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Application of Project Management Techniques for Timeline and Budgeting Estimates of Startups

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Abstract: This study aims to develop a framework by incorporating well-proven project management techniques to help startup owners effectively set up ventures and secure early-stage financing. Startups not only open ways for innovative and updated technologies in the markets but also bring employment opportunities in a country that eventually increase productivity and the per capita income of a country. Despite all the benefits, the success rate of startups is meager, especially in developing countries, due to ineffective management and vague business plans. Therefore, this study aims to facilitate entrepreneurs using well-proven project management techniques from the literature and devise a new framework applied to a business case, as discussed in this paper. This study presents an approach to project management techniques for smartphone app-based startups. This study utilizes the fuzzy PERT (FPERT) for the best completion time and budget estimates. Experts' opinions from eight private limited companies have been analyzed using FPERT. The critical path method (CPM) is also used to schedule activities. Finally, a techno-economic analysis is also performed to show the growth potential of such a startup, e-Karsaz. This study aims to help startups secure early-stage financing. Tech-based business ideas need to be commercialized in developing countries like Pakistan. There is a need to show long-term profitability to make an idea stand out among others and secure early-stage financing. The scope of project management techniques is confined to construction-based projects. The results show that it would take around 692 days for the e-Karsaz startup to become fully operational, with the capital budget estimated at around PKR 1.3 billion. The techno-economic analysis shows the project is economically viable with an internal rate of return (IRR) equal to 92 percent and a benefit-to-cost ratio (BCR) equal to 10. The sensitivity analysis, including five scenarios of weighted average cost of capital (WACC), shows that the project remains economically viable even if the required rate of return goes over 20 percent. This study is helpful for startups to make time and budget estimates and to show the growth potential to secure early-stage financing.

Keywords: startups; developing countries; fuzzy project management; techno-economic analysis; capital budgeting; sensitivity analysis; economic viability

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1. Introduction

The ever-increasing advancements in the technological era have made the world switch towards online and digital platforms. The online market proved to be a major disruptive innovation in this era. The focus of successful business firms is now shifted towards satisfying customers' needs via an online platform. With the emergence of online social networks, organizations have benefited from improved internet capabilities and generated platforms where people can conveniently share their goods and services. This

idea paved the way for the economic movement known as the sharing economy [1]. Airbnb and Uber are two sharing economy unicorns and dominate two significant industries: ride-hailing and travel [2]. Various online freelancing platforms successfully serve the community today, like TaskRabbit, Care.com, TopCoder, Uber, and Careem. The emergence of another term, "gig" or collaborative economy, where people work as freelancers or on a part-time basis, has also raised the population of gig workers by about 27 percent more than that of payroll employees [3]. These collaborative economy models are developing with the expanded utilization of the web, cell phones, and interpersonal interaction channels. These include one-of-a-kind and progressed stages to match customer needs to underutilize assets through dealing, exchanging, trading, and sharing resources [4]. The demand for online services is based on people's hectic lives, negotiating rates, and the availability of service providers in the market. The need for having services just a tap away using a smartphone is growing faster, whether for daily residential and commercial maintenance or grocery shopping [5]. Since the coronavirus disease (COVID-19) outbreak, the majority of businesses have had to suffer closure, and the pandemic has accentuated the trend of switching businesses to online channels [6]. The data inform us that COVID-19 pandemic-related firm limitations have constrained a worldwide business outlook toward the digital economy [7]. This pandemic has negatively affected conventional business models while opening online platforms [8], and the transition from globalization to national capitalization was also witnessed [9].

The community demands its needs be fulfilled more quickly; according to Google, searches for open have increased three times since 2015 [10]. Since then, the retail sector has evolved to satisfy the community's needs. However, the service sector must make significant breakthroughs, especially in developing countries. According to a report, the number of 3G and 4G users in Pakistan increased by 1.35 million from 122.8 million by the end of January 2023 to 124.16 million by the end of February, and their number will see precedent growth in the future [11]. This pattern has improved development in the telecom sector, paving the way for innovation and opening the doors of employment, not confined to the telecom sector but to online means of earning. This advancement in innovation in developing countries like Pakistan supports monetary, social, and economic well-being [12]. Given the technological advancements and the usage and accessibility of hand-held devices, various online platforms are now emerging in developing countries like Pakistan. In 2021 alone, Pakistani startups secured USD 240 million [13].

Despite all the benefits associated with the online platforms where the community can access diverse services like ride-hailing or handyman (electrical, plumbing, lawn mowing, roofing, etc.) and all this innovativeness, the success rate of such startups could be higher. The macro-environmental impacts on startups and their mitigation strategies are widely present in the literature [14]. However, the impacts of macro-economic factors, along with the approach that can address the challenges of startups through the lens of project management, are still being determined. Project management techniques and their applications in construction-based projects and civil works are already present in the literature, while their implementation in the project management of digitized startups is yet to be explored. The review of these project management techniques has been discussed thoroughly in the literature section.

The motivation behind this paper is to devise an approach equipped with lens project management that can serve a better purpose for the literature and entrepreneurs. Since project management is not confined only to traditional civil-based construction-related projects, we aim to use well-proven project management techniques to facilitate entrepreneurs in securing early-stage financing and a comprehensive outlook of their startup activities. To set up a digitized startup success, it is crucial to monitor all the activities and timeliness so that a startup can be operational within the stipulated time. After approaching the project management of digitized/smartphone app-based startups, this study also presents a methodology to show the profitability potential of such startups.

