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Identifying Critical Dimensions for Project Success in R&D Environment Using Delphi Study and Validation Techniques

HUMA HANIF[1], AAMER HANIF[2], (Member, IEEE), ALI AHSAN[3], ALI SAFAA SADIQ[4], (Senior Member, IEEE), SEYEDALI MIRJALILI[5,6], (Senior Member, IEEE), AND BASEM ALKAZEMI[7], (Senior Member, IEEE)

[1]Engineering Management Department, Center for Advanced Studies in Engineering, Islamabad 44000, Pakistan
[2]School of Management, Air University, Islamabad 44000, Pakistan
[3]Business Department, Torrens University Australia, Adelaide, SA 5000, Australia
[4]School of Mathematics and Computer Science, University of Wolverhampton, Wolverhampton WV1 1LY, U.K.
[5]Center for Artificial Intelligence Research and Optimization, Torrens University Australia, Fortitude Valley, Brisbane, QLD 4006, Australia
[6]Yonsei Frontier Laboratory, Yonsei University, Seoul 03722, South Korea
[7]Department of Computer Science, College of Computer and Information Systems, Umm Al-Qura University, Mecca 715, Saudi Arabia

Corresponding author: Huma Hanif (humahanif@gmail.com)

ABSTRACT In the current century, organizations face ever increasing dynamic ecosystems and are constantly devising strategies to meet their challenges. These include the implementation of the right organizational structure and avoid project schedule delays to achieve projects' success. Unfortunately, the classification of significant project success dimensions in the R&D environment is still an elusive concept. This study adopts a multi-dimensional qualitative and quantitative approach to explore the critical dimensions of organizational structure and schedule management that enhance or hinder the project success in R&D organizations. In Phase 1, a Delphi Study is conducted, results of reliability and other tests are the input of Phase 2. On the basis of these tests, variables have been selected for the next phase or final questionnaire. In Phase 2, through a survey of 285 responses in a R&D environment, the proposed framework is validated by conducting face, content and construct validity. The results indicated that formalization, specialization, differentiation, coordination mechanism, decentralization and authority of managers have a significant effect on the schedule management and successful execution of R&D projects; whereas, centralization and departmentalization do not correlate strongly. The results also imply that decentralized organizational structures (organic) are more preferable than centralized structures (mechanistic) for the execution of R&D projects when proposed timelines are to be met timely. The proposed framework will act as a supporting mechanism for engineering managers to deal with organizational structure and schedule management factors in a highly uncertain R&D environment where projects deviate frequently from their anticipated timeline.

INDEX TERMS Organizational Structure, Project Success, Project Management, R&D Environment, R&D Projects, Schedule Management, The Delphi Study.

I. INTRODUCTION

Every project in an organization is typically unique in terms of type, importance, complexity and contract type [1]. This will introduce some difficulties in comprehension that whether projects can meet a comprehensive set of success criteria or not? [2]. The relative importance and insights of project success differ by various phenomena, including but not limited to, concerning the nature of projects (e.g., R&D, non-R&D/ commercial, etc) and the population dispersed at different geographical locations [3]. Furthermore, the divergent viewpoints prevail across industries, individuals, and stakeholders on the account of success of projects [4]–[6]. Bringing new products into the market gives strength and vitality to the sustainable development of the organizations. The research and development (R&D)

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projects are special and handled differently than non-R&D projects. However, it is difficult to foretell that why some R&D projects are successful, and some are not. To gain competitive advantage and organizational renewal in a competitive marketplace; organizations should invest crucially in R&D activities [7]–[10]i. While explaining the challenges in globalization; R&D projects' success is the most valuable contributing factor in industrial-technology demanding organizations [11].

The existence of a high level of uncertainty in R&D projects directs to major R&D risks; hence, major R&D project failures occur [12]. R&D projects tend to have high uncertainty in the quality of output and schedule [13]. R&D projects also tend to deviate critically from planned schedules (time-to-market), unit and project costs, and products' performance parameters. As a result, unfortunately, they do not meet customers' expectations and demands [14]. In R&D projects, the delays are frequent and schedule pressure reduces productivity [15]–[18]. Similarly, productive management of engineering R&D projects is crucial in an organization and more specifically in an organizational structure. The findings of previous literature studies show that projects undertaken in different organizational structures come across a variety of problems related to the schedule delays.

The aforementioned problems are highlighted due to an inappropriate selection of organizational structures and schedule management factors that may lead to unwanted outcomes. One of the leading undesirable outcomes is a ''schedule slippage'' (especially on the critical activities) and harms the success and performance of R&D projects. The selection of right dimensions of organizational structure for the right project to achieve well-timed execution is an important factor for the successful management of R&D projects. This study aims to identify significant dimensions of organizational structures and schedule management that will help engineering managers in the prudent execution and successful completion of R&D projects.

The existing literature lacks a comprehensive framework that contains critical dimensions of organizational structure and schedule management for the successful implementation of projects in the R&D sphere. Without delving into the critical dimensions of organizational structure and schedule management, it would be difficult to gauge their impact on the schedule of R&D projects. If the R&D industry continues to execute projects without considering the significant dimensions of organizational structure and schedule management, massive failures can occur due to schedule slippages. In this study, therefore, we carefully explore the organizational structure and schedule management aspects in the R&D environment that have not been previously identified. Hence, the following research questions are designed for this study:

RQ #1: What should be the relevant sub-constructs and dimensions of organizational structure and schedule management for the R&D project success R&D environment?

RQ #2: How the sub-constructs and dimensions of both main constructs should be grouped to construct the proposed framework?

RQ #3: To what extent the proposed framework is validated?

The research question 1 and 2 are addressed in Phase 1; ''Refinement and Development of Proposed Framework'' and research question 3 in Phase 2; ''Validation of the Proposed Framework''. The rest of the paper is organized as follows:

The Section II provides an in-depth literature review of the related works. The research methodology of this work is presented in Section III. The results and conclusions are covered in Sections IV and V respectively.

II. LITERATURE REVIEW

It is undeniable that organizational structure affects schedule management of R&D projects in a practice-driven environment, massively. Therefore, a systematic investigation in this field generates a demand to address the impact of multiple contexts like; decision making, schedule management planning, communication, coordination, and rules and regulations being followed in an organizational structure. To a big extent, success relies on the type of project [19]. For example, major differences in success factors between construction and R&D projects were found in [20]. Shenhar *et al.* recommended a framework that links project success with a competitive advantage in [21]. The dimensions in this framework are; efficiency in terms of meeting schedule and budget requirements, business success, impact on customers, and creating new technological and market opportunities. However, the above-mentioned dimensions are dependent on time and the technological uncertainties embedded in R&D projects. The Researchers found that several variables (top-management support, unambiguous goals, and inter-functional team) have a big influence on the schedule adherence and efficiency of projects [22], [23].

The effect of organizational structure and project leaders on NPD (New Product Development)/ R&D projects' speed is also highlighted by Clark and Fujimoto in [24]. On the other hand, several other researchers recommended including factor 'teamwork' as an important component of project success [1], [2], [6], [25]–[29]. In NPD/ R&D projects, teamwork also creates a significant influence on the reduction of cycle time [28]. Nearly seventy-eight success and failure factors of R&D and NPD projects have been identified [8]. The researcher categorized the identified factors into four categories: organization, environment, market, and technology. In another attempt, the authors in [29] have also explored nine key factors that immensely created an impact on the ability of organizations that produce new products, promote innovation (R&D). These factors are defined as organizational structure, resources, management style, leadership, knowledge management, and innovation process. Lately, in [30], Trott conducted extensive research and identified several factors of R&D and product development.

It is also important to note that traditional project management (PM) methods that emphasize the success criteria of projects to meet technical requirements based on (time, cost, and quality, only) have become outdated and ineffective [31], [32]. In the late 1990s, researchers shifted the paradigm of project management towards a people-focused perspective from 'the iron triangle'. Therefore, project success is measured in this context, by the behavioral, interpersonal skills of project teams working together, stakeholder, and customer satisfaction [33], [34].

In the last 20 years, a great emphasis on the technological innovation for a firm's competitiveness can be witnessed and linked to the relationship with strategy, structure, and performance [35]. An organizational structure can be depicted as 'the total number of techniques through which an organization divides its people into various activities or tasks and achieve collaboration among them to achieve organizational goals and objectives' [36]. Multiple projects execute concurrently in various organizational structures, but the management of multiple projects is not trouble-free because of their complex nature.

Generally speaking, researchers have recently become more interested in knowing the factors, which have a great influence on the effectiveness of project management and also on the organizational structures [37]. However, several other researchers also indicated causes of failure of projects (including R&D projects) that contain; scarcity or lack of resources, ineffective communication, lack of definition of objectives, the unclear role of authorities, deficient project schedule, inadequate control, uncontrolled change, and not having top management support [38]–[40].

