, and Womack, 2002; Paker, 2020; Paker, 2022). In other words, this area of specialization, which started as 'interface' and 'semiotics' research within the communication and electronics sector, which entered our lives in the 2000's, and then had the basic title of 'user experience research and design' in scientific studies, although it seems to be an upper subject heading independent of lean product development and design processes, it has formed the focal point, perhaps the cause-effect link, of the new product design flow that has become lean. When we examine the reasons for sustainable global companies in the automotive industry to start user experience studies or lean design processes; Competitive advantage, Economic growth or regional and global expansion, Customer loyalty, Creating and promoting main and sub-brands, Development of social responsibility projects, Productivity increase, Development of critical parts or research and development on the global axis, similar basic reasons are included in the literature (Liker, 2004; Morgan, and Liker, 2006; Paker, 2022). Therefore, user

DOI: 10.15320/ICONARP.2025.338

experience studies that have recently been introduced in different sectors under severe competition conditions, the sustainability of innovations in the automotive industry on a global basis at regional or company level (autonomous vehicle levels (0- 5) and country-based development), the implementation of lean product development and industrial design processes with the culture or success of leanizations have led to important comparative measurement and scale results (Levitt, 1965; Thomas, and Singh, 2006; Paker, 2022). Lean design process stages (design management), or the high efficiency, time or cost-oriented stage fiction in the design and development flow brought about by the lean culture and concept in company employees, has ultimately structured the current industrial design steps of the new product within the scope of new technology and new customer habits for the last twenty years. In other words, at each step or each design verification step in the lean product development and industrial design phases, user experience outputs with integrated impact on continuous improvement and defined test values or phase transition checklist are targeted as project outcomes (Levitt, 1965; Paker, 2020; Paker, 2022; Palacı, 2024). On the other hand, today, the implementation of industrial design stages based on lean and user experience research and design studies with a higher approach has revealed the ability to create or add value focused on user experience in the new product together with lean concepts in order to gain competitive advantage under different variables in the local or global market with the final, newly designed product. Considering the different variables in different regions under the aforementioned user experience studies, according to the data for the years 2020- 22, for which national automotive industry companies regularly share statistics, %38 of government-funded R&D projects are new automotive product or innovation process management activities (Palacı, 2024; Saraç, and Arslan, 2024). In addition, another output of the shared research is that %41 of government-funded R&D projects are marketing or organizational innovation management studies (Chiffi, et al., 2022; Duggan, et al., 2023; Palacı, 2024; Saraç, and Arslan, 2024). Therefore, the distribution of these variables in the total value of the research in the specified date range revealed %28.5 as organizational innovation management and %33.6 as innovation management in marketing (Chiffi, et al., 2022; Duggan, et al., 2023). The main reason for the inclusion of user experience studies or lean new product development and industrial design processes in automotive industry companies is defined as increasing profitability in a sustainable way with cost reduction in increasing values (Chiffi, et al., 2022). In addition, being able to offer online or offline services with new technology-equipped products or products, together with the simplification of all managerial processes in the organizational structure, has brought sustainable value creation to the forefront. In the aforementioned simplified automotive industry, it is revealed that the design goals and approaches in the focus of user experience studies in products,

workflow and managerial processes, global and local marketing, organizational structure and activities provide benefits by creating commercial value (Chiffi, et al., 2022; Brophy, et al., 2023; Eaton, et al., 2023). On the other hand, mergers, acquisitions, supply management in global brands and companies in the automotive industry, communization in supply channels and critical parts manufacturing or R&D, use of common platform structure in critical parts suitable for mass production such as motor chassis, similar main and sub-brand based mergers-partnerships-acquisitions, similar new approaches are also among the outputs of lean design management and leanizations (Law, et al., 2014; Chiffi, et al., 2022; Duggan, et al., 2023; Eaton, et al., 2023). In today' s new automotive industry products, new online and offline services designed according to increasing and diversifying user experience study outputs; new variables such as autonomy level, online service and security with remote access, energy economy (alternative fuels), basic life and personalized comfort habits (eating, drinking, sleeping, cleaning, communication, etc.), communicated road or fuel and parking areas, and similar new variables reveal their importance day by day within the scope of user experience studies in national and international economies. In this context, as of 2023, our country ranked 43 rd with 38.9 points among 138 countries in user experience research and design or innovation coefficient evaluation on a global scale (Chiffi, et al., 2022; Duggan, et al., 2023; Palacı, 2024; Saraç, and Arslan, 2024). On the same axis, automotive industry companies that design new products for the current life model and habits created by new technologies and high comfort standards have focused on the high competitive success brought about by the variables in the industrial design process stages revealed by user experience studies in order to achieve global profitability and international economic development. Therefore, customer habits formed by new products developed under highly competitive conditions, together with user experience-oriented online services in the global communication network, are at the center of the user experience study steps as the golden key of these industrial design stages. Under the same approach, user experience studies have become an inevitable function for the survival of leading automotive industry brands, where new product design technologies and new online services that come with new product design technologies determine high comfort standards and habits, along with sustainable simplification for local and global success (Paker, 2020; Paker, 2021; Paker, 2022).