To demonstrate the applicability of the devised approach in this paper, a real-time startup named "e-Karsaz" is discussed. This startup aims to deliver handyman services like plumbing, electrical work, lawn mowing, etc., through smartphone-based applications. The startup e-Karsaz aims to fill the market gap by creating an online platform to serve the community's needs with a contemporary set of competitive advantages. However, this study will focus solely on creating timeline and budget estimations along with techno-economic analysis.

The studies in the literature show extensive applications of project management along with advancements in project management. These include the critical path method, program evaluation, and fuzzy PERT review technique. All these techniques are valuable for project execution as they provide a blueprint for the entire project, including the time and cost estimations [15]. For the scheduling of projects, networking methods are considered efficient as they provide graphs and simplify computational costs. These methods include the CPM and the PERT [16]. These methods help project managers monitor the overall progress of project activities. Projects are dynamic; there is always a risk of delay and budgeting associated with them [17]. Various researchers consider the PERT an effective technique for project scheduling. However, due to limitations regarding uncertainties and subjectivity, researchers adopted the hybrid technique of fuzzy PERT to have the best scheduling and cost estimates [15,18,19].

This study would contribute to the literature by expanding the scope of project management techniques to the project management of startups through a devised approach. This study's main objective is to devise an approach equipped with project management techniques to create timeline and budgeting estimates for smartphone-app-based startups. The devised approach not only enables the utilization of project management techniques by startups but also helps entrepreneurs make their business ideas workable and operationalize with time. The project management and techno-economic analysis of digitized startups will lure investors and help entrepreneurs pitch their business ideas more systematically to secure pre-seed funding and financing. This study presents a literature review of various project management techniques and then selects fuzzy PERT as the most suitable technique to analyze "e-Karsaz Startup." Two sources of data are used in this study: primary data and secondary data. The primary data include interviews with the top management of eight private sectors. The secondary data include the historical annual averages of the daily labor wage rate from the reports of the Pakistan Bureau of Statistics. A techno-economic and sensitivity analysis of the startup e-Karsaz is also conducted for economic viability.

Research Aims

(1) To devise a fit-for-purpose approach using project management techniques for digitized startups.

(2) To show digitized startups' growth potential and profitability using techno-economic and sensitivity analysis.

A literature review of various project management techniques to select the appropriate technique is shown in the next step. Further, this study contains methodology, results, conclusions, limitations, and future directions.

2. Literature Review

A digital business platform is a value-creation process with high-tech practices. It varies from traditional brick-and-mortar businesses located strategically where customers can visit, contemplate the product's price, and tangibly perceive it to make a purchase decision [10]. E-business incorporates ICT into operations and transforms the ways of interaction of a firm with customers, suppliers, and the workforce [20]. Organizations that opt for digital platforms must use electronic means to lead their marketing and sales cycles and embrace technical aspects like mobile commerce and fund transfers [21]. E-commerce incorporates online shopping websites to facilitate sales and offer discounts and online transactions [22]. It is crucial to remember that only implementing an e-commerce strategy

is not an online extension of traditional business; mobile commerce, which implies mobile devices, will be reached far wider in this regard [23]. M-commerce offers users great flexibility due to its accessibility anywhere and anytime [24,25]. Digitization also affects the cognition of emotions at individual levels and shapes the psychological behaviors of a community in a broader sense [26].

Recently, there has been a considerable increase in the sharing economy in which people can monetize their things; Uber and Airbnb are two platforms making magnificent progress globally [27]. A sharing economy is a platform consisting of a firm or service enabler acting as an intermediary between suppliers of services or goods and consumers [28]. The sharing economy, also called collaborative consumption, aims to share underutilized assets on a monetary basis, especially by increasing online marketplaces and enabling peer-to-peer transactions electronically [29]. The sharing economy has increased due to the growth of the internet, smartphone usage, and globalization [10]. Due to advancements in internet technology and digital marketing, commerce has become easy and accessible. Users can easily use a company's website or an application like Uber to conveniently avail themselves of the products and services [30]. The sharing economy model has opened ways for people to use online platforms to complete on-demand tasks as freelancers in a free-market system called the gig economy [31]. Although a concerted explanation of the gig economy needs to be included, this term usually refers to an economic system consisting of an intermediary platform that connects firms or service enablers with an on-demand workforce known as gig labor, such as Uber and TaskRabbit [32]. The gig economy is also a free market system, with short-term positions and independent contracts [33]. Some characteristics of the gig economy include unregulated times and a specific payment rate for a particular job conducted by an intermediary [34]. Despite conflicting with the conventional idea of regular-time work, this work gained fame for distinct reasons. Gig work enables young people to work as freelancers while continuing their studies, so unemployed people or those with low wages can earn more [35]. Recently, there has been a tremendous increase in the population of the gig workforce, incredibly independent contractors, as much as 27 percent more than payroll employees [36]. Another essential fact distinguishing the gig economy is that gig workers are not employees; therefore, organizations face fewer obligations such as minimum wage rates, health and life insurance, and retirement benefits [3].

The number of smartphone users in Pakistan has rapidly increased in the last decade. According to a report, the current broadband subscribers are 110 million and 189 million cellular subscribers, and this number will increase rapidly in the coming years [37]. Due to this emerging and ever-increasing trend, various smartphone application-based businesses are growing in Pakistan, including Careem, Uber, Bykea, Dukan.pk, Tajir, and In Driver.