Nevertheless, the selection of significant dimensions of organizational structure for successful management and execution of projects, especially for R&D projects, is a key area to consider. In [41] Barragán-Ocaña and Zubieta-García carried out research and found out that to promote the successful execution of R&D projects in public research centers; the organization structures should be categorized as a fundamental area. In [42], Lysonski *et al.* concluded that differentiation, the extent of decision making, and formalization perform a vital role while exploring the phenomenon of organizational structure, and environmental uncertainty from the perspective of product management. However, after a few years, the impact of structural dimensions like centralization, formalization, and complexity on just-in-time attainment was explored in [43]. In [44], Rahimi and Vazifeh argued that structure of an organization is an essential mission having determined and fundamental management, strong communication, and prudent decision mechanisms. Various dimensions or variables of organizational structures discussed by several researchers are formalization, specialization, vertical complexity, managerial attitude, vertical differentiation, limited/ slack resources, control, coordination mechanism, division of work (distribution of tasks and activities), internal and external communication and centralization [45]–[50]. Most of the researchers have reached a consensus that in organizational design research, the above-mentioned are the most frequently used dimensions [51]–[53].

The notion of project scheduling comes widely under the realm of project time management in different organizational structures. Inadequate project schedules cause massive delays due to which organizations fail to deliver products or services according to planned timelines. [54] concluded through conducting a qualitative analysis of several R&D projects that most of the difficulties of resource allocation arise due to the failure in project scheduling. Many studies have considered planning and scheduling as the most important processes of an R&D project and new product introduction [55]–[59]. However, the resource allocation disorder (which causes delay in project schedules) has always been a key dispute in organizational structures. One of the most important factors, schedule management planning [60] has been described as a process of founding policies and procedures, to plan, develop, maintain, and control project schedules. With regards to resource allocation while managing schedules, in [61] investigated the critical factors that affect project efficiency in the defense environment and results and analysis showed that managing multiple projects is difficult than managing a single project because of the shared scope and resources. Therefore, prioritization of projects in such an environment is crucial in achieving project efficiency in a multi-project environment. Moreover, it is also vital to align the scope and objectives of individual projects with the strategic goals, vision, and mission of the corresponding organization [63], [64]. [65] provided a solution to the resource schedule problem for multi-projects in research and development (R&D) processes for automobiles. The researchers suggested a multi-project schedule method based on a critical chain, evidence reasoning, and task priority. Nevertheless, uncertainty is 'inherent' in project schedules. [66] discussed different aspects of uncertainty associated with a project schedule. These uncertainties may be innate in weather, labor and equipment productivity, conditions at workplace and sites, etc. Alternatively, the researchers have found that project managers of R&D projects encounter uncertainty about schedules and product performance [67]. Several methods and techniques also incorporate uncertainty in schedules like; CCM & CCPM [60]–[63], and Monte Carlo Simulation & PERT [60] and also aid in assessing the impact of risks to make better decisions under uncertainty.

As mentioned earlier, R&D projects have characteristics of uncertainty, complexity, and interdependencies. Gauging the success of complex projects like R&D; is an intricate task. By only applying the traditional project management approach, success or failure cannot be predicted in advance or even during the implementation of projects. In [68], for instance, Gary *et al.* mentioned that as project management has shifted further towards a common body of knowledge, therefore, variation in different organizational structures must be known.

It is quite evident from the literature review, that factors for the success/ failure of R&D projects vary considerably

and contradictory as in [69]. Therefore, after conducting extensive research on the proposed topic, a gap has been identified related to the effect of different organizational structures' dimensions on the schedule (time) of R&D projects. To the best of our knowledge, no comprehensive framework regarding the optimal selection of dimensions of organization structures and time management has been formulated before. With the intervention of self-interests' of executing authorities only, the priority of critical activities and overall projects' priority suffers. This leads R&D projects to seriously deviate from planned schedules and delays occur. The erroneous selection of organizational design variables for the execution of extremely sensitive R&D projects may lead to enormous schedule slippages and lofty cost overruns. The purpose of the said research is to minimize this gap and propose in advance a methodical approach for decision-makers and project/ engineering managers to opt for the first-rated organizational design for the R&D projects' execution in complex and interdependent R&D environment. The sub-constructs and dimensions of organizational structure and schedule management are identified through a literature review and a preliminary theoretical framework is developed as shown in the Fig. 1 below:

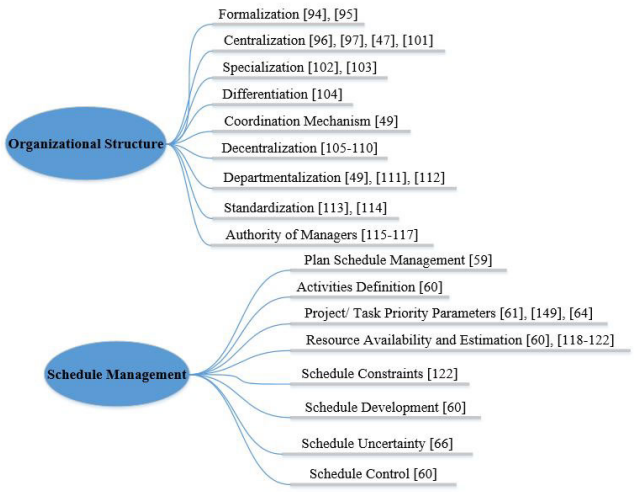


FIGURE 1. The preliminary theoretical framework.

III. RESEARCH METHODOLOGY

In this study, predominantly, a comprehensive literature review is conducted to categorize (organizational structure and schedule management) sub-constructs and its relevant dimensions. To inculcate the best possible facets of organizational structure and schedule management in this research, it was essential to proceed with experts' opinions and judgments through the Delphi study. A Delphi method is also used to develop a conceptual taxonomy related to the organizational design mechanisms and actions [98]. In this research, the Delphi method based on three rounds is used to establish a framework for the sub-constructs and dimensions of organizational structure and schedule management for the success of projects in an R&D environment. The Delphi method is used to build the proposed framework based on both, qualitative and quantitative data. Afterwards, the quantitative data is collected to construct a questionnaire, perform reliability analysis, and validate the sub-constructs and relevant dimensions of the proposed framework. The detailed methodologies are presented in two phases; ''Phase 1: Methodology of Delphi Study (Refinement and Development of Proposed Framework)'' and ''Phase 2: Methodology of Quantitative Research (Validation of the Proposed Framework''.

A. RESEARCH PROCESS

The research process in this study is comprised of two phases. In the first phase, the preliminary theoretical framework is refined and developed with the help of the Delphi study and in the second phase, the sub-constructs and dimensions of the framework are validated and final framework is proposed. The research process is shown in Fig. 2.

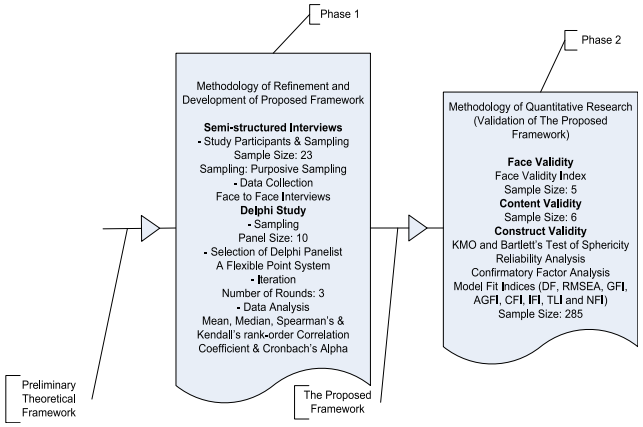


FIGURE 2. The research process.

1) PHASE 1: METHODOLOGY OF DELPHI STUDY (REFINEMENT AND DEVELOPMENT OF THE PROPOSED FRAMEWORK)

The sub-constructs and dimensions of organizational structure and schedule management identified through literature review are formalized as an 'input' to the panel of experts. Determining which sub-constructs and dimensions to be included in this research, has called upon the experience and knowledge of academicians and experts from R&D sector, in the form of Delphi method.

a: STUDY PARTICIPANTS AND SAMPLING

For this research, ten participants were considered adequate for the Delphi study as the saturation of data had attained. In addition, the participants hold vital roles in organizations e.g., Program/ Project Managers (30%), System Engineers (17%), Design Engineers (26%), and Configuration/ Quality Management Officers (27%). All participants from R&D organizations in this research have fifteen or more years of professional experience and are actively involved in

the dynamics of decision making, managing and controlling schedules, project management, and organizational structure-related issues of R&D projects.

The detailed methodology of Delphi method is discussed as follows:

b: OVERVIEW OF THE DELPHI METHOD

The Delphi method, formerly developed by RAND (Research and Development) Corporation exclusively for American Military in 1944, is a structured communication and a consensus-building process [70]–[72]. In [71], Ameyaw *et al.* discussed the distribution of research topics w.r.t ranking in the identified Delphi papers. According to the authors, third-ranking was given to the organizational issues in 12 papers. Similarly, four schedule-related papers were identified by [75]–[78] in which the Delphi was used as an evaluation and forecasting tool.