As a result, this study aims to examine the user experience studies under lean product development and design processes and their main effects in the flow together with design and research and development center managers and employees in 220 automotive main and sub-industry companies that have implemented lean product development and industrial design processes within the national automotive industry companies that constitute the defined field research area. The lean

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processes in practice of national automotive main and sub-industry companies in the research area, which constitute the boundary conditions determined by the approach in question, and user experience studies on a global scale or factors affecting the basic design flow, new products or technologies and online service design models, reasons or resistance of the user and designer in the face of innovation were examined together with the employees involved in the in-depth research.

Therefore, the first research question is to define and cascade innovation targets with newly introduced user experience activities that can bring customer-oriented needs and demands to the forefront of highly efficient lean product development and design processes, revealing the need to optimize the entire process. The research method, which is appropriate for the purpose of the study, has been established under the aforementioned approach. Today, the rise in living standards, the increase in integrated comfort areas, individual instant communication and the instant change in needs and demands have led to the need to design the online-offline service fiction together with the new product. This need for new product design also defines new environmental technology needs. However, determining service design scenarios or scenarios generated by online-offline customer preferences requires new user experience research methods that focus on the use-user interface and customer needs in a service-user approach rather than lean product development processes with high engineering efficiency.

LITERATURE REVIEW

Liker (1998) and Womack (1996) compared the manufacturing and new product development functions of intercontinental global automotive industry firms (North American and Japanese Automotive Industry Firms) with a focus on productivity (Womack, et al., 1990; Womack, and Jones, 1996; Liker, 1998; Jones, and Womack, 2002; Liker, 2004). Along with "The machine that changed the world", in which the same researchers defined the concept of just-in-time production at the end of the 1980's, "Toyota's way; Lean product development and design processes", published in the second half of the 1990's and spread in the automotive industry in the 2000's, defined losses by measuring the methods of focusing on product innovations that the customer will pay for or achieving cost-oriented innovation (Womack, et al., 1990; Liker, 2004; Morgan, and Liker, 2006). In their joint research, Liker (2004) and Morgan (2006), while focusing on lean product development and industrial design processes, focused on two variables as productivity outputs; value creation or value addition on the new product, defining them separately in the study and comparing them in detail in all sections and stages of the article with a cross-continental firm focus (Liker, 2004; Morgan, and Liker, 2006). The study, which also included cultural habits, also clearly identified losses in value creation or value

addition on the final new product in fourteen consecutive steps in patterns based on industrial design processes and engineering phase transition tests or design verification steps. In another approach, these two function definitions, which constitute a consecutive intertwined whole belonging to the same researcher, together with the concept of leanizations in global automotive industry companies, revealing the global competition variables or effects of global competition variables or effects, market share and profitability results, and their use in different sectors, the commonality of different approaches as "lean design methods and repetitive structure in new product for sustainable commercial product success" (Mishra, 2022; Longaigh, et al., 2023; Ryan, et al., 2023; Trubetskaya, et al., 2023).

The secondary main heading within this framework brings and includes the design of new products and integrated online new services and technologies, the design of new or significantly improved communication technologies on the product, online and offline communication channels, sales, service or distribution, security, payment and delivery and similar innovations (Norman, 2009; Hokkanen, et al., 2015; Vukovac, et al., 2019; Lallemand, et al., 2015). In addition, in online and offline service-oriented product innovation; solutions developed to reduce unit quantity, security, procurement, delivery or logistics costs, to increase regional or global expansion, to design or deliver new or significantly improved product technologies are revealed as environmental variables outside the focus of the study subject of the literature research (Nielsen, 1993; Norman, 2009; Law, et al., 2014; Lallemand, et al., 2015). Therefore, sales or marketing innovation, which is the last two functions of the three-basic user experience study models in the literature; together with the industrial design approaches of the new product, packaging, product architecture or product positioning, product hierarchy-position-oriented sales channels, after-sales services, promotion, pricing, similar new sales, marketing techniques and methods are also included in the state-supported R&D incentives in our country. Customer orientation in the organizational structure within the four basic user experience methods defined in this section affects the organizational structure, regional or global structuring, manufacturing, marketing, sales and service channels and strategic approaches of the automotive industry or other manufacturing industry companies together with their commercial practices. Therefore, organizational structure and management under these user experience studies result in brand mergers, acquisitions, mass production of different brands or I&D and R&D centre's among today' s automotive industry companies.