In Pakistan, the success of the online working environment is visible, as Uber, Careem, Food Panda, Cheetay, and Bykea are doing significant business. Careem is the only ride-hailing service that has become a unicorn in Pakistan. The technology-related startups in Pakistan have become the center of focus for venture capitalists, as they have been in the United States and China. Pakistan is catapulting into the digitized world; in 2021, Pakistani startups secured over USD 240 million [13].

This study aims to devise an approach by using the well-proven techniques of project management from the literature and conducting a techno-economic analysis to secure seed funding for tech startups. A case study of a similar startup, "e-Karsaz," is presented in this paper to show the operational philosophy of the devised approach. This study will form the basis for using project management techniques in scheduling and budgeting estimates for digitized/tech startups. Further, this study will help entrepreneurs secure seed funding for their business ideas by displaying the growth and profitability potential of their business ideas.

Project management is a complicated endeavor that includes arrangements for different activities that must be performed to develop a new product. Projects have a predefined starting and ending, subdivided into activities with determined beginnings and ends.

These activities must be completed in order, some activities before or after others, and some activities simultaneously; however, the estimated time for the completion of each activity must be figured out [38]. In the scheduling of projects, techniques are grouped into two methods: the Gantt chart and network planning. A Gantt chart shows a graphical representation of activities' starting and finishing dates and their dependencies.

Network planning is used for project scheduling and shows dependencies between project activities [28]. In network planning, two methods are used: the critical path method (CPM) and the program evaluation and review technique (PERT). James Kelly and Morgan Walker in the 1950s developed the critical path method. It is a well-known method for project scheduling. The CPM is a time-oriented technique that gives deterministic time estimates, whereas PERT gives probabilistic time estimates [39]. The CPM is widely used in projects to distinguish between critical tasks and non-critical tasks, which helps resolve conflicts and cut bottlenecks. The CPM helps calculate the minimum time needed to complete an activity, which eventually increases the efficiency of a project [40]. The CPM has been widely used to calculate various parameters of operations such as earliest start, late start, early finish, late finish, slack time, and maximum available time [41]. However, these project parameters are considered crisp values in the CPM. Given the dynamic nature of environmental conditions, it is impossible to predict the future precisely [15]. A cross-review analysis of the CPM and PERT concluded that PERT gives a better time estimation by considering the most optimistic and the most pessimistic times [42]. The PERT also gives the probability of completing activities before the specified time. Various studies showed the CPM had been utilized for project scheduling. For the planning and scheduling of the construction of a biogas plant [43], the CPM has been widely utilized in the defense construction and software industries and for the analysis and evaluation of mechanizing greenhouse construction projects [44,45]. A study on constructing schools and residential buildings concluded that the main difference between the CPM and PERT is time estimates [46]. A study on the CPM for finding the most optimum project scheduling concluded that the CPM is a deterministic approach that may lead to the infeasibility of the scheduled activity time, given a slight change [47]. Consequently, the crisp values of activities in real projects are unrealistic; therefore, the output of the CPM may have errors [15]. Therefore, there is a need for a more reliable scheduling technique due to uncertainties and the dynamic nature of the environment.

The second method of network planning is PERT, which is also called the back research technique [48]. The PERT chart is often constructed from back to front, accounting for variation in the CPM. Malcolm, Roseboom, Clark, and Fazar initially presented The PERT in 1959. The upper and lower bound values are taken from the expert's opinions. The PERT has been used by several project management teams in scheduling and planning projects in various fields [49]. The PERT was designed to plan and schedule large-scale and complex projects used for the United States Polaris missile project and has gained popularity since then [50].

In contrast to the CPM, PERT considers the uncertainties, for it is a probabilistic approach using three-point time estimates for the completion of each activity [51]. Since the time needed to complete each activity in a complex project is not precisely known ahead of time, the uncertainty factor must be considered [52]. The PERT can address this problem by considering the probabilistic estimations of the project's completion time [53]. The beta distribution in the PERT can be further used to evaluate project variance and the probability of completing a project in a specified amount of time.

Studies have shown applications of the CPM/PERT in various projects such as construction, research and development, healthcare systems, and services [54]. According to a study, the activity completion time is derived from a simple formula [55]. A study examined the importance of activity duration in sensitivity analysis using PERT [56]. The PERT has benefits like calculating the probability of completing a project within a specified timeline [57]. The CPM and PERT have been used in the scheduling and planning of construction projects for project management [58]. The benefits of using PERT in con-

struction projects are also shown in a study [43]. Another study used the CPM/PERT in a real-time project and argued that these techniques provide better control over project planning and improve project management [59]. The PERT was used for the data analysis of Megastar Technical Company and concluded that the project could be completed with high probability, as given by the PERT [48]. In another study, it was argued that the PERT is more effective for projects with unknown time estimates, while the CPM is effective for projects with known estimates [60]. A comparative study on the CPM and the PERT concluded that the PERT is more effective when implementing construction-based projects [45]. Regardless of its value in project management, various practitioners and researchers have criticized the classic PERT, and various improved models and modifications have been put forward [47]. Another study shows that the PERT only considers subjective estimates in its beta distribution [61]. It is also argued that there are various issues in the classic PERT, such as stochastic variables and beta distribution, to estimate the parameters [15]. These arguments and limitations necessitated a modified and fit-for-purpose version of PERT.