Six distinct characteristics of Delphi method are as follows:

Selection of Delphi Panelists – as per [73] and [79], a set of qualifications was suggested for the expert panelists known as 'a flexible point system'. According to these studies, an expert from a related field of research must meet at least 4 requirements and score 12 points in an expert evaluation system to complete the requirements of the study.

Panel Size - The literature on Delphi studies revealed that the majority of researchers have voted for different panel sizes and the largest frequency (41 Delphi papers) voted to employ a panel size between 8 and 20 [71].

However, to conduct the Delphi study, 10 experts [99] from R&D organizations were chosen. Three (3) academicians have been identified as faculty members of accredited universities, chairpersons/ members of miscellaneous committees and have noteworthy international and conference publications. Seven (7) highly ranked professionals positioned at top-level executive/ managerial statuses have been selected for the Delphi study. The experts selected for this study meet all the requirements of an expert evaluation system as shown in Table 1. The first three panelists correspond to academicians and others as professionals. The first six panelists hold PhD Degrees, whereas, last four hold MS Degrees.

Iteration (Number of Rounds) – In a Delphi study, the number of rounds is a vital facet that can be targeted to attain a consensus among experts through anonymous and controlled feedback [73]. A summary of peer-reviewed Delphi studies proposed two to six rounds [72], [81]. However, the decision about the number of rounds in the Delphi method is pragmatic [100]. When the degree of concurrence among panel experts is reached, the Delphi study can be stopped and results can be concluded for that round.

In this research, the Delphi study consists of a total of three consecutive rounds. Round 1 of the Delphi started with the set of open-ended questions to allow experts' freedom in their feedback and responses. The subsequent rounds (round 2 & 3) are generally well-structured in the form of questionnaires comparing with the round 1 and also incorporating the feedback of each panel member. Round 3 is conducted to re-evaluate the ratings provided in round 2.

TABLE 1. Aggregate qualification of experts for this study.

Panelist No	PR	PE	CP	MC	CC	PRJA	FMAU	A/EoB	AoBC	BS, MS & Ph.D.	Total Points (>=12)
Panelist 1	☒	☒	☒			☒	☒			☒	19.5
Panelist 2	☒	☒	☒			☒	☒			☒	19.5
Panelist 3	☒	☒	☒			☒	☒			☒	19.5
Panelist 4	☒	☒	☒	☒	☒	☒	☒		☒	☒	25.5
Panelist 5	☒	☒		☒	☒					☒	18
Panelist 6	☒	☒	☒	☒	☒	☒	☒			☒	23.5
Panelist 7	☒	☒		☒	☒					☒	14
Panelist 8	☒	☒			☒					☒	13
Panelist 9	☒	☒		☒	☒					☒	14
Panelist 10	☒	☒		☒	☒					☒	14
Cumulative Qualification of Panelists	100%	100%	50%	60%	70%	50%	50%	0%	10%	BS=100% MS=40% PhD=60%	-

Note: PR = Professional Registration, PE (3) = Year of Professional Experience (1), CP = Conference Presentation (0.5), MC = Member of a Committee (1), CC = Chair of a Committee (3), PRJA = Peer-Reviewed Journal Article (2), FMAU = Faculty Member at an Accredited University (3), A/EoB = Author/Editor of a Book (4), AoBC = Author of a Book Chapter (2), PhD (4), MS (2) and BS (4)

Anonymity – A Delphi study is run with the help of a facilitator or moderator, so anonymity is guaranteed. In this research, questionnaires were completed by the panel members and returned to the facilitator for the analysis of groups' responses. Providing anonymous responses in Delphi studies facilitates indirect communication among group members to attain a maximum level of agreement or consensus, which was ensured in this research [81].

Controlled Feedback Process and Statistical Group Response – After every round of the Delphi, feedback survey data was statistically analyzed, evaluated, and specified in an accumulated form. The statistical methods used in this Delphi study were mean and median (common statistical feedback methods (measures of central tendency)) [82], [73]. Spearman's rank correlation coefficient (r_s or the Greek letter ρ (rho)) test [71] and Kendall's rank-order correlation coefficient (tau-b) (inferential statistics) [83] are non-parametric methods used in this Delphi study for correlation analysis. Cronbach's alpha (α) (expected correlation of two tests) was also computed to ensure the internal consistency and reliability of instruments in round 2 and 3 [84].

2) PHASE 2: METHODOLOGY OF QUANTITATIVE RESEARCH (VALIDATION OF THE PROPOSED FRAMEWORK)

In this phase of research, quantitative research is carried out to validate the sub-constructs and dimensions of the proposed framework. The suggested framework is validated by face

validity [80], content validity [85] and construct validity [86], [80]. The detailed methodology is discussed as under:

a: FACE VALIDITY

Face validity refers to the appearance of the instrument to selected individuals to assess the operationalization of measures in the construct. It is also one of the types of 'translational validity' [80]. Face validity has been conducted for both constructs, separately. Face validity consists of two phases. In the first phase, five respondents (N = 5) are selected from R&D organizations for the face validity (pretest) of the survey instrument. Several actions are taken on indicators/ items individually. For example, retained (indicators which are deemed to be accurate and relevant), removed (which are not deemed to be related to the relevant subconstruct), updated (phrasing of indicators), merged (indicators which are explained already in the indicator of the same or different relevant sub-construct) and added (adding new indicator based on professional and academic knowledge). In Phase 2 of face validity, sub-constructs, and dimensions of organizational structure and schedule management are finalized. Nine criteria (Relevant, Correct, Feasible, Concrete, Concise, Fully Defined, Field-Tested, Clarity of Language, and Coherent) [87]–[89] are selected to compute the 'face validity index' of both constructs.

b: CONTENT VALIDITY

Content validity is defined as the extent to which an instrument measures the appropriateness of the sample of items for the construct being measured and addressed by the instrument [90]. Two types of content validity indexes; I-CVIs [91], [92], and S-CVI [93] have been computed for the validation of survey instruments according to [90]. Item level I-CVI (Item-level Content Validity Index) at 'individual item level' and Scale level S-CVI (Scale-level Content Validity Index) at 'scale level' for all sub-constructs and dimensions (items) of organizational structure and schedule management has been computed. In this research, six experts (N = 6) are chosen for content validation. A questionnaire was prepared based on two sections. Panel experts were asked to rate each item with its relevance with its respective sub-construct. 4-point scale; (Not Relevant (R1) = 0, Somewhat Relevant (R2) = 0, Quite Relevant (R3) = 1 and Highly Relevant (R4) = 1 is devised [92]. Data are analyzed by computing averages of ratings given by experts on a 4-point scale.

c: CONSTRUCT VALIDITY

The scale development's prime objective is to formulate an effective measure of the construct under investigation [86]. For data collection, a simple random sampling technique is used. This study estimates organizational structure and schedule management dimensions using reflective multi-item seven-point scales questionnaire, where (1 = Strongly Disagree), (2 = Disagree), (3 = Disagree Somewhat), (4 = Undecided/ Neutral), (5 = Agree Somewhat), (6 = Agree), and (7 = Strongly Agree), as shown in Appendix A.

Initially, 480 questionnaires were mailed to various R&D set-ups. There were 285 valid questionnaires received and the effective response rate was 59.37%. The respondents of questionnaire survey were Project Directors (21%), Senior Managers (Program and Project Managers) (18%), Design Engineers (22%), Quality Assurance and Control Officers (10%), Configuration Management Officers (9%), Junior Managers (6%) and others (14%). The required experience for junior managers was above 5 years and 10 years for senior managers in their respective R&D field. To evaluate the construct validity of components of the survey instrument, confirmatory factor analysis (CFA) is applied. The confirmatory factor analysis on the sample size of (N = 285) is performed in IBM Statistics AMOS 21, software package. The model fit indices: parsimonious (chi-square, degrees of freedom (DF), and relative chi-square), absolute fit indices (root mean square error of approximation (RMSEA), goodness-of-fit index (GFI) and adjusted goodness-of-fit index (AGFI) and incremental fit indices comparative fit index (CFI), incremental fit (IFI), tucker-lewis index (TLI) and normed fit index (NFI)) are computed and the hypothesized models are analyzed. The second-order modeling is also carried out to ensure that all the sub-constructs of the model denote a single construct.

IV. RESULTS AND ANALYSIS

In this study initially, nine sub-constructs of organizational structure and eight sub-constructs of schedule management have been extracted from the existing literature and deemed appropriate for the preliminary development of a theoretical framework. A preliminary theoretical framework is shown in Fig. 2.

A. PHASE 1: REFINEMENT AND DEVELOPMENT OF PROPOSED THEORETICAL FRAMEWORK - DELPHI STUDY (THREE ROUNDS RESULTS AND ANALYSIS)

Before each interview session, the results of the literature review were shown to the interviewees. An informed consent statement was signed from each Delphi expert by making them read 'ethics approval requirements.

1) DELPHI ROUND 1, RESULTS AND ANALYSIS

First-round aimed to encourage participants to brainstorm ideas and thoughts on the sub-constructs and dimensions of organizational structure and schedule management, both. In this study, first round of the Delphi covers the qualitative aspects of the research methodology. The Delphi question asked in the first round was:

Q: ''What are the different kinds of sub-constructs and dimensions of organizational structures (Part – I) and schedule management (Part – II) being practiced for the successful execution of R&D projects in your organization?''