RESEARCH METHOD

The current lean product development processes and customer-oriented design approaches used by the automotive main and sub-industry employees included in the field study of the research were

DOI: 10.15320/ICONARP.2025.338

calculated and analysed with a survey application under the statistical software model. While the first field study of the study was conducted with a questionnaire application, the second field study was conducted with face-to-face interviews with a quantitative approach. Therefore, the study conducted with the mixed research method was completed under the preference of quantitative face-to-face interview method in the in-depth questioning of the qualitative numerical data obtained by the questionnaire method. User experience activities, which are newer and less widespread than lean product development processes, have also revealed the frequency of project-based, customer-oriented design activities, along with the demographic organizational structure of the participating companies in the automotive industry, such as the age of establishment, number of employees, number of designers, etc. In the research; While the number of employees in automotive main and sub-industry companies, the age of the organization, and the techniques used in new projects constitute the fixed variables, the use of lean product development and user experience activities, preference for in-process or end-of-process work, the type of integration into the existing process, internal or external procurement of user experience studies, process setup and management support, the formation of new project objectives and the maintenance of in-process innovation objectives, the supply of qualified employees for user experience activities, customer demanded new technology investment, the impact of firms' financial resources and capital structure on the process, the impact of government support in new product development and design projects, new design and innovation promotion barriers and similar factors are considered as moving variables.

The boundaries chosen for the research, its limitations or its universe and the defined field are an important and decisive financial power for nations, which is periodically measured in international economic evaluations, together with heavy competition conditions in local and global dimensions.

In today's automotive industry, high comfort standards, redefined, updated and developed with the lean culture, have come to life by becoming lean under the new sustainable regulations of environment and energy resources together with the new life model. On the other hand, user-oriented innovations (autonomous driving and its levels (0-5)), artificial intelligence services (online and offline; route alternatives, self-parking, charging and other support services) in vehicles with or without drivers), the desire to increase the comfort of life in today's vehicle use, and the desire to increase the comfort of life in today's vehicle use, pioneering user experience-oriented concepts specific to the automotive sector, compared to other industries, are coming to the fore day by day. The second research question of the study is to determine customer-oriented demands and needs with sustainable methods together with new online-offline service technologies for product development-design under user experience-oriented inputs, especially

in the automotive industry; or to investigate in-depth efficiency. The most important intertwined difference between user experience research, which has recently been introduced in today's industries under heavy competition, and the concept of lean in automotive industry applications is to achieve lean in customer-oriented new product functions by identifying the value-creating and non-value-creating tasks in new product development and industrial design processes, and defining efficiency and optimization measurements guided by the priority map of the process. In addition, the revelation of some difficulties or obstacles in the user experience and design stages on the concept of simplification in terms of protecting or guiding sustainable values increases the innovation effect in the theoretical and practical projects that can be carried out in the future, as well as revealing the main purpose of the research. Therefore, the purpose of starting the research is to examine in depth the negative and positive effects of the factors affecting the user experience research or lean design process flow of the employees of the new product development and industrial design department of the company together with the operating age of the automotive industry companies in the defined comparison structure included in the research in terms of lean product development and design processes. In other words, the effect of the lean product development and industrial design processes that have been in operation for a long time in the automotive industry companies participating in the study has been revealed in terms of the presence of customer-oriented user experience research, which has recently started to be put into operation, in the defined or undefined flow steps, the high number of employees, the fiction or management of online-offline service technologies in new products.