Zadeh put forward the fuzzy theory in 1965. The fuzzy approach is widely applicable in various domains [62–65]. Project compression problems involve higher uncertainties, parameters, and variables [66]. The input information in fuzzy systems is inaccurate and can be presented in fuzzy numbers or sets, and linguistic variables may also be used [67,68]. Given the importance of fuzzy theory in forecasting, it has been widely used in different fields. The fuzzy approach was adopted in the PERT to present the duration of activities in a project as fuzzy numbers back in 1981 by Chanas and Kambursowski [69]. Their study calculated those fuzzy numbers by taking three estimates and an alpha cut to find upper and lower bounds. Random α values resulted in arbitrary bounds, making critical activities in a network ineffective. This problem was addressed by taking each activity duration as a positive fuzzy number in the classical PERT [70]. It is also proposed in a study that the duration of each activity can be a specific value or a fuzzy number in the PERT [71]. This research shows that uncertainty can be reduced to some extent by expressing activity durations in terms of fuzzy sets. However, the degree of criticality was hard to calculate.

Keeping these issues in mind, a study proposed that incorporating experts' opinions and the fuzzy Delphi method might be effective while using the PERT [15]. It is also suggested that uncertainty can be reduced by using experts' opinions to forecast the timeliness and cost estimations of activities in the form of fuzzy sets [72]. The scheduling results from the CPM and PERT were analyzed using a fuzzy method to improve scheduling in project management [28]. Another study concluded that PERT could be optimized using the fuzzy Delphi method for time and cost estimations [18]. Research on forecasting construction time for road projects concluded that the PERT with the fuzzy Delphi method is a precise way to find the best estimation of execution time [19]. The Delphi method is an iterative cycle based on systematically collecting and examining experts' opinions gathered by survey questionnaires. Another study used the fuzzy PERT approach to improve conventional time and cost estimation. It is also investigated that the fuzzy PERT significantly reduced the uncertainties compared to the CPM and PERT [15]. The advantages of using the fuzzy PERT are its ease of use, the direct use of experts' opinions and experiences, and the fact that it also considers experts' credibility.

The applications of project management techniques have been confined to construction-related projects, as seen in the literature. This study builds an approach for the project management of tech startups using well-proven project management techniques. The project management technique that is used in this study was selected through an extensive literature review. The applications of CPM, PERT, and fuzzy logic-based hybrid project management techniques, along with financial aspects, in the literature since 2010 are given in Table 1 below. The fuzzy PERT (FPERT) has been used for various construction and manufacturing-related projects and is recommended by various practitioners, as seen in the literature. However, no such study exists in the literature for using the FPERT to make timeline and budget estimations for tech startups or smartphone application-based startups.

Table 1. Research articles on the applications of project management techniques.

Year	Author	Application
2010	(Pradhan et al., 2010) [68]	Thermal power plant
2012	(Atli et al., 2012) [70]	Aircraft maintenance planning
2013	(Piros et al., 2013) [71]	Project planning of the infrastructure
2013	(Oladeinde et al., 2013) [72]	Project scheduling
2014	(Yang et al., 2014) [73]	Applying fuzzy time distribution in the PERT model
2014	(Y. Liu et al., 2014) [74]	Risk management of construction
2014	(Al Samman et al., 2014) [18]	Fuzzy PERT for project management
2015	(Toljaga-Nikolić et al., 2015) [75]	Fuzzy PERT method in project planning
2015	(Mazlum et al., 2015) [28]	Project management implementation of business
2016	(Shakenova, 2016) [76]	Oil and gas projects
2016	(Kang et al., 2016) [77]	Project management of wind turbine construction
2017	(Lee et al., 2017) [78]	Project management of renewable energy plant
2017	(Guneri et al., 2017) [79]	Project management in healthcare
2017	(Naderpour et al., 2017) [80]	Project time in Iranian gas refineries
2018	(Sangroungrai et al., 2018) [81]	Project management of petrochemical plant
2019	(Hendradewa, 2019) [82]	Schedule risk analysis
2019	(Leelavathy et al., 2019) [83]	Fuzzy project planning and scheduling
2020	(Turan et al., 2020) [84]	Ship repair and maintenance management
2020	(Kurniawan et al., 2020) [85]	Fuzzy critical path method in a housing project
2020	(Akpan et al., 2020) [48]	Modeling building renovation using PERT
2021	(Nemaa et al., 2021) [19]	Forecasting construction time for road projects
2022	(Farida et al., 2022) [86]	Network planning analysis on road construction
2022	(Rezakhani, 2022) [87]	Project scheduling and performance prediction
2022	(Shuaibu et al., 2022) [88]	Building a hydroelectric power station
2023	(Yi, Hong et al., 2023) [89]	Financial capability improves entrepreneurial performance

We aim to fill this research gap and help tech startups using the devised approach from the literature to have the best timeline and budget estimations. This approach will also enable startups to secure seed funding successfully and gain a more systematic view of their startup activities. We also aim to conduct a techno-economic analysis to show startups' profitability and growth potential. Furthermore, sensitivity analysis considers the different scenarios of weighted average cost of capital (WACC) to show how the project behaves economically. The case study of such an online startup, e-Karsaz, is discussed in this paper.