The sub-constructs added by experts are; organizational controls, contextual and workforce context, administration,

the span of control, organizational complexity, and commitment. The last four sub-constructs and relevant dimensions are dropped due to the low frequency of responses attained (less than and equal to 30%). These included administration intensity, employee commitment, workforce composition, and organizational environment. Few dimensions of schedule management are also added by experts in the existing sub-constructs e.g., schedule development and schedule control. Make-span as a measure of performance (30%, respondents' frequency) and cost deviation as a measure of performance (20%) are dropped due to fewer respondents' frequency.

2) DELPHI ROUND 2, RESULTS AND ANALYSIS

Second-round aimed to re-evaluate the constructs and dimensions identified in the previous round 1. Based on the results of round 1, a new questionnaire was designed and respondents were requested to rate the relative importance of (organizational structure; 12 sub-constructs and 55 dimensions, and schedule management; 9 sub-constructs and 37 dimensions) on a 5-point Likert scale (1= Not Important, 2= Slightly Important, 3= Moderately Important, 4= Important, and 5= Very Important). The quantitative data are coded and entered into IBM Statistics SPSS 21 and MS Excel. Based on respondent's answers, statistics are calculated; overall mean (academicians and professionals), median, overall ranking, and separate mean and ranking for academicians and professionals are calculated for both constructs [123].

The overall means of both sub-constructs and their relevant dimensions are arranged into descending order and ranked accordingly. Every group has two subsets: mean and ranking. The ranking of both groups' mean is listed in pairwise columns accordingly. The last 11 dimensions of the main construct 'organizational structure' and two of the second main construct 'schedule management' are dropped with their relevant sub-constructs because of the less overall mean (<= 3.50).

The reliability of scales used for the sub-constructs and dimensions in part I and part II are 0.808 and 0.753 respectively as shown in Table 2; which shows that both constructs are highly reliable. Spearman's rank (r_s) and Kendall's rank-order (tau-b) correlation coefficients between academicians and professionals are significant at 0.01 level (2-tailed). Since the computed values of both correlation coefficients exceeded critical values, a consistency is found between academicians and professionals' responses in round 2.

3) DELPHI ROUND 3, RESULTS AND ANALYSIS

The results of round two are presented in the form of a new questionnaire and provided to the Delphi panelists to re-evaluate the ratings of sub-constructs and dimensions of both main constructs. In Round 3, for (part I (organizational structure; nine sub-constructs and their 44 dimensions & part II (schedule management; eight sub-constructs and their 35 dimensions)), respondents are probed to rate the relative importance of on the same 5-point Likert scale. The identified dimensions are randomized (to minimize the bias in experts' opinions) and classified in their respective sub-constructs. The results are obtained from the Delphi panelists in round three and compiled as shown in the following Table 3.

TABLE 2. Analysis of round 2 – reliability and non-parametric tests.

1. Organizational Structure (Part I)			
Sr. No	**Reliability Statistics (Cronbach's alpha (α))**	**Spearman rank Correlation Coefficient (r_s or rho)**	**Kendall's rank-order Correlation Coefficient (tau-b)**
1	Computed Value = 0.808[a]	Computed Value = 0.863[c]	Computed Value = 0.732[e]
	N=55	Critical Value = 0.345	Critical Value = 0.216
2. Schedule Management (Part II)			
2	Computed Value = 0.753[b]	Computed Value = 0.785[d]	Computed Value = 0.709[f]
	N=37	Critical Value = 0.421	Critical Value = 0.267

[a,b] Computed value of Cronbach's Alpha (α) should be greater than 0.7. The values (0.808 & 0.753) > 0.7

[c,d,e,f] Computed value of r_s (rho) and tau-b should be greater than critical value, p-value = 0.01 (Significance level, (2-tailed))

The reliability of scales used for the sub-constructs and dimensions for part I and part II are 0.813 and 0.777 respectively as shown in Table 4; which shows that both constructs are highly reliable.

Spearman's rank (r_s) and Kendall's rank-order (tau-b) correlation coefficients are significant at 0.01 level (2-tailed). Since, the computed values of both correlation coefficients exceeded critical values, a consistency between academicians and professionals' responses has achieved. Therefore, three rounds are deemed enough to conclude the results. The achievement of consistency of groups' responses is considered as a stopping criterion in this Delphi study.

B. PHASE 2–RESULTS OF QUANTITATIVE RESEARCH (VALIDATION OF THE PROPOSED FRAMEWORK)

1) FACE VALIDITY INDEX

The responses are analyzed and computed for each criterion (Relevant, Correct, Feasible, Concrete, Concise, Fully Defined, Field-Tested, Clarity of Language, and Coherent). Finally, by taking the average of all indexes (criteria), the overall 'face validity index' is calculated. Separate 'face validity index' has been computed for both constructs; organizational structure and schedule management and is shown in Fig. 3.

2) CONTENT VALIDITY INDEX

The computed value of I-CVI for three items (Form1.3, Diff4.1, and SC8.4) is 0.5, which is considered as a low value. Therefore, these three items have been dropped. The values of I-CVI for all other items are 1 and 0.83. The computed S-CVI (content validity of overall scale) for organizational structure is 0.90 i.e., 90% and schedule management is 0.875 i.e., 87%. Many researchers have indicated that the value of S-CVI should be equal to 0.80 or greater than is acceptable [92], [90].

TABLE 3. Third round results of Delphi study (Part I and part II).

#	Sub-Constructs & Dimensions of an Organizational Structure (Part I)	Overall	
		Mean	Rank
1	**Formalization**		
1.1	Formal Orientation Program	5.00	1
1.2	Existence of Formalization	5.00	2
1.3	Enforcement of Formalization	5.00	3
2	**Centralization**		
2.1	Extent of Participation in Decision Making of New Programs	5.00	4
2.2	Direct Supervisor Determine Your Work	5.00	5
2.3	Discouraged if Make your Own Decision	4.90	6
2.4	Participation in Decision Making of Hiring and Promotion of Staff	4.90	7
2.5	Participation in Decision Making of Policies	4.90	8
2.6	Taking Boss's Approval Before You Take Any Decision	4.80	9
3	**Specialization**		
3.1	Division of Organizational tasks into Sub-tasks	4.80	10
3.2	Existence of professional and Educated Employees who fill the Specialist Roles	4.60	11
3.3	Vertical Task Specialization	4.50	12
3.4	Functional Specialization	4.50	13
3.5	Existence of Different Specialties in an Organization	4.50	14
3.6	Social Specialization	4.40	15
3.7	Horizontal Task Specialization	4.40	16
3.8	Level of Horizontal Integration	4.30	17
3.9	Horizontal Job Specialization	4.30	18
3.10	Vertical Job Specialization	4.20	19
4	**Differentiation**		
4.1	Functional Differentiation	4.20	20
4.2	Horizontal Differentiation	4.10	21
4.3	Spatial Differentiation	4.10	22
4.4	Specialized Differentiation	4.10	23
4.5	Routinized Differentiation	4.10	24
4.6	Vertical Complexity	4.10	25
4.7	Vertical Differentiation	4.00	26
5	**Coordination Mechanism**		
5.1	Horizontal Coordination	4.00	27
5.2	Mutual Adjustment	4.00	28
5.3	Informal Communication	4.00	29
5.4	Personal Communication	4.00	30
5.5	Team Coordination	4.00	31
5.6	Direct Supervision	3.90	32
6	**Decentralization**		
6.1	Vertical Decentralization	3.90	33
6.2	Horizontal Decentralization	3.90	34
6.3	Selective Decentralization	3.90	35
7	**Departmentalization**		
7.1	Product/Service Wise Departmentalization	3.80	36
7.2	Customer Group Wise Departmentalization	3.80	37
7.3	Process Wise Departmentalization	3.80	38
8	**Standardization**		
8.1	Standardization of Work Processes	3.70	39
8.2	Standardization of Skills/ Training and Indoctrination	3.70	40
8.3	Standardization of Output	3.60	41
9	**Authority of Managers**		
9.1	Authority of Functional Managers	3.50	42
9.2	Authority of Project Managers	3.40	43
9.3	Authority of Functional Managers	3.40	44
#	**Sub-Constructs & Dimensions of Schedule Management (Part II)**	**Overall**	
		Mean	**Rank**
1	**Plan Schedule Management**		
1.1	Project Management Plan	5.00	1
1.2	Tools and Techniques	5.00	2
1.3	Project Charter	5.00	3
1.4	Organizational Process Assets	5.00	4
1.5	Organizational Environmental Factors	4.90	5
1.6	Schedule Management Plan	4.90	6
2	**Activities Definition**		
2.1	Organizational Process Assets	4.90	7
2.2	Organizational Environmental Factors	4.80	8
2.3	Expert Judgment	4.80	9
2.4	Considering WBS, Deliverables and Assumptions	4.70	10
2.5	Sequence Activities	4.70	11
2.6	Cost Estimation	4.70	12
2.7	Attributes of Dependencies	4.60	13
2.8	Identification of Critical Paths (Critical Activities)	4.60	14
3	**Project/ Task Priority Parameters**		
3.1	Identifying critical chain priority of a task	4.60	15
3.2	Defining project priority	4.60	16
3.3	Identifying start priority of a task	4.50	17
3.4	Defining duration priority of a task	4.40	18
3.5	Defining delay priority of a task	4.40	19
3.6	Defining finish priority of a task	4.40	20
4	**Resource Availability and Estimation**		
4.1	Resource Factor	4.30	21
4.2	Resource Availability	4.30	22
4.3	Activity Resource Estimation	4.20	23
4.4	Resource Breakdown Structure	4.20	24
5	**Schedule Constraints**		
5.1	Temporal Constraints	4.00	25
5.2	Availability Constraints	4.33	26
5.3	Precedence Constraints	4.00	27
6	**Schedule Development**		
6.1	Analyzing Activity Sequences, Durations and Resource Requirements	4.10	28
6.2	Approval of Schedule Baseline	4.00	29
7	**Schedule Uncertainty**		
7.1	Correlation of Risk Factors with Activities	4.00	30
7.2	Using Methods which handles Uncertainty	4.00	31
7.3	Placing Project Buffers for Uncertainty	3.90	32
8	**Schedule Control**		
8.1	Using Schedule Control Tools	3.80	33
8.2	Processing of a Schedule Change Request through Change Control Process	3.60	34
8.3	To Recognize Deviations and Take Preventive and Corrective Actions to Minimize Risks	3.50	35