The starting point of the method used in the study is the flow steps of the industrial design discipline, in the literature examined in terms of user experience research and design processes, it has been tested linearly that as the number of employees of the company increases in different sectors, the existing product and service design also increases the tendency to innovate or develop new technology with a competitive focus. On the other hand, under the concepts brought by lean product development processes to today's automotive industry, with customer and cost-oriented approaches or process optimizations in new product design, the answer to the research questions on user experience studies with similar variables had a positive effect. The answers given by the employees involved in the new product development and design processes in the national main and subsidiary automotive industry, the results of the second face-to-face field research, are analysed in detail in the findings section of the study, and their synthesis is presented in the same section. In the first field study where the boundaries of the research were determined, the size of the national automotive main and supplier industry companies, the age of the participating companies and the number of models in the product range or the main and supplier

DOI: 10.15320/ICONARP.2025.338

industry brand cooperation, the lean product development process examples in customer or user experience oriented applications and the effect or reverse effect of the effect or reverse effect, together with the functions with which it is cross-related, revealed equal or different results. Therefore, with this study, the reasons for the automotive main and sub-industry companies using lean product development processes to carry out user experience activities defined as customer-oriented (whether user experience research and design processes are used within or outside the lean product development stages or as a separate research process in an independent time interval) were determined; customer-oriented product range reduction or increase, customer-oriented product options reduction or increase, entering environmental sectors with customer-oriented products, customer-oriented online and offline service design and technology development, increasing new local or global market share, entering new local or global markets or creating new markets, meeting customer demands and needs, reducing or increasing production flexibility with the product, reducing or increasing production flexibility with the product, reducing customer-oriented product or production cost and increasing profit-income, reducing energy consumption or environmental damage, main or sub-branding, increasing brand dependency or brand awareness as the most important factors. In addition, in the research, while the number of employees, the age of the organization, the techniques used in new projects constitute the fixed variables in automotive main and sub-industry companies; while the use of lean product development and user experience activities, preference for in-process or end-of-process work, type of integration into the existing process, internal or external supply of user experience studies, process setup and management support, formation of new project targets and protection of in-process innovation targets, supply of qualified employees for user experience activities, customer demanded new technology investment, the effect of financial resources and capital structure of the firms on the process, the effect of government support in new product development and design projects, new design and innovation promotion barriers and similar factors are accepted as moving variables in the study. Resistance or support in user experience research and design processes, high risk of habituation of user experience study outputs in practice, high cost of customer-oriented demand and need costs or additional product functions, financial resource investment status of the organization in the establishment of user experience studies or sufficient capital, number of qualified employees for user experience research or experience acquisition period, integration of lean product development and industrial design processes according to user experience research outputs, preference of user experience working methods, customer involvement in new product design process or end-of-process testing, top management support or profitability impact on lean product development or user experience studies, impact of government

supported R&D and I&D incentives; are outcome-oriented variables that need to be measured and planned in the study.

MATERIALS AND DATA

The field study of the research was carried out by including lean product development (R&D) and industrial design (I&D) employees and company managers in the automotive main and sub-industry of the country. Therefore, along with the automotive main industry companies, supplier sub-industry companies that produce new parts and technology under common processes for brands in global product manufacturing are also included in the study. Regardless of the size and structure of the supplier companies in question and their cooperation structure, automotive supply industry companies were identified and visited by random sampling, and firstly, the questionnaire method and then face-to-face interview techniques were applied in the study area. Therefore, a two-stage field study was planned with 60 employees from 6 automotive main industry companies and 180 employees from 18 sub-industry companies, totalling 240 white-collar employees. In the first phase of fieldwork, the questionnaire method was used for quantitative measurements and assessments, while in the second part of the sequential fieldwork, one-on-one interview notes were used for in-depth synthesis of quantitative data. In other words, mixed research method was preferred in the study.

In the first field studies, before the questionnaire application, the participating automotive main and sub-industry employees were briefed on lean product development or design processes, as well as customer-oriented user experience research and design processes. Therefore, additional short repeated explanations were given for questions that were not understood during the questionnaire administration, and firms were revisited for employees who were not present in the firm. In addition, a total of 20 employees could not be included in the study due to 15 of them being pregnant, 3 of them taking annual leave and 2 of them working abroad. As a result, while 240 participants were planned for the field research of the study, a total of 220 employees participated. Quantitative and qualitative field data were collected in January, February and March 2022 in 24 automotive main and sub-industry companies with 220 questionnaires and face-to-face interviews with audio recordings. Additionally, a 5-point/ Likert-type scale was used in the survey conducted in the field study. On the other hand, in the one-on-one interviews after the successive questionnaire surveys, the lean and user experience research processes, the knowledge and impact level scales or co-different methods and innovation enhancing techniques related to the inclusion of user experience research in the lean product development flow or the implementation of user experience research in the start-finish timing, the demographic characteristics of the company and their training and tendencies related to the lean product development flow were archived