3. Data Collection and Methodology

3.1. Data Collection

Two sources of data are used in this study: primary data and secondary data. The primary data include the interviews conducted by the top management of eight private limited companies in Pakistan. The interviews were conducted at the start of January 2022, and 21 responses were recorded and analyzed. Since this study aims to devise an approach for entrepreneurs in the field of digitized startups that tend to develop an online platform for the ease of the community, the primary data sampled are small. The major reason behind the small sample size is the number of startup owners in Pakistan who are

managing similar projects. We restrict our primary data to only the owners of digitized startups, as they can only provide the best estimates of the activities involved in such startups, along with their budgeting estimates and timeliness. However, the results cannot be generalized and may vary from country to country depending on the macroeconomic factors of those regions. However, the same approach can be used, as the method remains the same irrespective of the area in consideration.

The interviews included open-ended questions about the activities involved in setting up a digitized startup and the estimated completion time of activities and capital expenditures.

The secondary data include historical data for the past five years of labor daily wage rate (under the category of services and sales) in Pakistan. The secondary data were collected from the annual reports of the labor force survey of Pakistan published on the Pakistan Bureau of Statistics (PBS) website. The secondary data forecast the daily labor wages for the next ten years (2022–2031). The details of the companies contacted for primary data are given in Table 2.

Table 2. The primary dataset source for interviews.

Company Name	Affiliations	Experts	Headquarters	Industry
Star Systems and Services (Pvt.), Ltd.	SECP, PEC	CEO, CTO, H.R. Manager, Project Manager	Islamabad	Telecom/Construction/Power
e-Karsaz	SECP, PSEB	CEO, C.M.O., Director Projects, Director Operations,	Islamabad	BPO, Digital Marketing
IoT Center Pakistan (Pvt.), Ltd.	C.I.T., SECP	CTO, C.M.O., Director Finance	Islamabad	Information Technology
Wolf Marketing	PSEB, SECP	CEO, H.R. Manager, Manager Ops	Islamabad	Marketing Agency
Resource Hub (Pvt.), Ltd.	SEP	CEO, CFO, COO.	Lahore	Trading
Paklaunch.com	SEP	Online Community	Islamabad	Online Industrial Experts' Community
EPTech Technologies Pvt., Ltd.	SECP, PSEB	Manager Ops, HR manager	Faisalabad	Information Technology
3G Engineering (Pvt.), Ltd.	SECP, PEC	CEO	Islamabad	Engineering Works

3.2. The Fuzzy PERT

The steps involved in the fuzzy PERT (FPERT) typically include the following steps:

Step 1: "*n*" experts are requested to give their opinions on each activity's completion time and expected budget in the form of fuzzy triangular numbers per their expertise. The opinions are presented in Equation (1):

$$E_{ij}^{m} = \left(x_{ij}^{m}, y_{ij}^{m}, z_{ij}^{m}\right) \quad (1)$$

where

$i = 1, 2, 3 \ldots\ldots \mathrm{n}; j = 1, 2, 3 \ldots p$

In this context, "*i*" represents the index of experts. "*m*" is the number of steps or iterations to be performed. "*j*" shows the activity number. "*E*" is the fuzzy completion time or budget of activity "*j*" at step "*m*" given by expert "*i*" in the form of triangular fuzzy numbers $x_{ij}^{m}, y_{ij}^{m}, z_{ij}^{m}$. These fuzzy triangular numbers show the most optimistic, most likely, and most pessimistic estimates.

Step 2: After obtaining experts' opinions, the responses are categorized for activity "*j*" at step "*m*", as shown in Equation (2):

$$C_j^m = \begin{bmatrix} E_{1j}^m \\ E_{2j}^m \\ . \\ . \\ . \\ E_{Nj}^m \end{bmatrix} \quad j = 1,\ 2\ ,3 \ldots p \tag{2}$$

Step 3: In this step, the experts' opinions are assigned weights, and the mean is calculated for activity "*j*" at iteration "*m*". The weights are assigned to each expert's "*i*" opinion for time and budget estimation of activity "*j*" as per his/her knowledge and experience and represented as "W_{ij}". After assigning the weights and categorization, the mean is calculated as shown in Equation (3):

$$\overline{E_j}^m = \left(\overline{x}_j^m, \overline{y}_j^m, \overline{z}_j^m\right) = \left(\frac{\sum_{i=1}^n W_{ij} x_{ij}^m}{\sum_{i=1}^n W_{ij}}, \frac{\sum_{i=1}^n W_{ij} y_{ij}^m}{\sum_{i=1}^n W_{ij}}, \frac{\sum_{i=1}^n W_{ij} z_{ij}^m}{\sum_{i=1}^n W_{ij}}\right) \tag{3}$$

Step 4: After calculating the mean $\overline{E_j}^m$, if the process is stable as per the defined criteria, the iteration stops, and the resulting mean $\overline{E_j}^m$ is converted into crisp values by defuzzification by Equation (4):

$$CE_j^m = \frac{\overline{x}_j^m + 4\overline{y}_j^m, \overline{z}_j^m}{6} \tag{4}$$

Step 5: The results from Step 4 are sent back to experts for reexamination, and they are asked to provide new estimates based on the given information. Then, according to step 1, the new estimates are given new triangular numbers, as shown in Equation (5):

$$E_{ij}^{m+1} = \left(x_{ij}^{m+1}, y_{ij}^{m+1}, z_{ij}^{m+1}\right) \tag{5}$$

where

i = 1, 2, 3. . . n; j = 1, 2, 3. . . p

After this, a new iteration begins (m + 1). These new estimates are then returned to step 3, which continues until the stopping condition is met.