TABLE 4. Analysis of round 3 - reliability and non-parametric tests.

Organizational Structure (Part I)			
Sr. No	**Reliability Statistics (Cronbach's alpha (α))**	**Spearman rank Correlation Coefficient (r_s or rho)**	**Kendall's rank-order Correlation Coefficient (tau-b)**
1	Computed Value = 0.813a	Computed Value = 0.945[c]	Computed Value = 0.865[e]
	N=44	Critical Value = 0.386	Critical Value = 0.243
Schedule Management (Part II)			
2	Computed Value = 0.777[b]	Computed Value = 0.849[d]	Computed Value = 0.745[f]
	N=35	Critical Value = 0.433	Critical Value = 0.277

[a,b] Computed value of Cronbach's Alpha (α) should be greater than 0.7. The values (0.813 & 0.777) > 0.7

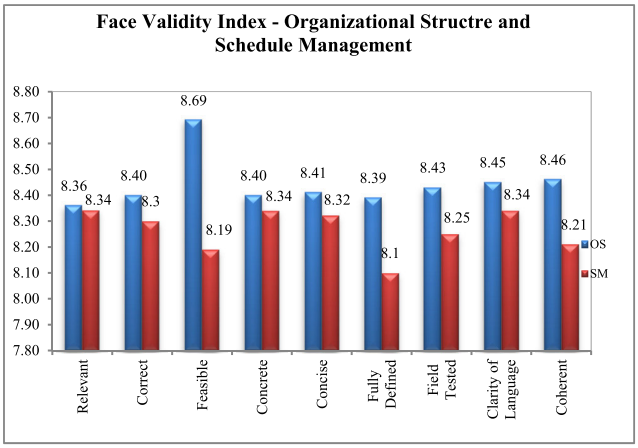
[c,d,e,f] Computed value of r_s (rho) and tau-b should be greater than critical value, p-value = 0.01 (Significance level, (2-tailed))

It means that the content validity of the overall scale is 90%. According to experts, two sub-constructs (Formalization and Standardization) should be merged due to the existence of the same content in both sub-constructs.

3) CONSTRUCT VALIDITY

a: PRE-REQUISITES OF CONFIRMATORY FACTOR ANALYSIS (CFA)

The idea behind 'factor analysis' is variable/ data reduction. It is known as the 'multivariate statistical technique'.



Note: The value of the 'average face validity index' of organizational structure is 8.44 and schedule management is 8.27.

FIGURE 3. Face validity index – organizational structure and schedule management.

As mentioned earlier that it is a data reduction technique, it also provides evidence for the construct validity. Another aspect of factor analysis is KMO and Bartlett's Test of Sphericity. It is considered as a measure of sampling adequacy (MSA). The value of KMO ranges from 0 and 1 ($0 < KMO < 1$), but the world-wide accepted index is above 0.5 [124]. It assumes that the original correlation matrix is an identity matrix.

Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity Results - KMO and Bartlett's test of sphericity is computed for the construct 'organizational structure' and 'schedule management' as shown in Table 5. These values indicate a superb measure of sampling adequacy and show that we may proceed with the factor analysis. Therefore, we can say that factor analysis is valid for both constructs and further analysis.

TABLE 5. Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett's test.

KMO and Bartlett's Test – Organizational Structure		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.863[a]
Bartlett's Test of Sphericity	Approximate Chi-Square	5907.309
	Degrees of Freedom (df)	1326
	Significance Level (Sig.)	0.000[c]
KMO and Bartlett's Test – Schedule Management		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.942[b]
Bartlett's Test of Sphericity	Approximate Chi-Square	7520.674
	Degrees of Freedom (df)	990
	Significance Level (Sig.)	0.000[d]

[a,b] The value of KMO and Bartlett's test must be> 0.8 and significant at 95% confidence interval i.e., $\alpha = 0.05$

[c,d] The p-value (Significance level (Sig.)) for both constructs is 0.000 that is less than 0.05 (0.000<0.05)

Reliability Analysis - Reliability analysis is the process of identification and maintenance of significant items in an instrument. To have a confidence and error-free measure, a reliability test is conducted for an instrument. The measures for acceptable levels of Cronbach's alpha qualify a value of 0.8 and above as good, 0.7 and above as satisfactory and 0.6 and above as acceptable for measurement [125]. The Reliability analysis and results of individual sub-constructs and overall constructs for both main constructs; 'Organizational Structure' and 'Schedule Management' are presented in the following Table 6.

TABLE 6. Reliability analysis of organizational structure and schedule management.

Reliability Analysis of Organizational Structure and Schedule Management			
The Cronbach's α Coefficients of Organizational Structure Sub-Constructs		*The Cronbach's α Coefficients of Schedule Management Sub-Constructs*	
Sub-Constructs	*Cronbach's alpha (α)*	*Sub-Constructs*	*Cronbach's alpha (α)*
Formalization (Form1)	0.794	Plan Schedule Management (PSM1)	0.895
Centralization (Central2)	0.805	Activities Definition (AD2)	0.875
Specialization (Special3)	0.762	Project/ Task Priority Parameters (TPP3)	0.876
Differentiation (Diff4)	0.805	Resource Availability and Estimation (RAE4)	0.789
Coordination Mechanism (CoMech5)	0.715	Schedule Constraints (SC5)	0.801
Decentralization (Decentral6)	0.611	Schedule Development (SD6)	0.754
Departmentalization (Depart7)	0.642	Schedule Uncertainty (SU7)	0.714
Authority of Managers (AOM8)	0.855	Schedule Control (SC8)	0.798
Overall Computed Value of Organizational Structure Instrument	0.917	*Overall Computed Value of Schedule Management Instrument*	0.962

The overall computed value of Cronbach's alpha for the organizational instrument is 0.917, 0.962 for the schedule management instrument which represents acceptable values of reliability and holds good internal consistency among items listed in both instruments.

4) CONFIRMATORY FACTOR ANALYSIS (CFA)

a: FIRST AND SECOND-ORDER MODELING OF EIGHT FACTORS OF ORGANIZATIONAL STRUCTURE AND SCHEDULE MANAGEMENT

The confirmatory factor analysis is performed and analyzed for eight factors (sub-constructs) of organizational structure and schedule management. The statistical results of 'parsimonious fit indices' depicts significant values of chi-square, degrees of freedom, and probability level on a sample data of ($N = 285$). The analysis of 'absolute fit indices' shows that the value of root mean square error (RMSEA) is significant i.e., which is less than 0.080. Other two absolute fit indices; goodness-of-fit and adjusted goodness-of-fit show a reasonable model fit. Other model fit indices include 'incremental fit indices' which also represent a good and satisfactory model fit. All values of 'model fit indices' suggested a good model fit of the first-order model of organizational structure and schedule management.

The purpose of second-order modeling is to find the relationship among eight sub-constructs and to test whether all

eight sub-constructs establish the main constructs i.e., organizational structure and schedule management. The analysis of results of model fit indices indicates that all items significantly load into their respective sub-constructs and into the main construct ultimately and is shown in Table 7. One sub-construct 'central2' has a factor loading smaller than 0.5 ($0.43 < 0.5$).

TABLE 7. Summary of model fit indices (First and second-order modeling of eight factors of organizational structure and schedule management).