DOI: 10.15320/ICONARP.2025.338

under audio recording through one-on-one interviews. The reasons for lean or user experience management, strategy or new product design and customer-management resistance of automotive main and sub-industry companies are revealed by synthesizing the quantitative data obtained under the survey results and in the light of qualitative one-to-one interviews. In order to reach the findings of the research, SPSS 20.0 statistical data analysis program was used after the questionnaire application and the results were evaluated under the mathematical model. Therefore, in the aforementioned statistical studies, parametric tests, linear regression and t-test formations, frequency analyses were carried out within the study. However, in statistical calculations and test model results, it was observed that the distribution was not normal and it was revealed that the resulting value varied. The CA (Cronbach's Alpha) reliability coefficient in the statistical evaluation correlation of the questionnaire application, which constitutes the first field study, was calculated as 0.85, and the high result or evaluation of this value was included under the results that should be checked within the research findings. The dependent variable, which constitutes the main hypothesis of the research, is determined as the positive effect of user experience studies in lean product development processes on the final new design product, while the independent variable is fixed as the age of the automotive industry companies implementing lean product development processes and the number of employees in lean product development and industrial design processes. Therefore, the ratio of the variables determined in the study to the independent variables was modelled under the test and analysis structure within the hypothesis boundaries of the research. The reasons for including user experience research, which constitutes the first field study of the research, in the basic processes, survey application results and participant distributions are given below (Table 1).

Table 1. The reasons for automotive main and supplier industry companies to engage in user experience activities sub-lean product development processes.

	Discrete Variables: significant or insignificant	Strongly Disagree	Disagree	No Idea	Agree	Strongly Agree
1	Design of new technology for a new product or service	2	13	16	**33**	44
2	Common part design for the same or different product family	2	13	16	**33**	44
3	Design for Competition and Market Share	0	0	6	**35**	**67**
4	Lean Product Development- Design for Efficiency	0	4	4	**33**	**67**
5	UXr User Experience Studies	0	3	10	20	**75**
6	UXd Design for Customer Loyalty	8	17	25	27	31
7	Designing Critical Common Parts for the Supply Chain	4	13	19	24	48
8	Energy- Design for environmental protection	9	14	25	22	38
9	Design for Global-Local Market Expansion	18	15	8	10	57
10	Critical co-design for Master and Sub Brands	1	4	11	28	**64**
	Total	44	96	140	265	**535**

When the reasons for automotive main and sub-industry companies to perform user experience studies under lean product development processes are analysed, it is observed that each variable in the questionnaire is answered as “agree or strongly agree” for each participant. Therefore, when the questions in the questionnaire are evaluated according to the response rates, design for competition and market share (67+ 35) ranks first, while UXd- oriented studies for

customer loyalty, meeting their demands and needs (75+ 20 people), and the answer to the question of design for lean product development and efficiency is also marked as “strongly agree” for the majority of participants (67+ 33 people). The management's support for user experience research, which constitutes the independent variables of the study, and the participant distribution of the fixed variables were realized as can be seen in Table 2.

Table 2. Impact of user experience activities sub-lean product development and industrial design processes.

	Discrete Variables: significant or insignificant	Strongly Disagree	Disagree	No Idea	Agree	Strongly Agree
1	Lean product development and user experience studies are carried out in every project	26	26	44	52	**72**
2	User experience studies are outsourced as a service	**41**	**63**	70	34	12
3	User experience studies are part of the lean product development process	12	36	76	**62**	**34**
4	User experience studies are done before the lean product development process	8	8	58	**98**	**48**
5	The customer is involved in the user experience work process from start to finish	6	34	58	**68**	**54**
6	At the end of the user experience work process, the customer is included for testing	32	52	90	30	16
7	User experience studies are supported by company management	**82**	**58**	42	22	16
8	We have qualified employees from different disciplines for user experience studies	**42**	**60**	74	20	24
	Total	208	274	442	**352**	264

When the barriers or variables that positively affect the integration of user experience studies into lean product development processes are examined in Table 2; it is revealed that the participants (98+48) supported the highest “agree and strongly agree” to the question that user experience studies are done before the lean product development process. In addition, among the influence factors, the rate of customer involvement in the user experience work process from beginning to end (68+54) and user experience work is included in the lean product development process (62+34) constituted another high preferred influence rate (Table 2). The fact that the investment risk posed by the fixed variables in Table 2 is very high and that customers are included in the flow at the end of the process in terms of user experience research has created a moderate impact rate. Another important finding of the assessment is that senior management's support for user experience research is negative or predominantly in the form of “strongly disagree”.