Stopping criteria

There are two stopping criteria for the FPERT:

The project management team defines the natural number "U" as the maximum number of iterations or steps to be performed. When the number of iterations "*m*" equals "U," the process stops.

The project management team sets a value of "ε" when the difference between the means of experts' opinions $\overline{E_j}^m$ becomes lower than "ε," the process stops.

3.3. The Critical Path Method

$$EF = ES + t \tag{6}$$

The critical path method (CPM) used for project scheduling includes calculations given in Equations (6) and (7), respectively:

$$LF = LS - t \tag{7}$$

Slack

After calculating forward and backward passes, the last step calculates the floating activity or slack associated with each activity. Slack is when an activity can be delayed without affecting the completion time. The critical path is then figured out by finding out that those activities with slack equal zero. The slack is found by Equation (8):

$$Slack = LS - ES = LF - EF \tag{8}$$

3.4. Techno-Economic Analysis

The techno-economic analysis used in this study includes:

Historical data

A weighted moving average computes the historical data. The formula to calculate the weighted moving average is given in Equation (9):

$$X = \frac{\sum_{t=1}^{n} W_t * A_t}{\sum_{t=1}^{n} W_t} \tag{9}$$

where

X = Average, A = Actual value, W = Weight, n = Number of periods

Net present value (*NPV*):

The net present value (*NPV*), which is the difference between the present value (PV) of cash inflows and the present value (PV) of cash outflows for a given time, is calculated by using Equation (10):

$$NPV = \frac{R_t}{(1+i)^t} \tag{10}$$

where R_t = Net cash flow (Inflows and Outflows), i = discount rate, and t = time.

Internal rate of return (*IRR*)

The internal rate of return (*IRR*) for the profitability of potential investments is calculated from Equation (11):

$$IRR = \sum_{t-1}^{t} \frac{C_t}{(1+i)^t} - C_o \tag{11}$$

where

C_t = Cash inflow in time intervals "t"
i = Discount rate
t = Time period
C_o = Initial investment

The benefit-to-cost ratio (*BCR*):

The benefit-to-cost ratio (*BCR*), which shows the relationship between relative costs and benefits of the project, is calculated by Equation (12):

$$BCR = \frac{|P{\cdot}V[Benefits]|}{|P{\cdot}V[Cost]|} \tag{12}$$

4. Analysis and Results

The goal of this study is to create a project management approach to secure early-stage financing or seed funding for digitized startups. The FPERT method finds the best estimations of completion time and budget. The FPERT gives the best estimations by considering the uncertainty factor, and we used this method to analyze the primary data. The experts gave estimates about the duration and budget of the project using linguistic variables in the form of triangular numbers (most optimistic and most pessimistic). After receiving responses, weights were assigned per the expert's knowledge and experience, and the mean was calculated. Experts reexamined the results, and then we converted the fuzzy triangular numbers into crisp values through defuzzification. In this way, the timeline and budget estimations are calculated.

The results obtained using FPERT are reliable as they include the expert's opinions, and uncertainty is partially reduced by expressing the duration of activities and budget as fuzzy numbers. The timeline estimations show that the total duration of the project would be 882 days. Then, project variance is calculated as a sum of squared deviations from the population means (mean of timeline and budget). The project standard deviation (STD) is then calculated using the square root of the project variance, approximately 53 days. Project STD shows a variation of 53 days from the project completion time. Further, using project STD, the probability of completing the project in the required time can also be calculated using the Z-table. The estimations of time are given in Table 3.

Table 3. Timeline estimations using the FPERT.

Timeline Estimations		**The Average Duration in Days**			**The PERT Calculations**	
Activities	**Experts**	**Most Optimistic Time (t_o)**	**Most Likely Time (t_m)**	**Most Pessimistic Time (t_p)**	**Defuzzifying** $\frac{to+4tm+tp}{6}$	**Variance** $\frac{(tp-to)^2}{36}$
1	21	63.48	97.81	138.68	99	157.0844
2	21	54.15	87.11	128.01	88	151.5292
3	21	28.64	47.38	76.74	49	64.2780
4	21	23.43	35.85	51.67	36	22.1422
5	21	33.98	59.24	95.67	61	105.7041
6	21	143.56	234.67	379.88	244	1551.211
7	21	71.55	130.75	216.35	135	582.4177
8	21	27.37	44.81	61.42	45	32.1977
9	21	36.10	64.27	96.41	65	101.0443

Expected Time = 882 days, Variance = 2767.609, Project ST D = 52.6080.

The project's budget estimations or capital expenditure (CAPEX) are calculated similarly, as shown in Table 4. The budget estimations from FPERT are presented in Pakistani rupees (PKR). The sum of the expected budget is around PKR 1.012 billion. The standard deviation is approximately PKR 113.16 million, which means there could be a variation of PKR 113.16 million in the total expected CAPEX.

Table 4. Budget estimations using the FPERT.