Summary of Model Fit Indices (First and Second-Order Modeling of Eight Factors of Organizational Structure and Schedule Management)			
Parsimonious Fit Indices			
CMIN (Chi-Square, χ^2)	DF (Degrees of Freedom)	P (Probability Level)	CMIN/DF[a] (Relative Chi-Square)
OS = 1st order = 643.712, 2nd order = 689.727 SM = 1st order = 1109.000, 2nd order = 1277.378	OS = 1st order = 376, 2nd order = 396 SM = 1st order = 665, 2nd order = 688	0.000	OS = 1st order = 1.712, 2nd order = 1.742 SM = 1st order = 1.668, 2nd order = 1.857
Absolute Fit Indices			
RMSEA[b] (Root Mean Square Error of Approximation)	GFI[c] (Goodness-of-Fit Index)	AGFI[d] (Adjusted Goodness-of-Fit Index)	
OS = 1st order = 0.050, 2nd order = 0.051 SM = 1st order = 0.048, 2nd order = 0.055	OS = 1st order = 0.869, 2nd order = 0.858 SM = 1st order = 0.837, 2nd order = 0.814	OS = 1st order = 0.838, 2nd order = 0.833 SM = 1st order = 0.808, 2nd order = 0.789	
Incremental Fit Indices			
CFI[e] (Comparative Fit Index)	IFI[f] (Incremental Fit Index)	TLI[g] (Tucker-Lewis Index)	NFI[h] (Normed Fit Index)
OS = 1st order = 0.918, 2nd order = 0.910 SM = 1st order = 0.929, 2nd order = 0.906	OS = 1st order = 0.920, 2nd order = 0.911 SM = 1st order = 0.930, 2nd order = 0.907	OS = 1st order = 0.906, 2nd order = 0.902 SM = 1st order = 0.921, 2nd order = 0.899	OS = 1st order = 0.827, 2nd order = 0.814 SM = 1st order =0.842, 2nd order = 0.818

[a] The value of parsimonious fit indices (CMIN/DF) must be less than 2
[b, c, d] The values of absolute fit indices (RMSEA) must be less than 0.08 & (GFI and AGFI) greater than 0.90
[e, f, g, h] The values of incremental fit indices (CFI, IFI, TLI, and NFI) must be greater than 0.90

V. DISCUSSION

In this research, a large number of critical dimensions of organizational structure and schedule management are identified through the Delphi study and validated through confirmatory factor analysis. However, both research techniques helped to take into consideration a wide range of concepts at both levels (organizational and project). Especially in an R&D environment, less significance is given in identifying these critical factors before-hand, which hampers the success of R&D projects, in the long run.

The significant dimensions of organizational structure are thoroughly examined and covered, for example, formalization is one of the most vital dimensions acknowledged by the Delphi experts and respondents of the final questionnaire from the R&D environment. Formalization can be defined as the extent/ degree to which jobs, rules, procedures, and policies are standardized within an organization. Without having a formalized structure, an organization may remain ineffective, disorganized, and erratic. Formalization cannot be achieved without effective standardization of work processes and skills and outputs. Formalization is also known as standardization which can be defined as a key factor influencing the projects' schedules. In reliability analysis and confirmatory factor analysis (2nd order), the strong values of Cronbach's alpha (0.794) and (0.93), respectively, also indicate that formalization is a strong sub-construct of organizational structure model. If R&D organizations develop formalized official rules, regulations, and procedures, the goals of the projects can be achieved within the defined timelines.

Similarly, the need for division of labor with regards to the number of hierarchical levels, spatial dispersion, and division of labor is also highlighted in the Delphi study. In an organization, personnel is properly distinguished onto various positions based on the several dimensions of differentiation; like notable ranks, division of labor and managerial level, or segregation into sub-divisions and sections. The results and analysis of Delphi surveys revealed that differentiation is also an important dimension of organizational structure and is directly proportional to R&D project success. Upon the validation of results, the values of Cronbach's alpha (0.805) and CFA (2nd order) (0.83) suggests differentiation to be an integral part of the proposed framework. If more work in an organization will be divided into organizational subunits, geographic dispersion and according to manager's goal orientation, more chances will be of effective execution of R&D project and that too within proposed timelines.

The management of project stakeholders is not possible without effective coordination mechanisms within an organizational structure. It is worth noting that the Delphi study also discovered dimensions of coordination (team coordination, mutual coordination, and horizontal coordination) beyond the traditional factors of coordination. Apart from upward and downward communication, horizontal communication is needed to communicate with the fellows and peers without the involvement of senior management. This reinforces literature review findings that horizontal coordination can promote extensive involvement of teams in knowledge sharing and communication amongst people working in various units of an organization [147], [148].

In the R&D environment, it is paramount to sustain effective coordination among all stakeholders to avoid conflicts and misapprehensions during all stages of a project. Later on, the values of Cronbach's alpha (0.715) and confirmatory factor analysis (2nd order) (0.93) recommends the implementation of coordination mechanisms as a fundamental factor of the proposed framework. The coordination mechanism attained a broader viewpoint during the Delphi study and it has been analyzed that it is a prime factor influencing the R&D project life cycle and hence overall project success. It helps to identify internal and external stakeholders of a project, schedule the resources, schedule constraints, risk factors, and project/ task priority parameters.

For instance, the results and analysis of the Delphi study shows that specialization is an important dimension of an organizational structure affecting project success in an R&D

environment. The specialization corresponds to the development of specific skills and knowledge exclusively possessed by the individuals working in an organization. One of the dimensions of specialization is horizontal task specialization which refers to the division of operational and functional tasks among a wide range of members and people in an organization. The extent to which units, departments, divisions, and employees are specialized functionally is known as a 'low level of integration', whereas; the extent to which employees' efforts, skills, and training are integrated is referred to as 'high level of horizontal integration'. The strong values of Cronbach's alpha (0.762) in reliability analysis and confirmatory factor analysis (2nd order) (0.64) validate the results and advocates its inclusion in the proposed framework. An organization's ability to maintain a project team with diversified and specialized skills is assumed to provide several benefits through the minimization of training, development of new teams, and preserving a large amount of knowledge regarding the project. Through specialized skill-sets in R&D projects, planning of schedules, identifying different project and task parameters, analyzing resource availability and estimation, uncertainty, and development of schedules can be achieved commendably.

Likewise, the authority of managers is highlighted as a fundamental 'success factor' in the Delphi study. In the R&D environment, the project manager's experience has an immense impact on the performance of projects (in terms of success and failure). A project manager has to deal with upper management more than functional and technology managers. Lack of project managers' competence together with the lack of top management support can lead to project delay and failure. The scale reliability and confirmatory factor analysis (2nd order) of the authority of managers represent high values (0.855) and (0.66) which shows that items of this sub-construct have high internal consistency and significantly loads in their respective model as well i.e., organizational structure. It is clear from the results and analysis of this study that managerial efficiency is considered to be a key factor for the successful execution of R&D projects and improve the project schedule performance. As a part of project management, it is the prime and foremost obligation of a project manager to plan, develop and control the schedule of the project keeping in view all the constraints, uncertainties, and resource-related issues.

Traditionally, within organic structures, centralization has been given less importance due to stringent decision-making processes. Initially, in the Delphi study, academicians and professionals ranked centralization's dimensions as the top nine factors. But later, upon confirmatory factor analysis, the calculated factor loading (2nd order) of centralization resulted in a low value ($0.43 < 0.5$), which shows that it cannot be a significant part of the whole organizational structure model proposed for R&D projects in this study. Therefore, trends in the overall results and analysis show that the proposed framework suggests implementing and executing R&D projects in an organic environment, i.e., decentralized, confirmatory factor analysis (2nd order, 0.77). The speedy decision-making processes in a decentralized structure do not hamper the schedule performance and meet customer requirements in due course.

On the other hand, Delphi experts also identified the vital dimensions of schedule management for R&D project success. For example, Delphi experts emphasized one of the schedule managements' sub-construct i.e., plan schedule management, and its dimensions are also ranked as the top six factors. The reliability analysis results, and CFA of plan schedule management shows that this sub-construct has a high value of internal consistency among its items (Cronbach's alpha $= 0.895$) and also significantly loads (CFA, 2nd order $= 0.89$) into its main construct. Other sub-constructs: activities definition, project/ task priority parameters, resource availability and estimation, schedule constraints, development, uncertainty and control also reveal significant results of reliability (0.875, 0.876, 0.789, 0.801, 0.754, 0.714 and 0.798) and 2nd order confirmatory factor analysis (0.94, 0.94, 0.80, 0.89, 0.83, 0.91, 0.82, and 0.90). The findings show that, on one hand, the identified sub-constructs of schedule management are crucial for the success of R&D projects whilst, on the other hand, the industry practitioners and academicians are fully aware that the acknowledged factors of organizational structure create a great impact on the schedule management of R&D projects.

Overall, in this research, a systematic methodology was adopted to uncover the critical dimensions at organizational structure level as well as project management level (schedule management, specifically). The findings of the Delphi study are considered consistent and dependable because all experts of the Delphi study shared the same viewpoints on the formulated research problem. In this study, the Delphi study worked as a self-validating mechanism. Before conducting the Delphi study, the results of a comprehensive literature review in the form of a preliminary theoretical framework were presented as food for thought at the early stage of the Delphi study. Therefore, the results Delphi study is considered reliable because of the similar kind of understanding among all participants. Furthermore, after framework development, it is further validated through proven validation methods to judge the reliability and consistency of the analytical results of the proposed framework.