DATA ANALYSIS

The fieldwork questions and the stratification of the moving variables supporting the main hypothesis of the research are correlated under the software results of the test application under the parametric (Chi-Square) model (Table 3). In other words, the analyses of the nonparametric test results are presented in Table 3 below (H1: There is a significant direct proportional relationship between the age of the automotive main and sub-industry company and the frequency of periodic user experience research).

DOI: 10.15320/ICONARP.2025.338

Table 3. The main link between the age of automotive main and supplier industry companies and the interval of conducting user experience research (Demographic Structure).

	Company Activity	User Experience Yes	User Experience No	Total	X2	sd	p
Operation Time of Automotive Company (years)	1- 5	30	10	40	6,251	4	0,181
	5- 10	28	34	62			
	10- 15	12	6	18			
	15- 20	24	12	32			
	20 +	42	18	60			
	Total	136	80	212			

AIC Age of Activity (Year)	User Experience Research Interval (Number of Projects/Year) 0	5	10	15	20	25
1- 5						
5- 10	Minumum					
10- 15						
15- 20						
20+	Maximum					

According to the results of the first field research survey, as seen in Table 3 above, a significant relationship is calculated under the statistical software model between the working age of the automotive main and sub-industry company and the frequency of project-based periodic realization of user experience studies under the statistical software model, as the p-value is greater than 0.05. While the rate of conducting user experience studies together with the lean product development process is calculated as 22% when the automotive companies participating in the field research have been operating for at least five years, the user experience research period increases to 35% with the lean product development process in organizations with increasing operating age or at least twenty years; again, the calculation result from the same statistical mathematical model. Looking at the general calculation results of the statistical software model, it is another important study finding that 63% of the companies included in the research carried out user experience studies and design together with lean product development. On the other hand, in the secondary research question supporting the research hypothesis; H2: There is a significant relationship between the number of employees in automotive main and sub-industry companies and the rate-period of realizing lean product development process and user experience studies. Since a graded structure was established between the fixed variables of the research, nonparametric tests or Chi-Square test structure was applied. The calculations and findings regarding this test structure are presented in Table 4 below.

Table 4. The relationship between the number of employees in the automotive main and sub-industry companies and the frequency of conducting user experience research.

	Industrial Designer	User Experience Activity		Total	X2	sd	p
		Yes	No				
Employees of Automotive Companies (Main and Supply)	1- 25	18	26	44	24,380	4	0,005
	25- 50	42	**44**	86			
	50- 75	**22**	10	32			
	75- 100	**16**	0	16			
	100 +	**38**	0	38			
	Total	**136**	80	216			

Company Employees (R&D Person)	Ratio of Number of Employees to Frequency of User Experience Studies					
	0	1	2	3	4	5
10- 100						
100- 500	Minumum					
500- 1.000						
1.000- 1.500						
1.500- Over	Maximum					

Although the frequency of user experience study and design increases in direct proportion to the employee population in each of the automotive main and sub-industry companies participating in the research, it is among the main findings of the study that it provides a positive significant relationship and effect calculated under the statistical software model (Table 4). On the other hand, it was determined that the high number of employees in each of the automotive main industry companies included in the research positively affected the frequency of performing user experience studies and risk mitigation from the independent variables. While the rate of user experience studies and design of organizations with two hundred and fifty or more employees in the automotive supply industry companies in the field study was calculated with a rate of 27%, the rate of performing user experience activities in the automotive supply industry companies with a lower number of employees between 10 and 250 people was calculated under the statistical model to be 30% and below (Table 4). Nevertheless, as the number of employees of the automotive main and sub-industry companies, which mainly participated in the research under the statistical model, increased, user experience activities and studies increased, and therefore customer-oriented design and approaches may also increase.

FINDINGS AND DISCUSSION

Kindly Findings Product-dependent service design or customer-oriented approaches that spread with the new product, the design goals of online-offline service technologies pass through the fiction of user experience studies. Lean product development flow and process optimization, which provide process efficiency together with customer-oriented approaches in the development of today's automotive industry products, ensure the protection and continuity of project design goals under time and cost gains. With this efficiency, customer demands and needs remain secondary, creating significant risk factors in the commercial success of the new product. On the other hand, the most

DOI: 10.15320/ICONARP.2025.338

important recommendation of the study is that the basic process will benefit positively by including user experience activities, which are the most important application of customer-oriented design approaches, into the highly efficient lean product development flow. The step-by-step addition of customer-user-oriented design goals to the lean product development process flow, determining, updating and controlling the impact, and getting support from user experience research for similar functions are explained at every stage of the study. User experience activities and new product design processes, which came to life in the communication technologies sector and continue their journey in today's pioneering automotive sector, are an important development for customer-oriented approaches included in scientific, theoretical and practical study outputs.