Budget Estimations in Million PKR		**The Average Budget Estimations in Million PKR**			**The PERT Calculations**	
Activities	**Experts**	**Most Optimistic Budget (b_o)**	**Most Likely Budget (b_m)**	**Most Pessimistic Budget (b_p)**	**Defuzzifying** $\frac{bo+4bm+bp}{6}$	**Variance** $\frac{(bp-bo)^2}{36}$
1	21	0.52	0.72	0.96	0.72	0.0055
2	21	0.64	0.77	0.96	0.78	0.0028
3	21	2.47	3.68	5.28	3.75	0.2196
4	21	0.65	0.97	1.39	0.99	0.0155
5	21	0.34	0.52	0.73	0.53	0.0043
6	21	1.44	2.12	3.1	2.16	0.0724
7	21	680.6	995.63	1359.58	1003.78	12,805.12

Sum of expected budget = PKR 1012.713 million; project variance = 12,805,044; project STD = 113.16; the critical path method.

After obtaining the best estimations of project duration and capital expenditure (CAPEX), the critical path method (CPM) is applied. The CPM is a valuable tool as it gives the deterministic value of project completion. We used the CPM to find the most

critical tasks. Another advantage of the CPM is that it helps reduce a project's timeline by providing a critical path. The CPM provides a comparison between planned progress and actual scheduling.

Furthermore, it helps to calculate floating activities or slack time to find which activities can be rescheduled without affecting the deadline. The results from the CPM show that activities 3, 4, and 8 (building acquisition, infrastructure, and facility centers, respectively) are off the critical path, which means they can be implemented earlier or later as needed. It will not change the completion of critical activities. The critical path activities 1, 2, 5, 6, 7, and 9 must be completed in their estimated time because a delay of one day would result in the overall delay of the entire project and incur added costs. Using the CPM, the expected 822 days are now reduced to 692. The result of the CPM also shows its significance, as it helps to schedule the projects effectively. After applying the critical path method (CPM), the results are given in Table 5.

Table 5. The critical path method.

Activities	Predecessor	Expected Time (Days)	Critical Activity
1. Business model	-	99	Yes
2. Mock App	1	88	Yes
3. Building Acquisition	1	49	No
4. Infrastructure	3	36	No
5. Hiring	3,4	61	Yes
6. App and web development	2,5	244	Yes
7. Market searching	5,6	135	Yes
8. Facility centers	5,7	45	No
9. Onboarding	5,7,8	65	Yes

Sum of expected time = 692.

4.1. The Techno-Economic Analysis

After obtaining the timeline and budget estimations from FPERT and setting up the project schedule from the CPM, we conducted a techno-economic analysis (TEA) to find the project's profitability and growth potential. The TEA is used to analyze the economic performance of projects. TEA helps determine the economic viability of technology-related projects. TEA shows overall economic viability using per unit or service cost estimations, revenues, profit margins, return on investments, and capital and operating expenses. TEA also helps potential investors or venture capital firms make investment decisions. We used TEA as an economic viability tool to find out this project's growth potential and profitability. The budget estimations for CAPEX are already calculated from the FPERT. The operating expenses (OPEX) are calculated by the data provided by e-Karsaz, including per-annum salaries, office expenses per annum, the expected annual marketing budget, and other miscellaneous expenses. The OPEX is assumed to start right after the launch of e-Karsaz, which is expected to be operational in December 2022. The operating expenses in Pakistani rupees (PKR) are given in Table 6.

Table 6. Operating expenses.

Expenses Category	Expenses in PKR per Annum
Marketing budget	PKR 1,003,784,722
Salaries	PKR 108,060,000
Rent and Misc.	PKR 24,600,000
Total operating expenses per annum	PKR 1,136,444,722

4.2. Revenue Model

The revenue model spans over ten years, as such types of capital-intensive projects have a payback period spanning over the years. The labor wage rate (under the category of services and sales) is taken from the historical data of the past five years (2014–2018) from the annual labor force survey reports of the Pakistan Bureau of Statistics [90]. The projections for the next ten years are calculated using a three-year weighted moving average from past data. The forecasting of daily labor wages for ten years (2022–2031) is given in Figure 1.

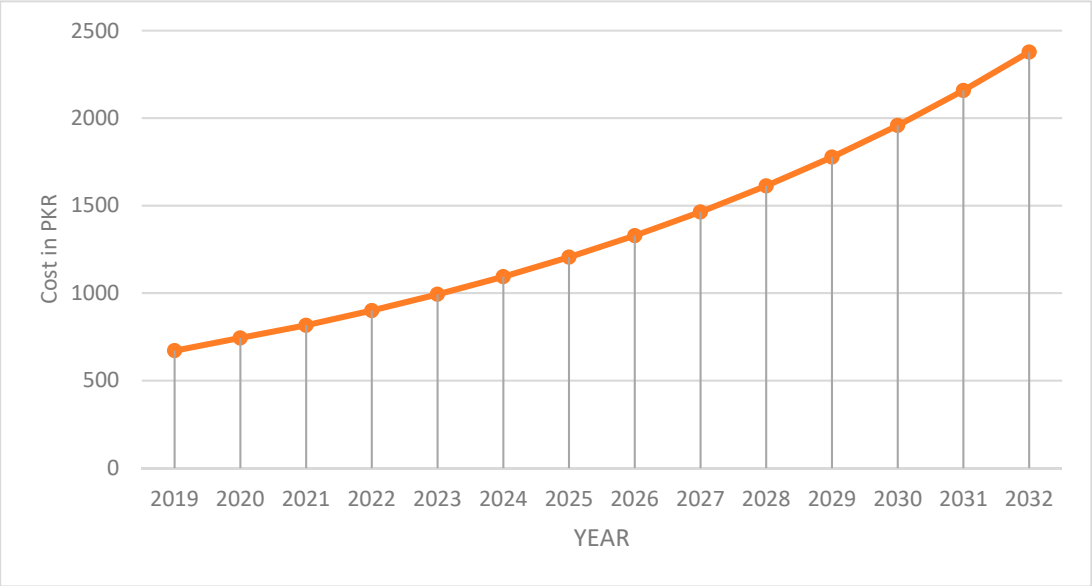

Figure 1. Historical data for annual averages of daily labor wages (2022–2031).