VI. CONCLUSION

The R&D environments are primarily dealing with extensive and large-scale nationwide projects. Due to the complex nature of R&D projects, lots of issues arise at the organizational and project level that hampers project success. However, there are limited studies that generally identify the issues of the relationship between schedule management and organizational structures.

This study explored the critical dimensions of organizational structure and schedule management via two research techniques: Delphi method and validation techniques. To facilitate the successful implementation of

projects, it not only adequate to pay attention to the success factors at project management level (schedule management), rather, it is essential to focus on the dimensions at the organizational level (e.g., formalization, specialization, differentiation, and locus of decision making) as well. Nevertheless, a determination is required to enhance the capability of organizational structure by focusing on the critical dimensions to achieve better execution of projects in terms of existence and enforcement of rules and regulations, standardization of work processes, coordination mechanisms, distribution of tasks and activities, complexity (specialization and differentiation) of organizational structure.

To avoid time lags and schedule slippages during the execution of R&D projects, each project should be aware of schedule management planning before-hand. This will enable projects to plan, maintain, and control project schedules in a systematic way. Defining activities and finding optimal resources well in time is a tedious task. However, managing schedule constraints is cumbersome, but by embracing state-of-the-art scheduling techniques can lessen the impact of possible risks and save the project from delays and unforeseen events (uncertainty). Some scheduling techniques currently used in engineering projects have become obsolete (e.g., CPM) and are not appropriate for the engineering project environment. However, prudent selection of prominent dimensions while scheduling with better estimates can lead to the timely execution of activities. Similarly, a better correlation of organizational structure's dimensions with the individual projects' schedules will increase the efficiency of the project team and overall success of projects.

The R&D organizations formulate an exceptional environment to undertake R&D projects. However, if compared with non-R&D organizations, gauging performance in terms of efficiency and success is difficult. Therefore, a careful review of organizational structure and schedule related success dimensions or indicators should be a part of project review reports in all major phases of an R&D project (e.g., concept, definition, design, qualification, and production). The engineering managers can also conduct post-project analysis after the implementation of the proposed framework as an effective way to learn about the success of R&D projects.

Generally speaking, R&D organizations have various organizational structures and project management issues (specific to schedule management) to cater for in the successful execution of projects. This research provides a detailed framework and a useful guide for the successful implementation of R&D projects in terms of planning schedules and organizing structures that include a wide range of concepts. The proposed framework is aligned with the challenges faced by the industry practitioners and technical managers of the R&D environment. The results of this study will help to improve the practices of engineering management within the R&D environment and in-time completion of R&D projects aligned with the important dimensions of organizational structure.

A. IMPLICATIONS FOR ENGINEERING MANAGERS AND PRACTITIONERS OF R&D INDUSTRY

The engineering managers and practitioners of the R&D industry frequently manage R&D projects of strategic importance in different types of organizational structure. Being team leaders of the projects, they deal with the challenges of the selection of organizational design variables and their impact on the project's scheduling. To tackle with the challenges of the selection of optimal variables of organizational structure, their impact on the schedules of projects and overall success of R&D projects, team leaders should be vigilant.

The knowledge about these success factors at the project and organizational level create great awareness for engineering managers coping up with the issues of organizational structure that hampers project scheduling. This research explores the application of theory in practice. A thoughtful framework of potential dimensions of organizational structure and schedule management is evaluated by taking insights from industry experts and academicians. Following are some implications for the engineering managers and practitioners of the R&D industry:

a) The application of the proposed framework will enable engineering managers to deal with the organizational design and project schedule-related issues.
b) At the outset, it will provide an organized and holistic approach to select the suitable dimensions of organizational design that can lead to well-organized completion of R&D projects where uncertainty is a great factor.
c) This study recommends several practical suggestions for engineering managers that will help them to avoid unwanted results of the projects e.g., schedule slippages, inappropriate selection, and allocation of resources, unclear roles of authorities, ineffective communication, and lack of standardized policies and procedures in an organizational structure.
d) The research presented in this paper indicates that engineering managers can structure their organizations before-hand for the execution of R&D projects based on the dimensions as suggested in this framework, formalized guidelines and procedures, specialized skills, flexible coordination mechanisms, decentralization, functional grouping into manageable divisions and competence of managers. These dimensions have a strong relationship with the R&D project' scheduling processes, for example, if managers will create an organizational environment based upon the above factors, it will help in schedule management planning, defining critical activities of the project, resource availability, and estimation, and schedule (constraints, development and control, and uncertainty).

Finally, targeting the right amalgamation of these dimensions can increase the reliability of the R&D products that will be the ultimate success of the engineering managers.

TABLE 8. Final questionnaire (organizational structure (Section 1) and schedule management (Section 2).

SECTION I		
Item Code	**Organizational Structure**	**References/ Contributions**
Form1.1	Does a "rules and procedures" manual exist in your organization and is readily available within the organization?	[125], [94] Recommended by Delphi Experts
Form1.2	Is there any formal orientation program for new employees/ members of the organization?	
Form1.3	Does your organization enforce norms and rules?	[94]
SWP1.1	Do you think that the subject matter of the assigned work is programmed or identified in your organization?	[126], [127] Recommended by Delphi Experts
SS/ TI1.2	To what extent you agree that skills and knowledge in your organization through extensive educational programs is standardized, before the individual starts his/ her job?	
SO1.3	To what extent do you agree that the results of work are specified?	
PDM2.1	Do you frequently participate in the decisions on the adoption of new programs?	[100]
PDM2.2	Do you frequently participate in the decisions of new policies?	
PDM2.3	Do you frequently participate in the decisions on the hiring and promotions of any of the professional staff?	
HOA2.1	Do you get discouraged if you make your own decisions?	Added by Delphi Experts
HOA2.2	Do you need to take your boss's approval before you take any decision?	[128], [129], [100]
HOA2.3	Does your direct supervisor decide and determine your work?	
Special3.1	Has your organization divided organizational tasks into subtasks?	[130], [131] Recommended by Delphi Experts
Special3.2	Does your organization have educated and professional employees who fill specialist roles?	
Special3.3	Are there different specialties found in your organization?	
Special3.4	Do you believe that specialization on a large scale is likely to improve the skills and abilities of staff in the activities they perform?	
VTS3.1	Do different people and units have different levels of authority involved in decision making in your organization?	[129] Recommended by Delphi Experts
HTS3.1	To what extent do you agree that among different people and units, the operational tasks are allocated?	
SS3.1	Does your organization hold a concept of "social specialization"?	[131], [110]
SS3.2	Does your organization hire professionals who possess skills that are not easy to routinize?	Added by Delphi Experts
FS3.1	Do you think that departments and workers in your organization are functionally specialized?	[130], [131], [132], [133]
FS3.2	To what extent you are satisfied with the phenomenon of "Job Rotation"?	
HJS3.1	To what extent you think that division of labor in a given position (describes the number and breadth of tasks) in your organization is well determined?	[134], [132] Recommended by Delphi Experts
VJS3.1	To what extent there is an incumbent's control over tasks in your organization?	
SpDiff4.1	To what extent you think that spatial differentiation (geographical separation of organizational facilities and personnel) is well defined?	[103], [135]
Diff4.2	Are notable managerial levels well defined?	
Diff4.3	To what extent the subunits e.g., sections within branches or division, local branches or headquarter divisions well defined?	
FD/HD4.1	To what extent do you agree that new work specialties are created?	[131], [36]
FD/HD4.2	Does your organization promote horizontal differentiation i.e., the invention of new methods, technologies, or products?	
FD/HD4.3	To what extent your organization require a group of individuals; who work for the development of joint projects and share a mutual knowledge base?	[136], [48]
FD/VD4.1	To what extent do you agree that new types of leadership positions are created?	

TABLE 8. *(Continued.)* Final questionnaire (organizational structure (Section 1) and schedule management (Section 2).