The distribution of the number of employees in the automotive main and sub-industry companies participating in the research is given in Table 5 below. Therefore, when the ratios in Table 5 are analysed, it is seen that 39.8% of the employees of the automotive supply industry companies have between 100 and 500 employees. On the other hand, only 17.6% of the automotive companies in the field study have 1500 employees or more (Table 5). The automotive main industry companies constitute the majority of this ratio.

Table 5. Number of employees in automotive main and sub-industry companies (persons-experience).

Number of Employees in Automotive Company (Person)	N	%
10- 100	220	20,4
100- 500	*430	39,8
500- 1000	160	14,8
1.000– 1.500	80	7,4
1.500- Over	190	17,6
total	1.080	100
*mod	24	

Number of Company R&D Employees	Ratio of Number of Automotive Company Employees to User Experience Studies					
	0	1	2	3	4	5
10- 100						
100- 500						
500- 1000						
1.000– 1.500						
1.500- Over						

During the interviews with newly established organizations, which constitute the lowest values between the age and number of employees of the automotive industry companies in Table 5, the importance of customer-oriented approaches and the information that their participation in the company will be established as soon as possible are indicators of the high benefit of the issue by the sector. In Table 6 below, the distribution between the installation age of the automotive main and sub-industry companies participating in the research and the frequency of user experience is calculated. When the automotive industry companies are analysed according to the duration of their activities in Table 6, it is observed that the companies with the oldest installations have a high frequency of user experience; however, it is a field observation that companies with new installations have also implemented user experience studies through outsourcing.

Table 6. Age of automotive main and sub-industry companies (years-experience).

Age of Automotive Companies (years)	N	%
1-5	200	18,5
5-10	310	**28,7**
10-15	90	8,3
15-20	180	16,7
20- Over	300	**27,8**
total	1080	100
*mod		

Age of Automotive Companies (years)	User Experience Study Frequency of Automotive Industry Companies				
	0	10	20	30	40
1- 5					
5- 10					
10- 15					
15– 20					
20- Over					

While the automotive main and sub-industry companies participating in the research are predominantly composed of enterprises with 5-10 years of establishment with a rate of 28.7%, it is revealed that the year of operation of the most intensive enterprises that we encounter most frequently in the secondary value is organizations with an establishment age of more than 20 years with a rate of 27.8% (Table 6). Therefore, the proportion of the oldest automotive main and sub-industry companies with an establishment age of 5-10 years is above half of the total number of organizations participating in the research. In addition, the statistical development of the last ten years of "patent, utility model and design registration" applications and registrations obtained from the information registered in the database of the Turkish Patent and Trademark Office was examined (Table 7).

Table 7. Development of patents, utility models and design registrations of local automotive main and sub-industry companies (Saraç, 2024; Palacı, 2024).

Development of Design Registration Year in Automotie Companies									
Year		2015	2016	2017	2018	2019	2020	2021	2022	2023
Number of applications	F.K:12-18	10	0	20	20	20	40	40	70	90
Development of Patent Application Year in Automotive Companies										
Year		2015	2016	2017	2018	2019	2020	2021	2022	2023
Number of applications	F.K:12-18	0	0	0	0	0	0	10	10	50
Development of Utility Model Registration Year in Automotive Companies										
Year		2015	2016	2017	2018	2019	2020	2021	2022	2023
Number of applications	F.K:12-18	20	20	40	10	40	50	20	60	50

In Table 7, according to the patent, utility model, industrial design registration and application tables made to the Turkish Patent and Trademark Office every year, which are officially directed by the Ministry of Science, Industry and Technology, the number of design registration applications across Turkey (2016) shows an increase every year, while utility model applications fluctuate with ups and downs (Saraç, 2024; Palacı, 2024). Therefore, it is seen in Table 7 that the registration applications in terms of intellectual, industrial and property rights in the automotive industry are not sufficient and at the desired level. However, although the international product class of automotive industry products is defined as 12 and 18, the international product

DOI: 10.15320/ICONARP.2025.338

codes of iron and steel industry products or different sector classes are not included in the research.