The historical data in Figure 1 are then used to figure out yearly cash outflows for ten years.

4.3. Sensitivity Analysis

After processing all data, including CAPEX, OPEX, and annual averages of daily labor wages, yearly net cash flows are calculated. The aim was to figure out this project's net present value (NPV), which presents each cash outflow's value for a given time. The NPV is an absolute measure of profitability that shows the expected outcome of an investment. It is an evaluation technique that helps investors make investment decisions. For calculating NPV, we used the weighted average cost of capital (WACC), which finds potential investors' required rate of return. WACC includes the cost of each capital source, whether preferred stock, debt, or an ordinary share, weighted by its percentage contribution to overall capital and their sum. In our study, we used four values of WACC ranging from 10% to 20% since the startup, e-Karsaz, is looking for early-stage financing. We used different values of WACC to check the impact on NPVs and assess whether the project is economically viable. The ranges of WACC are taken from the project management team of e-Karsaz. The NPVs of the project by using WACC ranges (10, 14, 16, and 20%, respectively) are significant, which shows the project is economically viable and profitable, as given in Table 6. We also calculated the internal rate of return (IRR), which shows the percentage value of the project's profitability. The IRR helps decision-makers check the economic viability of a project by showing a single value in percentage. In our study, the IRR of the project was 92%, which is quite significant and shows that the project is economically viable. After this, the benefit-to-cost ratio (BCR) is also calculated to summarize the relationship between capital expenses, yearly operating expenses, and yearly revenues. In our study, the BCR of

the project is around ten, which shows that this project is highly profitable. The values of NPV, IRR, and BCR are given in Table 7.

Table 7. The economic viability.

OPEX (yearly)	PKR 1.136 billion	WACC	NPV
CAPEX (one-time)	PKR 1.012 billion	10%	3,577,384,141
IRR	92%	14%	2,369,820,018
BCR	10.108	16%	1,897,056,223
		20%	1,145,715,068

5. Conclusions

The advancements in the technological era have made a paradigm shift in modes of doing business. Today, firms are adopting online modes to satisfy the needs of their customers. The online marketplace has proved to be a significant breakthrough in this century. Due to this market change, various smartphone-app-based startups or tech startups in Pakistan intend to use online platforms to serve the community. These startups need early-stage financing to commercialize their ideas and show a startup's growth potential and profitability. This study aimed to create an approach for the project management of digitized startups using project management techniques (FPERT and CPM) that were confined only to construction and manufacturing-related projects in the past. This study uses FPERT to create the best timeline estimates and budget estimations for such a digitized startup. The case study of e-Karsaz is discussed in this paper, and the expected time and budget are calculated. The project schedule using the critical path method (CPM) is used to schedule the project's critical activities. We conducted techno-economic and sensitivity analyses to show economic viability, including the NPV, IRR, and BCR. From this study, we concluded that having the best estimates of timeline and budget and a techno-economic analysis can make a startup stand out among others to secure seed funding. It is also recommended that such startups follow the approach used in this study to show their profitability and attract potential investors. Relying only on an idea about a startup without having the best estimates, scheduling, traction, and economic viability can make a brilliant idea a complete waste.

Although the approach proposed in this study is novel and has original value, it is applied to a startup based in Pakistan. The approach presented in this paper has yet to be used for the project management of smartphone-app-based startups; therefore, its results cannot be generalized. However, the approach can be used to set up other startups.

Creating new businesses, especially technology-related ones, is complex and challenging. Entrepreneurs need help to make accurate estimates of timelines and capital expenditures. Project management tools and utilities are often expensive. Secure early-stage financing for a business idea requires making a timeline of the entire project along with budget estimates. The approach presented in this study has been implemented at the startup e-Karsaz. More research is needed to validate the proposed approach by performing comparative analysis and implementation in other startups. There is also a need to integrate other project management techniques with the proposed approach in this study to improve the accuracy of the results.

6. Limitations

The primary goal of this study is to devise an approach through which digitized/technology-based/online startup project management can be conducted more systematically and well-established. The techno-economic analysis complements the study by enabling startup owners to display their business ideas more compellingly to secure early-stage financing for their startups. Whether it is a traditional construction-based project or an advanced digitized startup, project management is crucial for project completion within

the stipulated period for efficient use of resources. The approach presented in this study can be used for the analysis of digitized startups by using the lens of project management; however, its results cannot be generalized. The reason is that the primary data used in this study are small. The reason already mentioned is that we restricted our sample size to the entrepreneurs of similar startups. Having opinions from experts who have gone through every single activity involved in completing such startups gives them more accurate results. Therefore, the results may vary from one region to another depending on the macroeconomic conditions and other applicable factors of that region. Furthermore, this study also opens the opportunity to explore more how project management can be used for modern-era startups and how entrepreneurs can better display their business ideas and pitch them to prospective investors to convert them into a successful reality.

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