SD4.1	Is there an advanced division of labor in combination with professionalization of the work force in your organization?	[137] Recommended by Delphi Experts
RD4.1	Is there a division of labor in the absence of professionalization?	
VD/VC4.1	Is your organization's hierarchy (Number of levels) well-defined? (e.g., as revealed in the organization documents like the organization chart)	[48] Recommended by Delphi Experts
HC5.1	To what extent inter-unit teams' set-up are allowed for joint decision making and collaboration?	[138] Recommended by Delphi Experts
HC5.2	To what extent you approve that there should be a person responsible to make all the necessary agreements in order to facilitate cooperation with the other unit?	[139] Recommended by Delphi Experts
MA/IC5.1	Do you coordinate with the other unit for the execution of activities informally via personal contacts?	[126], [127], [140], [141]
PC5.1	To what extent you agree self-coordination (self-monitoring) exists in your organization?	[141]
TC5.1	Are you satisfied with the level of team coordination within your organization?	Added by Delphi Experts
DS5.1	Is there a concept of unity of command and scalar principles in your organization?	[126], [127]
Decentral 6.1	Does your organization allow the incorporation of a greater number of individuals and organizational levels into the process of strategic reflection?	[135], [131] Recommended by Delphi Experts
Decentral 6.2	To what extent you approve that if more individuals become involved in the decision making process, the differentiation strategies will be improved due to more variety of ideas?	[142] Recommended by Delphi Experts
Decentral 6.3	To what extent you approve that decentralization gives autonomy and flexibility to the different organizational units in your organization?	Added by Delphi Experts
VD6.1	To what extent, down the chain of command, there is a distribution of power or shared authority between subordinates and super-ordinates in your organization?	[126], [127] Recommended by Delphi Experts
HD6.1	Do non-administrators (including staff) share an authority or make decisions between line and staff?	
SD6.1	To what extent the power of decision-making within the organization delegated to selective units?	
Depart7.1	Are tasks grouped by product/service in your organization?	[143], [131] Recommended by Delphi Experts
Depart7.2	Are tasks grouped by customer group in your organization?	
Depart7.3	Are tasks grouped by process in your organization?	
APM8.1	Does Project manager have enough authority to make decisions and use organizational resources in your organization?	[114]
AFM8.1	Does Functional manager have enough authority to make decisions and use organizational resources in your organization?	Added by Delphi Experts
ATM8.1	Does Technology manager have enough authority to make decisions and use organizational resources in your organization?	
SECTION II		
Item Code	**Schedule Management**	**References/ Contributions**
PMP1.1	To what extent you agree that your project management plan (scope baseline, cost, risk, and communications decisions related to scheduling) is ready before the development of schedule management plan?	[59] Recommended by Delphi Experts
PC1.1	To what extent you agree that project charter (requirements related to project approval and summary milestone schedule) is available for the development of schedule management plan?	
EF1.1	To what extent you agree that organizational environmental factors have been catered in your	

TABLE 8. ***(Continued.)*** **Final questionnaire (organizational structure (Section 1) and schedule management (Section 2).**

TPP3.5	To what extent delay priority is defined; means the activity which has the lengthiest delay time than the initial plan has the highest priority?	
TPP3.6	To what extent finish priority is defined; means the task which finishes first possesses the highest priority?	
RF4.1	To what extent the resource factor, RF is identified for your project?	[117], [118], [119], [120]
RA4.2	To what extent you think that resource strength (RS) that includes skills too may influence the planning of project schedules?	[118], [119], [120] Recommended by Delphi Experts
ARE4.3	To what extent activity resources have been estimated in your project?	[59] Recommended by Delphi Experts
RBS4.4	To what extent resource breakdown structure is defined in your project?	[59], [121] Recommended by Delphi Experts
TC5.1	To what extent temporal constraints are defined in your project?	[121] Recommended by Delphi Experts
PC5.2	To what extent precedence constraints are defined in your project?	
AC5.3	To what extent availability constraints are defined in your project?	
SD6.1	To what extent you analyze resource requirements, durations and activity sequences, durations, and schedule constraints are being defined to develop a project schedule model?	[59]
SD6.2	Does a schedule baseline get approved in your project?	
SU7.1	During project execution, to what extent you think project schedules are affected by labor and equipment efficiency, design, uncertainties in weather, site conditions, etc.?	[65]
SU7.2	To what extent you think that risk factors and activities in your project are correlated?	[59], [144], [61], [145] Recommended by Delphi Experts
SU7.3	Are you using any method that handles uncertainty by taking risk factors into account?	
SU7.4	To what extent project buffers are defined in your project?	[59], [61], [145] Recommended by Delphi Experts
SC8.1	To what extent you think, adopting means to identify deviations from the plan, take corrective and preventive actions to minimize risks in your project are being implemented to control the schedule?	[59] Recommended by Delphi Experts
SC8.2	To what extent you think that schedule control tools are being implemented in your project?	
SC8.3	Does a schedule change request get processed for review through a change control process?	

B. LIMITATIONS AND FUTURE WORK

In this study, the data has been acquired from R&D organizations wherein confidentiality is the main concern. Due to such concerns, the researcher faced difficulties in achieving the requisite size of data.

For future work, the diversity of respondents/ participants and the size of data can be extended. Moreover, this framework can be used in other various technology-related R&D projects which will further validate the results. Also, this study can be expanded in the future by conducting simulation and artificial intelligence algorithms to select optimal project management organizational structure for the prudent schedule management of R&D projects.

APPENDIX A

See Table 8.

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HUMA HANIF received the B.Sc. degree in software engineering from Fatima Jinnah Women University, Rawalpindi, in 2004, and the M.Sc. and Ph.D. degrees in engineering management from the Center for Advanced Studies in Engineering (CASE)-UET, Taxila, Pakistan, in 2008 and 2019, respectively. Her specialization is in project and configuration management and industrial experience of above ten years in the same field. She is the author of one journal (HEC recognized) and the coauthor of one international journal (IJHRM) research articles. She has also published a conference paper at the IEEE 3rd International Conference on Computer Science and Information Technology, Chengdu, China. Her current research interests include research and development projects, project management, configuration management, and using artificial intelligence (AI) techniques in the field of management/engineering management.

AAMER HANIF (Member, IEEE) received the B.E. degree in aerospace engineering from NED University, Karachi, in 1989, the M.S. degree in computer science from FAST-NU, Islamabad, Pakistan, in 2006, the M.S. degree in engineering management from CASE-UET, Taxila, in 2010, and the Ph.D. degree in engineering management from the College of E&ME, NUST, Islamabad, in 2019. He is currently a Faculty Member with the School of Management, Air University, Islamabad. His research interests include data mining and business analytics, project management, and technology enhanced learning. He has published international journals and conference papers in these areas.

ALI AHSAN specializes in field of business and technology. He has more than two decades of highly successful industrial and academic experience in USA, Asia, Australia, and Africa, in the field of business analysis, project management, business administration, management (strategic and operations), information systems, information and communication technology, engineering management, technology management, change management, entrepreneurship and innovation management, business improvement, process engineering/improvement, quality assurance, artificial intelligence in business, tertiary education, corporate training, software engineering, data sciences, management consultancy, accounts management, stakeholder and vendor management, customer relationship management, organizational development, and organizational behavior. He is a Gold Medalist and has represented many organizations at many national and international forums. Other than his consultancy work, he is a Senior Academician at Torrens University Australia. Before joining Torrens University, he was the CEO of WISSEN Group, the Dean of Foundation University, and a Visiting Professor at Stratford University, USA. He has several publications and has supervised an enormous number of post graduate and doctorate students.

ALI SAFAA SADIQ (Senior Member, IEEE) received the degree in computer science, in 2004, and the M.Sc. and Ph.D. degrees in computer science, in 2011 and 2014, respectively. He is currently a Faculty Member and the Course Coordinator of artificial intelligence and robotics and a member at Wolverhampton Cyber Research Institute (WCRI) at the Faculty of Science and Engineering, School of Mathematics and Computer Science, University of Wolverhampton, U.K. He is also an Adjunct Staff at Monash University and an Adjunct Associate Professor at the Centre for Artificial Intelligence Research and Optimization, Torrens University Australia. He had five years of industrial experience in computer science and networking. He has published several scientific/research papers in well-known international journals and conferences. Recently, he has involved as a Co-Investigator with a research project CYBERMIND that was funded £91k by Innovate U.K. Cyber Academic Start-Up Accelerator 2020, and currently leading a research project under the same program called TrustMe. He has supervised more than five Ph.D. students and six master's students as well as some other undergraduate final year projects. His current research interests include wireless communications, network security, and AI applications in networking.

SEYEDALI MIRJALILI (Senior Member, IEEE) is currently an Associate Professor at Torrens University Center for Artificial Intelligence Research and Optimization and internationally recognized for his advances in nature-inspired artificial intelligence (AI) techniques. He is the author of more than 150 publications, including five books, 100 journal articles, 20 conference papers, and 30 book chapters. With over 30,000 citations and H-index of 60, he is one of the most influential AI researchers in the world. From Google Scholar metrics, he is globally the most cited researcher in optimization using AI techniques, which is his main area of expertise. He has been a keynote speaker of several international conferences. He is serving as an Associate Editor for top AI journals, including *Neurocomputing*, *Applied Soft Computing*, *Advances in Engineering Software*, *Applied Intelligence*, IEEE Access, and the *Journal of Algorithms*.

BASEM ALKAZEMI (Senior Member, IEEE) is currently a Professor with the College of Computer and Information System, Umm Al-Qura University, Saudi Arabia, where he is also the Head of the Software Engineering Research Group. He is also holding the position of the Vice Dean for research projects and grants in the deanship of scientific research. His main research interests include software engineering, data mining, and machine learning. He is involved as a PI in a number of funded research projects in the area of WSN, big data, and NLP. He served as a reviewer for a number of international conferences and journals. He supervised several postgraduate students those conducted their theses in software continuous delivery (CD), BPM, the IoT, big data for retails, and machine translation.