Since our country is also an important production and assembly center in the European and global automotive sector, this research suggests that the way to increase the national economic return is to improve global and local sales-marketing strategies or conditions and to transform into larger organizations that manufacture and assemble in different countries through user experience research and similar customer-oriented studies. However, another study suggestion is that national R&D and investment incentives are not sufficiently utilized, and that more emphasis should be placed on customer-oriented approaches or user experience studies for the design of high value-added products brought about by high global competition in automotive industry products.

In the second field research, which progressed linearly with the results of the first field research, it was found that almost all of the automotive industry companies are motivated to carry out customer-oriented approaches or user experience study and design activities. The fact that the issue is known by the companies included in the study or that it is important for the continuity of the company has facilitated the study. Therefore, the companies that participated in the research strengthened the observation part and the final findings of the study by sharing information, documents and ongoing projects and samples due to the content, benefits and importance of the subject. In addition, as seen in Table 7 above, it is observed that patent and design registrations have increased positively over the years and are in an upward trend.

RESULTS AND CONCLUSION

Under the statistical mathematical model, a constant proportion, a significant relationship was found between the number of employees in the automotive industry companies in the first research question supporting the main hypothesis of the research and the rate of realization of customer-oriented approaches or user experience activities. Therefore, a positive and positive effect was calculated between the number of employees in automotive industry companies and the frequency of customer-oriented approaches or user experience activities. According to the general characteristics of automotive industry firms such as the ratio of white and blue-collar employees or years of employment, employee profile, product sales ratios, market share, ownership structure of the organization, etc., which constitute the initial information and preferences of the study; the results of previous researches have given variable results under the established mathematical model. In the research conducted in the national automotive industry, it has been observed that organizations with an establishment age of more than 10 years and companies with an establishment age of more than 20 years have more customer-oriented design approaches, where the interval between user experience design

and activities is more frequent. The different perspective brought by the same approach results in an increase in the number of employees involved in lean product development and design processes, thus increasing customer-oriented evaluations in stage transitions and increasing functional specialization and cooperation structure between departments. This is considered to have a positive impact on the diffusion success of customer-oriented design approaches. Nevertheless, the success in the implementation of customer-oriented design or user experience activities in old companies that new entrants to the automotive industry can take as a model, and the positive or negative aspects of the process flow in their preferred method, may bring the company's mobility to be more flexible and faster in the future, and thus competitive and market success.

Suggestions at the micro and macro level for this study to be carried out by different researchers or renewed research topic brought about by this approach: the relationship of existing process stages with innovation, the impact of user experience activities provided internally and externally, the efficiency comparison of customer-oriented design approaches, creating a comparison model between two different regions, more comprehensive research by expanding similar variables and more different results may reveal. Therefore, the user experience research and design activities or customer-oriented design approach levels of automotive industry companies' independent of lean product development and design processes can be examined more comprehensively. Ultimately, this research will serve as a guide for companies that are keen on a customer-centred design approach and want to set up user experience activities, and will provide guidance on the customer's preferred goal and reason for innovation or the barriers they will face. Based on the research results obtained with the employees of automotive industry companies, organizations can easily make rational decisions about new investments in new design. The findings obtained from the survey, which is the first field study of the research, suggest and present a decision-making model for companies planning customer-oriented new design and customer-oriented redesign of existing products. Customer-oriented design capability, especially in leaner automotive industry companies, the benefit of user experience study and design activities is recommended in organizations in order to achieve high profit margins in local or global markets or to create new markets. Along with new product design, service design is of great importance in increasing online-offline technologies, increasing service efficiency and commercial success and profitability of companies with products, user experience activities and formation fiction, process integration. It has become an inevitable necessity for the global competitiveness and profitability in the automotive industry to be built in sustainable values and variables, together with the user experience-oriented new product that forms customer preferences, together with

DOI: 10.15320/ICONARP.2025.338

the user experience-oriented design of online-offline service design, under lean processes, in today's industrial organizations.

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Resume

Fuat Ali Paker is a assistant professor in the Industrial Design, Department of the Konya Technical University, Konya, Turkey. He graduated from the Industrial Design Department of the Mimar Sinan University in 1995. He completed his master’s studies in the Industrial Design Department of the Mimar Sinan University in 2007. He got his Ph.D. degree from the Industrial Design Department of the Istanbul Technical University in 2019. He has attended several national and international congresses; summer schools and workshops related to industrial design process of the autonomous vehicle and automotive design. He has written 2 books and more than 20 papers on UXr, automotive design process and lean-new product development system. He worked as a design researcher or project manager in many national and institutional or company projects. He has awards about vehicle design, new product development and design management.

DOI: 10.15320/ICONARP.2025.338